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SUBJECT	PHYSICAL SCIENCES PAST QUESTIONS PAPERS AND MEMOS PAPER 1 AND EXAMINATION GUIDELINE
GRADE	12
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES

EXAMINATION GUIDELINES

GRADE 12

2021

These guidelines consist of 36 pages.

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1. INTRODUCTION

The Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences outlines the nature and purpose of the subject Physical Sciences. This guides the philosophy underlying the teaching and assessment of the subject in Grade 12.

The purpose of these Examination Guidelines is to:

- Provide clarity on the depth and scope of the content to be assessed in the Grade 12 National Senior Certificate (NSC) Examination in Physical Sciences.
- Assist teachers to adequately prepare learners for the examinations.

This document deals with the final Grade 12 external examinations. It does not deal in any depth with the school-based assessment (SBA).

These Examination Guidelines should be read in conjunction with:

- The *National Curriculum Statement (NCS) Curriculum and Assessment Policy Statement (CAPS): Physical Sciences*
- The National Protocol of Assessment: *An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding the National Protocol for Assessment (Grades R–12)*
- The national policy pertaining to the programme and promotion requirements of the National Curriculum Statement, Grades R–12

2. ASSESSMENT IN GRADE 12

2.1 Format of question papers

Paper	Type of questions	Duration	Total	Date	Marking
1	Physics 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	External
2	Chemistry 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	External

2.2 Numbering and sequence of questions

QUESTION 1: Multiple-choice questions

Subquestions numbered 1.1 to 1.10 (2 marks each)

Questions may cover all cognitive levels and will be arranged according to topics.

QUESTION 2 onwards:

Longer questions assessing skills and knowledge across cognitive levels. Numbering starts with QUESTION 2 and will be continuous. Subquestions will be numbered by two digits, e.g. 2.1, 2.2. Numbering is restricted to a maximum of three digits, e.g. 2.1.1, 2.1.2.

2.3 Information sheets

The separate information sheets for Paper 1 and Paper 2 are included in this document.

2.4 Weighting of cognitive levels

Papers 1 and 2 will include questions across four cognitive levels. The distribution of cognitive levels in Physics and Chemistry papers is given below.

Cognitive level	Description	Paper 1 (Physics)	Paper 2 (Chemistry)
1	Remembering (Recall)	15%	15%
2	Understanding (Comprehension)	35%	40%
3	Applying and analysing	40%	35%
4	Evaluating and creating (synthesis)	10%	10%

2.5 Weighting of prescribed content

Paper 1: Physics Focus							
Content	Marks	Total	Duration	Weighting of cognitive levels			
Mechanics	65	150 marks	3 hours	15	35	40	10
Waves, sound and light	15						
Electricity and magnetism	55						
Matter and materials	15						

Paper 2: Chemistry Focus							
Content	Marks	Total	Duration	Weighting of cognitive levels			
Chemical change	92	150 marks	3 hours	15	40	35	10
Matter and materials	58						

2.6 Skills in Physical Sciences

- Identify and question phenomena:
 - Formulate an investigative question.
 - List all possible variables.
 - Formulate a testable hypothesis.
- Design/Plan of an investigation:
 - Identify variables (dependent, independent and controlled variables).
 - List appropriate apparatus.
 - Plan the sequence of steps which should include, amongst others:
 - The need for more than one trial to minimise experimental errors.
 - Identify safety precautions that need to be taken.
 - Identify conditions that ensure a fair test.
 - Set an appropriate control.

- Graphs:
 - Draw accurate graphs from given data/information.
 - Interpret graphs.
 - Draw sketch graphs from given information.
- Results:
 - Identify patterns/relationships in data.
 - Interpret results.
- Conclusions:
 - Draw conclusions from given information, e.g. tables, graphs.
 - Evaluate the validity of conclusions.
- Calculations:
 - Solve problems using two or more different calculations (multistep calculations).
- Descriptions:
 - Explain/Describe/Argue the validity of a statement/event using scientific principles.

2.7 Prior knowledge from Grades 10 and 11

All skills and application of knowledge learnt in Grades 10 and 11 are applicable to assessment in Grade 12. In addition to content from Grades 10 and 11 included under examinable content for Grade 12, skills and knowledge from Grades 10 and 11 that may be assessed in Grade 12 include the following:

- The use of equations of motion in solving problems dealing with momentum, vertical projectile motion, work, energy and power
- Sound waves and properties of sound
- Electromagnetism

NOTE: Although there will be no direct questions about these aspects, applications thereof can be assessed.

3. ELABORATION OF THE CONTENT

The final examination in Physical Sciences will cover the topics outlined below.

3.1 Paper 1: Physics

Newton's Laws and Application of Newton's Laws

(This section must be read in conjunction with the CAPS, p. 62–66.)

Different kinds of forces: weight, normal force, frictional force, applied force (push, pull), tension (strings or cables)

- Define *normal force*, N , as the force or the component of a force which a surface exerts on an object with which it is in contact, and which is perpendicular to the surface.
- Define *frictional force*, f , as the force that opposes the motion of an object and which acts parallel to the surface.
Define *static frictional force*, f_s , as the force that opposes the tendency of motion of a stationary object relative to a surface.
Define *kinetic frictional force*, f_k , as the force that opposes the motion of a moving object relative to a surface.
Know that a frictional force:
 - Is proportional to the normal force
 - Is independent of the area of contact
 - Is independent of the velocity of motion
- Solve problems using $f_s^{\max} = \mu_s N$ where $f_s^{\max}$ is the maximum static frictional force and μ_s is the coefficient of static friction.

NOTE:

- If a force, F , applied to a body parallel to the surface does not cause the object to move, F is equal in magnitude to the static frictional force.
- The static frictional force is a maximum ($f_s^{\max}$) just before the object starts to move across the surface.
- If the applied force exceeds $f_s^{\max}$, a resultant net force accelerates the object.
- Solve problems using $f_k = \mu_k N$, where f_k is the kinetic frictional force and μ_k the coefficient of kinetic friction.

Force diagrams, free-body diagrams

- Draw force diagrams.
- Draw free-body diagrams. (This is a diagram that shows the relative magnitudes and directions of forces acting on a body/particle that has been isolated from its surroundings.)
- Resolve two-dimensional forces (such as the weight of an object on an inclined plane) into its parallel (x) and perpendicular (y) components.
- Determine the resultant or net force of two or more forces.

Newton's first, second and third laws of motion

- State Newton's first law of motion: A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force acts on it.
- Discuss why it is important to wear seatbelts using Newton's first law of motion.
- State Newton's second law of motion: When a net force acts on an object, the object will accelerate in the direction of the force and the acceleration is directly proportional to the force and inversely proportional to the mass of the object.
- Draw force diagrams and free-body diagrams for objects that are in equilibrium or accelerating.

- Apply Newton's laws to a variety of equilibrium and non-equilibrium problems including:
 - A single object:
 - Moving on a horizontal plane with or without friction
 - Moving on an inclined plane with and without friction
 - Moving in the vertical plane (lifts, rockets, etc.)
 - Two-body systems (joined by a light inextensible string) by applying Newton's laws of motion separately to EACH of the bodies:
 - Both on a flat horizontal plane with and without friction
 - One on a horizontal plane with and without friction, and a second hanging vertically from a string over a frictionless pulley
 - Both on an inclined plane with or without friction
 - Both hanging vertically from a string over a frictionless pulley
- State Newton's third law of motion: When object A exerts a force on object B, object B SIMULTANEOUSLY exerts an oppositely directed force of equal magnitude on object A.
- Identify action-reaction pairs.
- List the properties of action-reaction pairs.

Newton's Law of Universal Gravitation

- State Newton's Law of Universal Gravitation: Each body in the universe attracts every other body with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.
- Solve problems using $F = \frac{Gm_1m_2}{r^2}$.
- Describe *weight* as the gravitational force the Earth exerts on any object on or near its surface.
- Calculate weight using the expression $w = mg$.
- Calculate the weight of an object on other planets with different values of gravitational acceleration.
- Distinguish between *mass* and *weight*.
- Explain *weightlessness*.

Momentum and Impulse

(This section must be read in conjunction with the CAPS, p. 99–101.)

Momentum

- Define *momentum* as the product of an object's mass and its velocity.
- Describe *linear momentum* as a vector quantity with the same direction as the velocity of the object.
- Calculate the momentum of a moving object using $p = mv$.
- Describe the vector nature of momentum and illustrate it with some simple examples.
- Draw vector diagrams to illustrate the relationship between the initial momentum, the final momentum and the change in momentum for each of the cases above.

Newton's second law in terms of momentum

- State Newton's second law of motion in terms of momentum: The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force.
- Express Newton's second law of motion in symbols: $F_{\text{net}} = \frac{\Delta p}{\Delta t}$
- Explain the relationship between net force and change in momentum for a variety of motions.
- Calculate the change in momentum when a resultant/net force acts on an object and its velocity:
 - Increases in the direction of motion, e.g. 2nd stage rocket engine fires
 - Decreases, e.g. brakes are applied
 - Reverses its direction of motion, e.g. a soccer ball kicked back in the direction it came from

Impulse

- Define *impulse* as the product of the resultant/net force acting on an object and the time the net force acts on the object.
- Use the impulse-momentum theorem, $F_{\text{net}}\Delta t = m\Delta v$, to calculate the resultant/net force exerted, the time for which the force is applied and the change in momentum for a variety of situations involving the motion of an object in one dimension.
- Explain how the concept of impulse applies to safety considerations in everyday life, e.g. airbags, seatbelts and arrestor beds.

Conservation of momentum and elastic and inelastic collisions

- Explain what is meant by a *system* (in Physics).
- Explain (when working with systems) what is meant by *internal* and *external forces*.
- Explain what is meant by *an isolated system* (in Physics), i.e. a system on which the net external force is zero.
(An isolated system excludes external forces that originate outside the colliding bodies, e.g. friction. Only internal forces, e.g. contact forces between the colliding objects, are considered.)
- State the principle of conservation of linear momentum: The total linear momentum of an isolated system remains constant (is conserved).
- Apply the conservation of momentum to the collision of two objects moving in one dimension (along a straight line) with the aid of an appropriate sign convention.
- Distinguish between *elastic collisions* and *inelastic collisions* by calculation.

Vertical Projectile Motion in One Dimension (1D)

(This section must be read in conjunction with the CAPS, p. 102–103.)

- Explain what is meant by a *projectile*, i.e. an object which has been given an initial velocity and then it moves under the influence of the gravitational force only.
- Define *free fall* as motion during which the only force acting on an object is the gravitational force.
- Use equations of motion to determine the position, velocity and displacement of a projectile at any given time.
- Sketch position versus time (x vs. t), velocity versus time (v vs. t) and acceleration versus time (a vs. t) graphs for:
 - A free-falling object
 - An object thrown vertically upwards
 - An object thrown vertically downwards
 - Bouncing objects (restricted to balls)
- For a given x vs. t , v vs. t or a vs. t graph, determine:
 - Position
 - Displacement
 - Velocity or acceleration at any time t
- For a given x vs. t , v vs. t or a vs. t graph, describe the motion of the object:
 - Bouncing
 - Thrown vertically upwards
 - Thrown vertically downward

Work, Energy and Power

(This section must be read in conjunction with the CAPS, p. 117–120.)

Work

- Define the work done on an object by a constant force F as $F \Delta x \cos \theta$, where F is the magnitude of the force, Δx the magnitude of the displacement and θ the angle between the force and the displacement. (Work is done by a force – the use of the term 'work is done against a force', e.g. work done against friction, must be avoided.)
- Draw a force diagram and free-body diagrams.
- Calculate the net work done on an object.
- Distinguish between *positive net work done* and *negative net work done* on the system.

Work-energy theorem

- State the work-energy theorem: The work done on an object by a net force is equal to the change in the object's kinetic energy OR the work done on an object by a net force is equal to the change in the object's kinetic energy.
In symbols: $W_{\text{net}} = \Delta K = K_f - K_i$
- Apply the work-energy theorem to objects on horizontal, vertical and inclined planes (for both frictionless and rough surfaces).

Conservation of energy with non-conservative forces present

- Define a *conservative force* as a force for which the work done in moving an object between two points is independent of the path taken. Examples are gravitational force, the elastic force in a spring and electrostatic forces (coulombic forces).
- Define a *non-conservative force* as a force for which the work done in moving an object between two points depends on the path taken. Examples are frictional force, air resistance, tension in a chord, etc.
- State the principle of conservation of mechanical energy: The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant. **NOTE:** A system is isolated when the net external force (excluding the gravitational force) acting on the system is zero.
- Solve conservation of energy problems using the equation: $W_{nc} = \Delta E_k + \Delta E_p$
- Use the relationship above to show that in the absence of non-conservative forces, mechanical energy is conserved.

Power

- Define *power* as the rate at which work is done or energy is expended.
In symbols: $P = \frac{W}{\Delta t}$
- Calculate the power involved when work is done.
- Perform calculations using $P_{ave} = Fv_{ave}$ when an object moves at a constant speed along a rough horizontal surface or a rough inclined plane.
- Calculate the power output for a pump lifting a mass (e.g. lifting water through a height at constant speed).

Doppler Effect (relative motion between source and observer)

(This section must be read in conjunction with the CAPS, p. 121–122.)

With sound and ultrasound

- State the Doppler effect as the change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation.
- Explain (using appropriate illustrations) the change in pitch observed when a source moves toward or away from a listener.
- Solve problems using the equation $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ when EITHER the source OR the listener is moving.
- State applications of the Doppler effect.

With light – red shifts in the universe (evidence for the expanding universe)

- Explain red shifts.
- Use the Doppler effect to explain why we conclude that the universe is expanding.

Electrostatics

(This section must be read in conjunction with the CAPS, p. 84–85.)

Coulomb's law

- State Coulomb's law: The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them:
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in one dimension (1D) (restrict to three charges).
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in two dimensions (2D) – for three charges in a right-angled formation (limit to charges at the 'vertices of a right-angled triangle').

Electric field

- Describe an *electric field* as a region of space in which an electric charge experiences a force. The direction of the electric field at a point is the direction that a positive test charge would move if placed at that point.
 - Draw electric field lines for the following configurations:
 - A single point charge
 - Two point charges (one negative, one positive OR both positive OR both negative)
 - A charged sphere
- NOTE:** Restrict to situations in which the charges are identical in magnitude.
- Define *electric field at a point*: The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. In symbols: $E = \frac{F}{q}$
 - Solve problems using the equation $E = \frac{F}{q}$.
 - Calculate the electric field at a point due to a number of point charges, using the equation $E = \frac{kQ}{r^2}$ to determine the contribution to the field due to each charge. Restrict to three charges in a straight line.

Electric Circuits

(This section must be read in conjunction with the CAPS, p. 88–89 & 121.)

Ohm's law

- State Ohm's law in words: The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
- Determine the relationship between current, potential difference and resistance at constant temperature using a simple circuit.
- State the difference between ohmic conductors and non-ohmic conductors and give an example of each.
- Solve problems using $R = \frac{V}{I}$ for series and parallel circuits (maximum four resistors).

Power, energy

- Define *power* as the rate at which work is done.
- Solve problems using $P = \frac{W}{\Delta t}$.
- Solve problems using $P = VI$, $P = I^2R$ or $P = \frac{V^2}{R}$.
- Solve circuit problems involving the concepts of power and electrical energy.
- Deduce that the kilowatt hour (kWh) refers to the use of 1 kilowatt of electricity for 1 hour.
- Calculate the cost of electricity usage given the power specifications of the appliances used, the duration and the cost of 1 kWh.

Internal resistance, series and parallel networks

- Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel (maximum four resistors excluding internal resistance).
- Define the term *emf* as the maximum energy provided by a battery per unit charge passing through it.
- Solve circuit problems using $\varepsilon = V_{\text{load}} + V_{\text{internal resistance}}$ or $\varepsilon = IR_{\text{ext}} + Ir$.
- Solve circuit problems, with internal resistance, involving series-parallel networks of resistors (maximum four resistors).

Electrodynamics

(This section must be read in conjunction with the CAPS, p. 130–131.)

Electrical machines (generators, motors)

- State the energy conversion in generators.
- Use the principle of electromagnetic induction to explain how a generator works.
- Explain the functions of the components of an AC and a DC generator.
- State examples of the uses of AC and DC generators.
- State the energy conversion in motors.
- Use the motor effect to explain how a motor works.
- Explain the functions of the components of a motor.
- State examples of the use of motors.

Alternating current

- State the advantages of alternating current over direct current.
- Sketch graphs of voltage versus time and current versus time for an AC circuit.
- Define the term *rms* for an alternating voltage/current.
The rms potential difference is the AC potential difference which dissipates/produces the same amount of energy as an equivalent DC potential difference.
The rms current is the alternating current which dissipates/produces the same amount of energy as an equivalent direct current (DC).
- Solve problems using $I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$, $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$.
- Solve problems using $P_{\text{ave}} = I_{\text{rms}} V_{\text{rms}} = \frac{1}{2} I_{\text{max}} V_{\text{max}}$ (for a purely resistive circuit),
 $P_{\text{ave}} = I_{\text{rms}}^2 R$ and $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R}$.

Optical Phenomena and Properties of Materials

(This section must be read in conjunction with the CAPS, p. 132–133.)

Photo-electric effect

- Describe the *photoelectric effect* as the process whereby electrons are ejected from a metal surface when light of suitable frequency is incident on that surface.
- State the significance of the photoelectric effect.
- Define *threshold frequency*, f_0 , as the minimum frequency of light needed to emit electrons from a certain metal surface.
- Define *work function*, W_0 , as the minimum energy that an electron in the metal needs to be emitted from the metal surface.
- Perform calculations using the photoelectric equation:
 $E = W_0 + E_{k(\text{max})}$, where $E = hf$ and $W_0 = hf_0$ and $E_{k(\text{max})} = \frac{1}{2} m v_{\text{max}}^2$
- Explain the effect of intensity and frequency on the photoelectric effect.
- State that the photoelectric effect demonstrates the particle nature of light.

Emission and absorption spectra

- Explain the *formation of atomic spectra* by referring to energy transition.
- Explain the difference between *atomic absorption* and *emission spectra*.
An atomic absorption spectrum is formed when certain frequencies of electromagnetic radiation passing through a substance is absorbed.
For example, when light passes through a cold gas, atoms in the gas absorb characteristic frequencies of the light and the spectrum observed is a continuous spectrum with dark lines where characteristic frequencies of light were removed. The frequencies of the absorption lines are unique to the type of atoms in the gas.
An atomic emission spectrum is formed when certain frequencies of electromagnetic radiation are emitted due to an atom making a transition from a higher energy state to a lower energy state.
For example, atoms in a hot gas emit light at characteristic frequencies. The spectrum observed is a line spectrum with only a few coloured lines of frequencies unique to the type of atom that is producing the emission lines.

3.2 Paper 2: Chemistry

Representing Chemical Change

(This section must be read in conjunction with the CAPS, p. 37.)

Balanced chemical equations

- Write and balance chemical equations.
- Interpret balanced reaction equations in terms of:
 - Conservation of atoms
 - Conservation of mass (use relative atomic masses)

Quantitative Aspects of Chemical Change

(This section must be read in conjunction with the CAPS, p. 82.)

Molar volume of gases

- 1 mole of any gas occupies 22,4 dm³ at 0 °C (273 K) and 1 atmosphere (101,3 kPa).

Volume relationships in gaseous reactions

- Interpret balanced equations in terms of volume relationships for gases, i.e. under the same conditions of temperature and pressure, equal number of moles of all gases occupy the same volume.

Concentration of solutions

- Calculate the molar concentration of a solution.

More complex stoichiometric calculations

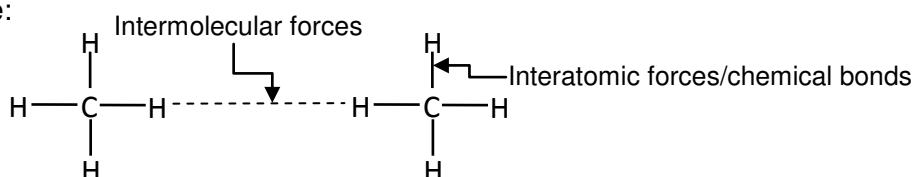
- Determine the empirical formula and molecular formula of compounds.
- Determine the percentage yield of a chemical reaction.
- Determine percentage purity or percentage composition, e.g. the percentage CaCO₃ in an impure sample of seashells.
- Perform stoichiometric calculations based on balanced equations.
- Perform stoichiometric calculations based on balanced equations that may include limiting reagents.

Intermolecular Forces

(This section must be read in conjunction with the CAPS, p. 71–73.)

Intermolecular and interatomic forces (chemical bonds)

- Name and explain the different intermolecular forces (Van der Waal's forces):
 - Dipole-dipole forces:
Forces between two polar molecules
 - Induced dipole forces or London forces:
Forces between non-polar molecules
 - Hydrogen bonding:
Forces between molecules in which hydrogen is covalently bonded to nitrogen, oxygen or fluorine – a special case of dipole-dipole forces
- Describe the difference between *intermolecular forces* and *interatomic forces* (*intramolecular forces*) using a diagram of a group of small molecules; and in words.
Example:



- State the relationship between intermolecular forces and molecular size. For non-polar molecules, the strength of induced dipole forces increases with molecular size.

- Explain the effect of intermolecular forces on boiling point, melting point and vapour pressure.
Boiling point:
The temperature at which the vapour pressure of a substance equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.
Melting point:
The temperature at which the solid and liquid phases of a substance are at equilibrium. The stronger the intermolecular forces, the higher the melting point.
Vapour pressure:
The pressure exerted by a vapour at equilibrium with its liquid in a closed system. The stronger the intermolecular forces, the lower the vapour pressure.

Organic Molecules

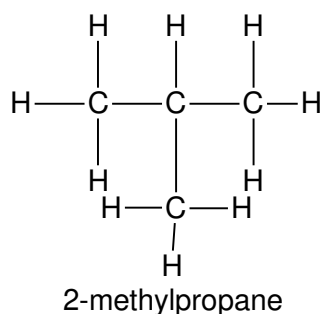
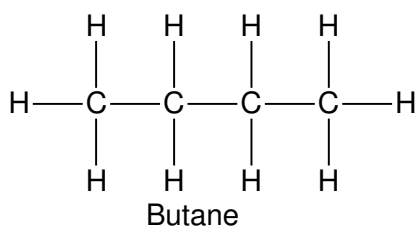
(This section must be read in conjunction with the CAPS, p. 104–116.)

- Define organic molecules as molecules containing carbon atoms.
- Organic molecular structures – functional groups, saturated and unsaturated structures, isomers**
- Write down condensed structural formulae, structural formulae, molecular formulae and IUPAC names (up to 8 carbon atoms) for:
 - Alkanes (no ring structures)
 - Alkenes (no ring structures)
 - Alkynes
 - Halo-alkanes (primary, secondary and tertiary haloalkanes; no ring structures)
 - Alcohols (primary, secondary and tertiary alcohols)
 - Carboxylic acids
 - Esters
 - Aldehydes
 - Ketones
 - Know the following definitions/terms:
 - Molecular formula: A chemical formula that indicates the element and numbers of each of the atoms in a molecule.
Example: C_4H_8O
 - Structural formula: A structural formula of a compound shows which atoms are attached to which within the molecule. Atoms are represented by their chemical symbols and lines are used to represent ALL the bonds that hold the atoms together.
Example:
$$\begin{array}{ccccccc} & H & H & O & H & & \\ & | & | & || & | & & \\ H & -C & -C & -C & -C & -H \\ & | & | & & | & & \\ & H & H & & H & & \end{array}$$
 - Condensed structural formula: This notation shows the way in which atoms are bonded together in the molecule, but DOES NOT SHOW ALL bond lines.
Example:
$$CH_3CH_2COCH_3 \quad \text{OR} \quad \begin{array}{c} O \\ || \\ CH_3CH_2CCH_3 \end{array}$$
 - Hydrocarbon: Organic compounds that consist of hydrogen and carbon only.
 - Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a CH_2 group

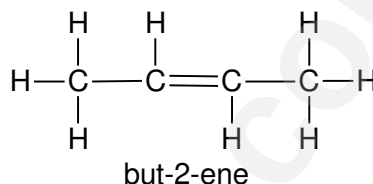
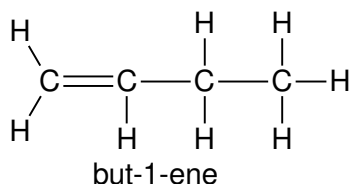
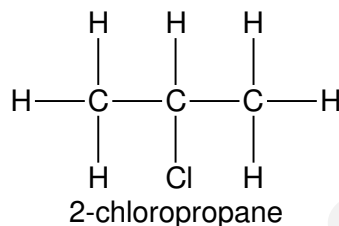
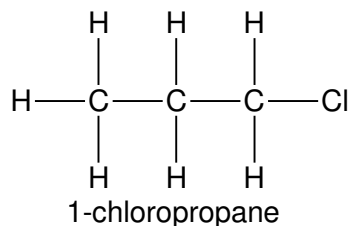
- Saturated compounds: Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains
- Unsaturated compounds: Compounds with one or more multiple bonds between C atoms in their hydrocarbon chains
- Functional group: A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds

Homologous series	Structure of functional group	
	Structure	Name/Description
Alkanes	$\begin{array}{c} & \\ -C & -C- \\ & \end{array}$	Only C-H and C-C single bonds
Alkenes	$\begin{array}{c} \diagup & \diagdown \\ C & =C \\ \diagdown & \diagup \end{array}$	Carbon-carbon double bond
Alkynes	$-C \equiv C-$	Carbon-carbon triple bond
Haloalkanes	$\begin{array}{c} \\ -C-X \\ \\ (X = F, Cl, Br, I) \end{array}$	Halogen atom bonded to a C atom in an alkane
Alcohols	$\begin{array}{c} \\ -C-O-H \\ \end{array}$	Hydroxyl group bonded to a saturated C atom
Aldehydes	$\begin{array}{c} O \\ \\ -C-H \end{array}$	Formyl group
Ketones	$\begin{array}{c} & O & \\ & & \\ -C & -C & -C- \\ & & \end{array}$	Carbonyl group bonded to two C atoms
Carboxylic acids	$\begin{array}{c} O \\ \\ -C-O-H \end{array}$	Carboxyl group
Esters	$\begin{array}{c} O \\ \\ -C-O-C- \\ & \end{array}$	-

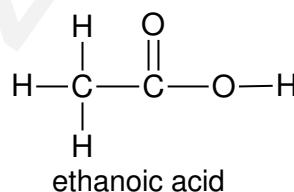
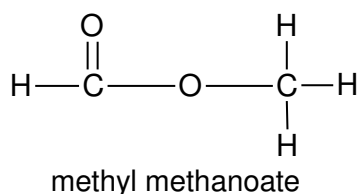
- Structural isomer: Organic molecules with the same molecular formula, but different structural formulae
- Identify compounds (up to 8 carbon atoms) that are saturated, unsaturated and are structural isomers.
- Restrict structural isomers to chain isomers, positional isomers and functional isomers.
 - Chain isomers: Same molecular formula, but different types of chains, e.g. butane and 2-methylpropane



- Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-chloropropane and 2-chloropropane or but-2-ene and but-1-ene



- Functional isomers: Same molecular formula, but different functional groups, e.g. methyl methanoate and ethanoic acid



IUPAC naming and formulae for compounds in the homologous series above

- Write down the IUPAC name when given the structural formula or condensed structural formula.
- Write down the structural formula when given the IUPAC name or molecular formula.
- Compounds must be restricted to one functional group per compound (except haloalkanes).
- Haloalkanes restricted to two functional groups per compound.
- Alkyl substituents (methyl- and ethyl- only) restricted to a maximum of THREE on the parent chain.
- When naming haloalkanes:
 - Halogen substituents do not get preference over alkyl groups.
 - Numbering should start from the end nearest to the first substituent.
 - When substituents, e.g. Br and Cl or Cl and methyl, have the same number when numbered from different ends of chain, preference is given to alphabetical order, e.g. bromo- over chloro-; chloro- over methyl-.
- When writing IUPAC names, substituents are written alphabetically namely bromo, chloro, ethyl, methyl. Ignore prefixes di and tri.

Structure and physical properties (boiling point, melting point, vapour pressure) relationships

- For a given example (from the above functional groups), explain the relationship between physical properties and:
 - Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces
 - Type of functional groups
 - Chain length
 - Branched chains

Oxidation of alkanes

- State the use of alkanes as fuels.
- Write down an equation for the combustion of an alkane in excess oxygen.

Esterification

- Write down an equation, using structural formulae or condensed structural formulae, for the formation of an ester.
- Name the alcohol and carboxylic acid used and the ester formed.
- Write down reaction conditions for esterification.

Substitution, addition and elimination reactions

- Identify reactions as elimination, substitution or addition.
- Write down, using structural formulae or condensed structural formulae, equations and reaction conditions for the following addition reactions of alkenes:
 - Hydrohalogenation:
The addition of a hydrogen halide to an alkene
 - Halogenation:
The reaction of a halogen (Br_2 , Cl_2) with a compound
 - Hydration:
The addition of water to a compound
 - Hydrogenation:
The addition of hydrogen to an alkene
- Identify major and minor products in the above addition reactions.
- Write down, using structural formulae or condensed structural formulae, equations and reaction conditions for the following elimination reactions:
 - Dehydrohalogenation of haloalkanes:
The elimination of hydrogen and a halogen from a haloalkane
 - Dehydration of alcohols:
Elimination of water from an alcohol
 - Cracking of alkanes:
The chemical process in which longer chain hydrocarbon molecules are broken down to shorter more useful molecules.
- Identify major and minor products in the above elimination reactions.
- Write down, using structural formulae or condensed structural formulae, equations and reaction conditions for the following substitution reactions:
 - Hydrolysis of haloalkanes
Hydrolysis: The reaction of a compound with water
 - Reactions of HX ($\text{X} = \text{Cl}, \text{Br}$) with alcohols to produce haloalkanes
 - Halogenation of alkanes
The reaction of a halogen (Br_2 , Cl_2) with a compound
- Distinguish between *saturated* and *unsaturated hydrocarbons* using bromine water.

Energy and Change

(This section must be read in conjunction with the CAPS, p. 90–91.)

Energy changes in reactions related to bond energy changes

- Define heat of reaction (ΔH) as the energy absorbed or released in a chemical reaction.
- Define *exothermic reactions* as reactions that release energy.
- Define *endothermic reactions* as reactions that absorb energy.
- Classify (with reason) reactions as exothermic or endothermic.

Exothermic and endothermic reactions

- State that $\Delta H > 0$ for endothermic reactions, i.e. reactions in which energy is absorbed.
- State that $\Delta H < 0$ for exothermic reactions, i.e. reactions in which energy is released.

Activation energy

- Define *activation energy* as the minimum energy needed for a reaction to take place.
- Define an *activated complex* as the unstable transition state from reactants to products.
- Draw or interpret fully labelled sketch graphs (potential energy versus course of reaction graphs) of catalysed and uncatalysed endothermic and exothermic reactions.

Rate and Extent of Reaction

(This section must be read in conjunction with the CAPS, p. 123–124.)

Rates of reaction and factors affecting rate

- Define reaction rate as the change in concentration of reactants or products per unit time.
- Calculate reaction rate from given data for reactants:
$$\text{Rate} = \frac{\Delta c}{\Delta t} \quad (\text{Unit: mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})$$

Calculate reaction rate from given data for products:
$$\text{Rate} = \frac{\Delta c}{\Delta t} \quad (\text{Unit: mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})$$

Questions may also include calculations of rate in terms of change in mass/volume/ moles per time.
- List the factors that affect the rate of chemical reactions, i.e. nature of reacting substances, surface area, concentration (pressure for gases), temperature and the presence of a catalyst.
- Explain in terms of the collision theory how the various factors affect the rate of chemical reactions. The collision theory is a model that explains reaction rate as the result of particles colliding with a certain minimum energy to form products.

Measuring rates of reaction

- Answer questions and interpret data (tables or graphs) on different experimental techniques for measuring the rate of a given reaction.

Mechanism of reaction and of catalysis

- Define the term catalyst as a substance that increases the rate of a chemical reaction without itself undergoing a permanent change.
- Explain that a catalyst increases the rate of a reaction by providing an alternative path of lower activation energy. It therefore decreases the net activation energy.
- Interpret Maxwell-Boltzmann curves (number of particles against kinetic energy) to explain the effect of a catalyst, temperature and concentration on reaction rate.

Chemical Equilibrium

(This section must be read in conjunction with the CAPS, p. 125–126.)

Chemical equilibrium and factors affecting equilibrium

- Explain what is meant by:
 - Open and closed systems: An open system continuously interacts with its environment, while a closed system is isolated from its surroundings.
 - A reversible reaction: A reaction is reversible when products can be converted back to reactants and vice versa.
 - Chemical equilibrium: It is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction.
- List the factors that influence the position of an equilibrium, i.e. pressure (gases only), concentration and temperature.

Equilibrium constant

- List the factors that influence the value of the equilibrium constant, K_c .
- Write down an expression for the equilibrium constant, having been given the equation for the reaction.
- Perform calculations based on K_c values.
- Explain the significance of high and low values of the equilibrium constant.

Application of equilibrium principles

- State Le Chatelier's principle: When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance.
- Use Le Chatelier's principle to explain changes in equilibria qualitatively.
- Interpret graphs of equilibrium, e.g. concentration/rate/number of moles/mass/volume versus time.

Acids and Bases

(This section must be read in conjunction with the CAPS, p. 127–128.)

Acid-base reactions

- Define *acids* and *bases* according to Arrhenius and Lowry-Brønsted theories:
Arrhenius theory: Acids produce hydrogen ions (H^+/H_3O^+ /hydronium ions) in aqueous solution. Bases produce hydroxide ions (OH^-) in aqueous solution.
Lowry-Brønsted theory: An acid is a proton (H^+ ion) donor. A base is a proton (H^+ ion) acceptor.

Relative strengths of acids and bases

- Distinguish between *strong acids/bases* and *weak acids/bases* with examples.
Strong acids ionise completely in water to form a high concentration of H_3O^+ ions. Examples of strong acids are hydrochloric acid, sulphuric acid and nitric acid.
Weak acids ionise incompletely in water to form a low concentration of H_3O^+ ions. Examples of weak acids are ethanoic acid and oxalic acid.
Strong bases dissociate completely in water to form a high concentration of OH^- ions. Examples of strong bases are sodium hydroxide and potassium hydroxide.
Weak bases dissociate/ionise incompletely in water to form a low concentration of OH^- ions.
Examples of weak bases are ammonia, calcium carbonate, potassium carbonate, calcium carbonate and sodium hydrogen carbonate.
- Distinguish between *concentrated acids/bases* and *dilute acids/bases*.
Concentrated acids/bases contain a large amount (number of moles) of acid/base in proportion to the volume of water.
Dilute acids/bases contain a small amount (number of moles) of acid/base in proportion to the volume of water.

Acid-base reactions

- Write down the reaction equations of aqueous solutions of acids and bases.
Examples: $\text{HCl}(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq})$ (HCl is a monoprotic acid.)
 $\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
 $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_3\text{O}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$ (H_2SO_4 is a diprotic acid.)
 - Identify conjugate acid-base pairs for given compounds.
 - Describe a substance that can act as either acid or base as ampholyte. Water is a good example of an ampholyte substance. Write equations to show how an ampholyte substance can act as acid or base.
 - Write down neutralisation reactions of common laboratory acids and bases.
Examples: $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq})/\text{KOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq})/\text{KCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
 $\text{HCl}(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
 $\text{HNO}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$
 $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$
 $(\text{COOH})_2(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow (\text{COO})_2\text{Na}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
 $\text{CH}_3\text{COOH}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{CH}_3\text{COONa}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- NOTE:** The above are examples of equations that learners will be expected to write from given information. However, any other neutralisation reaction can be given in the question paper to assess, e.g. stoichiometry.

Hydrolysis

- Define *hydrolysis* as the reaction of a salt with water.
- Determine the approximate pH (equal to, smaller than or larger than 7) of salts in salt hydrolysis.
 - Hydrolysis of the salt of a weak acid and a strong base results in an alkaline solution, i.e. the $\text{pH} > 7$. Examples of such salts are sodium ethanoate, sodium oxalate and sodium carbonate.
 - Hydrolysis of the salt of a strong acid and a weak base results in an acidic solution, i.e. the $\text{pH} < 7$. An example of such a salt is ammonium chloride.
 - The salt of a strong acid and a strong base does not undergo hydrolysis and the solution of the salt will be neutral, i.e. $\text{pH} = 7$.

Acid-base titrations

- Motivate the choice of a specific indicator in a titration. Choose from methyl orange, phenolphthalein and bromothymol blue.
- Define the *equivalence point of a titration* as the point at which the acid/base has completely reacted with the base/acid.
Define the *endpoint of a titration* as the point where the indicator changes colour.
- Perform stoichiometric calculations based on titrations of a strong acid with a strong base, a strong acid with a weak base and a weak acid with a strong base. Calculations may include percentage purity.
- For a titration, e.g. the titration of oxalic acid with sodium hydroxide:
 - List the apparatus needed or identify the apparatus from a diagram.
 - Describe the procedure to prepare a standard oxalic acid solution.
 - Describe the procedure to conduct the titration.
 - Describe safety precautions.
 - Describe measures that need to be in place to ensure reliable results.
 - Interpret given results to determine the unknown concentration.

pH and the pH scale

- Explain the pH scale as a scale of numbers from 0 to 14 used to express the acidity or alkalinity of a solution.
- Calculate pH values of strong acids and strong bases using $\text{pH} = -\log[\text{H}_3\text{O}^+]$.
- Define K_w as the equilibrium constant for the ionisation of water or the ion product of water or the ionisation constant of water, i.e. $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ by 298 K.

- Explain the *auto-ionisation of water*, i.e. the reaction of water with itself to form H_3O^+ ions and OH^- ions.
- Interpret K_a values of acids to determine the relative strength of given acids. Interpret K_b values of bases to determine the relative strength of given bases.
- Compare strong and weak acids by looking at:
 - pH (monoprotic and diprotic acids)
 - Conductivity
 - Reaction rate

Electrochemical Reactions

(This section must be read in conjunction with the CAPS, p. 134–137.)

Galvanic cells

- Define the *galvanic cell* as a cell in which chemical energy is converted to electrical energy.
- Define *oxidation* and *reduction* in terms of electron (e^-) transfer:
Oxidation is a loss of electrons. Reduction is a gain of electrons.
- Define *oxidation* and *reduction* in terms of oxidation numbers:
Oxidation: an increase in oxidation number
Reduction: a decrease in oxidation number
- Define an *oxidising agent* and a *reducing agent* in terms of oxidation and reduction:
Oxidising agent: a substance that is reduced/gains electrons.
Reducing agent: a substance that is oxidised/loses electrons.
- Define an *anode* and a *cathode* in terms of oxidation and reduction:
Anode: the electrode where oxidation takes place
Cathode: the electrode where reduction takes place
- Define an *electrolyte* as a substance of which the aqueous solution contains ions OR a substance that dissolves in water to give a solution that conducts electricity.

Relation of current and potential difference to rate and equilibrium

- State that the potential difference of a galvanic cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium.
- State and use the qualitative relationship between V_{cell} and the concentration of product ions and reactant ions for the spontaneous reaction, namely V_{cell} decreases as the concentration of product ions increases and the concentration of reactant ions decreases until equilibrium is reached at which the $V_{\text{cell}} = 0$ (the cell is 'flat'). (Qualitative only. Nernst equation is NOT required.)

Understanding of the processes and redox reactions taking place in galvanic cells

- Describe the movement of ions in the solutions.
- State the direction of electron flow in the external circuit.
- Write down the half-reactions that occur at the electrodes.
- State the function of the salt bridge.
- Use cell notation or diagrams to represent a galvanic cell.
When writing cell notation, the following convention should be used:
 - The $\text{H}_2|\text{H}^+$ half-cell is treated just like any other half-cell.
 - Cell terminals (electrodes) are written on the outside of the cell notation.
 - Active electrodes:
reducing agent | oxidised species || oxidising agent | reduced species
 - Inert electrodes (usually Pt or C):
Pt | reducing agent | oxidised species || oxidising agent | reduced species | Pt
Example: $\text{Pt} | \text{Cl}^-(\text{aq}) | \text{Cl}_2(\text{g}) || \text{F}_2(\text{g}) | \text{F}^-(\text{aq}) | \text{Pt}$
- Predict the half-cell in which oxidation will take place when two half-cells are connected.

- Predict the half-cell in which reduction will take place when connected to another half-cell.
- Write down the overall cell reaction by combining two half-reactions.
- Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell.
- Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions.

Standard electrode potentials

- Write down the standard conditions under which standard electrode potentials are determined.
- Describe the standard hydrogen electrode and explain its role as the reference electrode.
- Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values.

Electrolytic cells

- Define the *electrolytic cell* as a cell in which electrical energy is converted into chemical energy
- Electrolysis: The chemical process in which electrical energy is converted to chemical energy OR the use of electrical energy to produce a chemical change

Understanding the processes and redox reactions taking place in electrolytic cells

- Describe the movement of ions in the solution.
- State the direction of electron flow in the external circuit.
- Write equations for the half-reactions taking place at the anode and cathode.
- Write down the overall cell reaction by combining two half-reactions.
- Describe, using half-reactions and the equation for the overall cell reaction as well as the layout of the particular cell using a schematic diagram, the following electrolytic processes:
 - The decomposition of copper(II) chloride
 - Electroplating, e.g. the electroplating of an iron spoon with silver/nickel
 - Refining of metals, e.g. copper
 - The electrolysis of a concentrated solution of sodium chloride

4. GENERAL INFORMATION

4.1 Quantities, symbols and units

The most common quantities, symbols and SI units used in introductory Physics are listed below. **A quantity should not be confused with the unit in which it is measured.**

Quantity	Preferred symbol	Alternative symbol	Unit name	Unit symbol
mass	m		kilogram	kg
position	x, y		metre	m
displacement	$\Delta x, \Delta y$	s	metre	m
velocity	v_x, v_y	u, v	metre per second	$\text{m}\cdot\text{s}^{-1}$
initial velocity	v_i	u	metre per second	$\text{m}\cdot\text{s}^{-1}$
final velocity	v_f	v	metre per second	$\text{m}\cdot\text{s}^{-1}$
acceleration	a		metre per second per second	$\text{m}\cdot\text{s}^{-2}$
acceleration due to gravity	g		metre per second per second	$\text{m}\cdot\text{s}^{-2}$
time (instant)	t		second	s
time interval	Δt		second	s
energy	E		joule	J
kinetic energy	K	E_k	joule	J
potential energy	U	E_p	joule	J
work	W		joule	J
work function	W_0		joule	J
power	P		watt	W
momentum	p		kilogram metre per second	$\text{kg}\cdot\text{m}\cdot\text{s}^{-1}$
force	F		newton	N
weight	w	F_g	newton	N
normal force	N	F_N	newton	N
tension	T	F_T	newton	N
friction force	f	F_f	newton	N
coefficient of friction	μ, μ_s, μ_k		(none)	
torque	τ		newton metre	$\text{N}\cdot\text{m}$
wavelength	λ		metre	m
frequency	f	ν	hertz or per second	Hz or s^{-1}
period	T		second	s
speed of light	c		metre per second	$\text{m}\cdot\text{s}^{-1}$
refractive index	n		(none)	
focal length	f		metre	m
object distance	s	u	metre	m
image distance	s'	v	metre	m
magnification	m		(none)	
charge	Q, q		coulomb	C
electric field	E		newton per coulomb or volt per metre	$\text{N}\cdot\text{C}^{-1}$ or $\text{V}\cdot\text{m}^{-1}$
electric potential at point P	V_P		volt	V
potential difference	$\Delta V, V$		volt	V
emf	$\mathcal{E}$	ε	volt	V
current	I, i		ampere	A
resistance	R		ohm	Ω
internal resistance	r		ohm	Ω
magnetic field	B		tesla	T
magnetic flux	Φ		tesla·metre ² or weber	$\text{T}\cdot\text{m}^2$ or Wb

Conventions (e.g. signs, symbols, terminology and nomenclature)

The syllabus and question papers will conform to generally accepted international practices.

NOTE:

1. For marking purposes, alternative symbols will also be accepted.
2. Separate compound units with a multiplication dot, not a full stop, e.g. $\text{m} \cdot \text{s}^{-1}$.
For marking purposes, m.s^{-1} will also be accepted.
3. Use the equal sign only when it is mathematically correct, e.g.
Incorrect: $1 \text{ cm} = 1 \text{ m}$ (on a scale drawing)
Correct: $1 \text{ cm} = 10^{-2} \text{ m}$ 1 cm represents 1 m (on a scale drawing)

4.2 Information sheets – Paper 1 (Physics)

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Speed of light in a vacuum	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass	m_e	$9,11 \times 10^{-31} \text{ kg}$
Mass of the Earth	M	$5,98 \times 10^{24} \text{ kg}$
Radius of the Earth	R_E	$6,38 \times 10^6 \text{ m}$

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ OR $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ OR $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ OR $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1 m_2}{d^2}$ OR $F = \frac{Gm_1 m_2}{r^2}$	$g = \frac{GM}{d^2}$ OR $g = \frac{GM}{r^2}$

WORK, ENERGY AND POWER

$W = F \Delta x \cos \theta$	$U = mgh$ OR $E_p = mgh$
$K = \frac{1}{2} mv^2$ OR $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ OR $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ OR $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ OR $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = Fv_{\text{ave}}$	

WAVES, SOUND AND LIGHT

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf \quad \text{OR} \quad E = h \frac{c}{\lambda}$
$E = W_o + E_{k(max)} \quad \text{OR} \quad E = W_o + K_{max} \quad \text{where}$ $E = hf \quad \text{and} \quad W_o = hf_o \quad \text{and} \quad E_{k(max)} = \frac{1}{2}mv_{max}^2 \quad \text{OR} \quad K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{OR} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	$\text{emf} (\epsilon) = I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I \Delta t$
$W = Vq$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{ave} = V_{rms} I_{rms}$ $P_{ave} = I_{rms}^2 R$ $P_{ave} = \frac{V_{rms}^2}{R}$
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4.3 Information Sheets – Paper 2 (Chemistry)

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature	T^θ	273 K
Charge on electron	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$	
$E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}}$ OR $E^\theta_{\text{cell}} = E^\theta_{\text{reduction}} - E^\theta_{\text{oxidation}}$ OR $E^\theta_{\text{cell}} = E^\theta_{\text{oxidising agent}} - E^\theta_{\text{reducing agent}}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Al 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cl 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tl 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															
			58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175	
			90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

KEY

Atomic number

Electronegativity →

← Symbol

↑
Approximate relative atomic mass

TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions		E° (V)
$F_2(g) + 2e^-$	$\rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	$\rightleftharpoons 2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons Pt$	+ 1,20
$Br_2(l) + 2e^-$	$\rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons Hg(l)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	$\rightleftharpoons H_2(g)$	0,00
$Fe^{3+} + 3e^-$	$\rightleftharpoons Fe$	- 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons Pb$	- 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons Sn$	- 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons Ni$	- 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons Co$	- 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons Cd$	- 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons Fe$	- 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons Cr$	- 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons Zn$	- 0,76
$2H_2O + 2e^-$	$\rightleftharpoons H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons Cr$	- 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons Mn$	- 1,18
$Al^{3+} + 3e^-$	$\rightleftharpoons Al$	- 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons Mg$	- 2,36
$Na^+ + e^-$	$\rightleftharpoons Na$	- 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons Ca$	- 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons Sr$	- 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons Ba$	- 2,90
$Cs^+ + e^-$	$\rightleftharpoons Cs$	- 2,92
$K^+ + e^-$	$\rightleftharpoons K$	- 2,93
$Li^+ + e^-$	$\rightleftharpoons Li$	- 3,05

Increasing strength of oxidising agents

Increasing strength of reducing agents

TABLE 4B: STANDARD REDUCTION POTENTIALS

Half-reactions			E° (V)
$\text{Li}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Li	- 3,05
$\text{K}^{+} + \text{e}^{-}$	$\rightleftharpoons$	K	- 2,93
$\text{Cs}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Cs	- 2,92
$\text{Ba}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Ba	- 2,90
$\text{Sr}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Sr	- 2,89
$\text{Ca}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Ca	- 2,87
$\text{Na}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Na	- 2,71
$\text{Mg}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Mg	- 2,36
$\text{Al}^{3+} + 3\text{e}^{-}$	$\rightleftharpoons$	Al	- 1,66
$\text{Mn}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Mn	- 1,18
$\text{Cr}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Cr	- 0,91
$2\text{H}_2\text{O} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{H}_2(\text{g}) + 2\text{OH}^{-}$	- 0,83
$\text{Zn}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Zn	- 0,76
$\text{Cr}^{3+} + 3\text{e}^{-}$	$\rightleftharpoons$	Cr	- 0,74
$\text{Fe}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Fe	- 0,44
$\text{Cr}^{3+} + \text{e}^{-}$	$\rightleftharpoons$	Cr^{2+}	- 0,41
$\text{Cd}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Cd	- 0,40
$\text{Co}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Co	- 0,28
$\text{Ni}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Ni	- 0,27
$\text{Sn}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Sn	- 0,14
$\text{Pb}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Pb	- 0,13
$\text{Fe}^{3+} + 3\text{e}^{-}$	$\rightleftharpoons$	Fe	- 0,06
$2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{H}_2\text{S}(\text{g})$	+ 0,14
$\text{Sn}^{4+} + 2\text{e}^{-}$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$\text{Cu}^{2+} + \text{e}^{-}$	$\rightleftharpoons$	Cu^{+}	+ 0,16
$\text{SO}_4^{2-} + 4\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
$\text{Cu}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Cu	+ 0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^{-}$	$\rightleftharpoons$	4OH^{-}	+ 0,40
$\text{SO}_2 + 4\text{H}^{+} + 4\text{e}^{-}$	$\rightleftharpoons$	$\text{S} + 2\text{H}_2\text{O}$	+ 0,45
$\text{Cu}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Cu	+ 0,52
$\text{I}_2 + 2\text{e}^{-}$	$\rightleftharpoons$	2I^{-}	+ 0,54
$\text{O}_2(\text{g}) + 2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	H_2O_2	+ 0,68
$\text{Fe}^{3+} + \text{e}^{-}$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$\text{NO}_3^{-} + 2\text{H}^{+} + \text{e}^{-}$	$\rightleftharpoons$	$\text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
$\text{Ag}^{+} + \text{e}^{-}$	$\rightleftharpoons$	Ag	+ 0,80
$\text{Hg}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{Hg}(\ell)$	+ 0,85
$\text{NO}_3^{-} + 4\text{H}^{+} + 3\text{e}^{-}$	$\rightleftharpoons$	$\text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
$\text{Br}_2(\ell) + 2\text{e}^{-}$	$\rightleftharpoons$	2Br^{-}	+ 1,07
$\text{Pt}^{2+} + 2\text{e}^{-}$	$\rightleftharpoons$	Pt	+ 1,20
$\text{MnO}_2 + 4\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$\text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
$\text{O}_2(\text{g}) + 4\text{H}^{+} + 4\text{e}^{-}$	$\rightleftharpoons$	$2\text{H}_2\text{O}$	+ 1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^{+} + 6\text{e}^{-}$	$\rightleftharpoons$	$2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^{-}$	$\rightleftharpoons$	2Cl^{-}	+ 1,36
$\text{MnO}_4^{-} + 8\text{H}^{+} + 5\text{e}^{-}$	$\rightleftharpoons$	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
$\text{H}_2\text{O}_2 + 2\text{H}^{+} + 2\text{e}^{-}$	$\rightleftharpoons$	$2\text{H}_2\text{O}$	+ 1,77
$\text{Co}^{3+} + \text{e}^{-}$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$\text{F}_2(\text{g}) + 2\text{e}^{-}$	$\rightleftharpoons$	2F^{-}	+ 2,87

Increasing strength of oxidising agents

Increasing strength of reducing agents

5. MARKING GUIDELINES: PAPER 1

5.1 Calculations

- 5.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.
- 5.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.
- 5.1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
- 5.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.
- 5.1.5 **No penalisation if zero substitutions are omitted** in calculations where **correct formula/principle is given correctly**.
- 5.1.6 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.
- 5.1.7 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer given.
- 5.1.8 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
- 5.1.9 All calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
- 5.1.10 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
- 5.1.11 Questions where a series of calculations do not necessarily always have to follow the same order (as in circuit calculations) full marks will be awarded provided that it is a valid solution to the problem.
- 5.1.12 Any calculation that will not bring the candidate closer to the answer than the original solution, will not count any marks.

5.2 Units

- 5.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
- 5.2.2 Units are only required in the final answer to a calculation.
- 5.2.3 Marks are only awarded for an answer, and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
 - Wrong answer + correct unit
 - Correct answer + no unit
- 5.2.4 SI units must be used, except in certain cases, e.g. $\text{V}\cdot\text{m}^{-1}$ instead of $\text{N}\cdot\text{C}^{-1}$, and $\text{cm}\cdot\text{s}^{-1}$ or $\text{km}\cdot\text{h}^{-1}$ instead of $\text{m}\cdot\text{s}^{-1}$ where the question warrants this.

5.3 General

- 5.3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
- 5.3.2 For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted.
- 5.3.3 Separate compound units with a multiplication dot, not a full stop, e.g. $\text{m}\cdot\text{s}^{-1}$. For marking purposes, $\text{m}\cdot\text{s}^{-1}$ and m/s will also be accepted.

5.4 Positive marking

Positive marking regarding calculations will be followed in the following cases:

- 5.4.1 **Subquestion to subquestion:** When a certain variable is incorrectly calculated in one subquestion (e.g. 3.1) and needs to be substituted into another subquestion (3.2 or 3.3), **full marks** are to be awarded for the subsequent subquestions.
- 5.4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

5.5 Negative marking

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for, for example, QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 should be considered.

6. MARKING GUIDELINES: PAPER 2

6.1 Calculations

- 6.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.
- 6.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.
- 6.1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
- 6.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.
Example: No K_c expression, correct substitution:
$$K_c = \frac{(2)^2}{(2)(1)^3} \checkmark = 2 \checkmark \quad \left(\frac{2}{3}\right)$$
- 6.1.5 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer has been given.
- 6.1.6 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
- 6.1.7 The final answer to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
- 6.1.8 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
- 6.1.9 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.

Example:

CORRECT	ANSWER (1)	POSSIBLE	ANSWER (2)	POSSIBLE
$n = \frac{m}{M} \checkmark$ $0,01 \checkmark = \frac{m}{52} \checkmark$ $m = 0,52 \text{ g} \checkmark$	$n = \frac{m}{M} \checkmark$ $0,01 \checkmark = \frac{52}{m} \times$ $m = 5\,200 \text{ g} \times$	$m = \frac{n}{M} \times$ $= \frac{0,01}{52}$ $= 0,002 \text{ g}$	$n = \frac{m}{M} \checkmark$ $m = \frac{M}{n} \times$ $= \frac{52}{0,01} \checkmark$ $= 5\,200 \text{ g} \times$	$n = \frac{m}{M} \checkmark$ $= 0,52 \text{ g} \checkmark$
(4)	(2)	(0)	(3)	(2)

6.2 Units

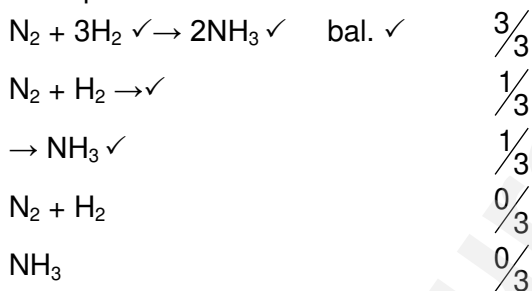
- 6.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
- 6.2.2 Units are only required in the final answer to a calculation.
- 6.2.3 Marks are only awarded for an answer and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
 - Wrong answer + correct unit
 - Correct answer + no unit
- 6.2.4 Separate compound units with a multiplication dot, not a full stop, e.g. $\text{mol} \cdot \text{dm}^{-3}$. Accept $\text{mol}.\text{dm}^{-3}$ (or mol/dm^3) for marking purposes.

6.3 General

- 6.3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
- 6.3.2 When a chemical **FORMULA** is asked, and the **NAME** is given as answer, the candidate forfeits the marks. The same rule applies when the **NAME** is asked and the **FORMULA** is given.
- 6.3.3 When redox half-reactions are to be written, the correct arrow should be used.
If the equation
- $$\text{H}_2\text{S} \rightarrow \text{S} + 2\text{H}^+ + 2\text{e}^- \quad (2/2)$$
- is the correct answer, the marks must be given as follows:
- $$\text{H}_2\text{S} = \text{S} + 2\text{H}^+ + 2\text{e}^- \quad (1/2)$$
- $$\text{H}_2\text{S} \leftarrow \text{S} + 2\text{H}^+ + 2\text{e}^- \quad (0/2)$$
- $$\text{S} + 2\text{H}^+ + 2\text{e}^- \leftarrow \text{H}_2\text{S} \quad (2/2)$$
- $$\text{S} + 2\text{H}^+ + 2\text{e}^- = \text{H}_2\text{S} \quad (0/2)$$
- 6.3.4 When candidates are required to give an explanation involving the relative strength of oxidising and reducing agents, do not accept the following:
- Stating the position of a substance on Table 4 only (e.g. Cu is above Mg).
 - Using relative reactivity only (e.g. Mg is more reactive than Cu).
 - The correct answer would be for instance: Mg is a stronger reducing agent than Cu, and therefore Mg will be able to reduce Cu^{2+} ions to Cu. The answer can also be given in terms of the relative strength as electron acceptors and donors.
- 6.3.5 One mark is forfeited when the charge of an ion is omitted per equation (not for the charge on an electron).

- 6.3.6 The error-carrying principle does not apply to chemical equations or half-reactions. For example, if a learner writes the wrong oxidation/reduction half-reaction in the subquestion and carries the answer to another subquestion (balancing of equations or calculation of $E_{\text{cell}}^{\ominus}$), then the learner will not be credited for this substitution.
- 6.3.7 In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks must be deducted if hydrogen atoms are omitted.
- 6.3.8 When a structural formula is required, marks must be deducted if the candidate writes the condensed formula.
- 6.3.9 When a IUPAC name is asked and the candidate omits the hyphen (e.g. instead of pent-1-ene or 1-pentene the candidate writes pent 1 ene or 1 pentene), marks will be forfeited.
- 6.3.10 When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.
If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow, is/are written, marks may be awarded for the reactant(s) or product(s). If only a reactant(s) or only a product(s) is/are written, without an arrow, no marks are awarded for the reactant(s) or product(s).

Examples:



6.4 Positive marking

Positive marking regarding calculations will be followed in the following cases:

- 6.4.1 **Subquestion to subquestion:** When a certain variable is calculated in one subquestion (e.g. QUESTION 3.1) and needs to be substituted in another (QUESTION 3.2 or QUESTION 3.3), e.g. if the answer for QUESTION 3.1 is incorrect and is substituted correctly in QUESTION 3.2 or QUESTION 3.3, **full marks** are to be awarded for the subsequent subquestions.
- 6.4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

6.5 Negative marking

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for e.g. QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 could be considered.

7. CONCLUSION

This Examination Guidelines document is meant to articulate the assessment aspirations espoused in the CAPS document. It is therefore not a substitute for the CAPS document which teachers should teach to.

Qualitative curriculum coverage as enunciated in the CAPS cannot be over-emphasised.



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

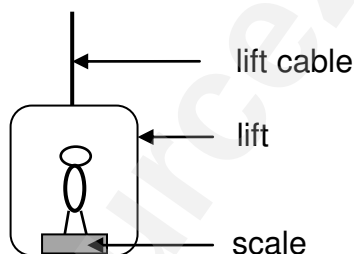
INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 11 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

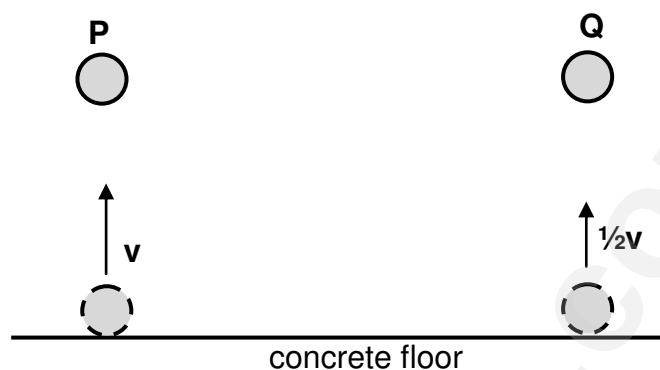
- 1.1 Inertia is the tendency of an object to ...
- A maintain its mass.
 - B continue in a state of non-uniform motion.
 - C remain at rest or in the state of uniform motion.
 - D maintain its velocity when a non-zero net force is acting on it. (2)
- 1.2 A person stands on a bathroom scale that is fixed to the floor of a lift, as shown in the diagram below.



- The reading on the scale is largest when the lift moves ...
- A upwards at a constant speed.
 - B downwards at a constant speed.
 - C upwards at a increasing speed.
 - D downwards at a increasing speed. (2)
- 1.3 An object is projected vertically upwards. Ignore air resistance.
- As the object rises, its velocity ...
- A and acceleration are both directed upwards.
 - B and acceleration are both directed downwards.
 - C is directed upwards, but its acceleration is directed downwards.
 - D is directed downwards, but its acceleration is directed upwards. (2)

- 1.4 Ball **P** and ball **Q**, of the same mass, are dropped onto a concrete floor. Both balls hit the concrete floor at the same speed, v . Ball **P** rebounds with the same vertical speed, v , but ball **Q** rebounds with speed $\frac{1}{2}v$.

Refer to the diagram below. Ignore air resistance.



Which ONE of the following statements regarding the collision of EACH ball with the concrete floor is CORRECT?

- A Kinetic energy is conserved for both balls **P** and **Q**.
- B The change in momentum of ball **P** is greater than that of ball **Q**.
- C The contact time with the floor is the same for both balls **P** and **Q**.
- D Momentum is conserved for the collision of ball **P**, but not for that of ball **Q**.

(2)

- 1.5 If the net work done on a moving object is POSITIVE, then we can conclude that the kinetic energy of the object ...

- A is zero.
- B has increased.
- C has decreased.
- D has not changed.

(2)

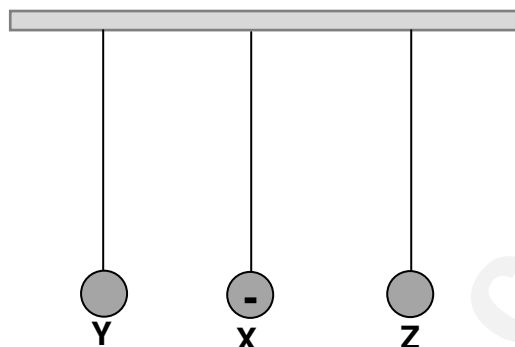
- 1.6 The spectrum produced by a moving asteroid, as observed from Earth, indicates that the light has shifted towards the blue end of the spectrum.

Which ONE of the following frequency combinations of the observed light and the distance between the asteroid and Earth is CORRECT?

	FREQUENCY OF OBSERVED LIGHT	DISTANCE BETWEEN ASTEROID AND EARTH
A	Increased	Decreases
B	Increased	Increases
C	Decreased	Decreases
D	Decreased	Increases

(2)

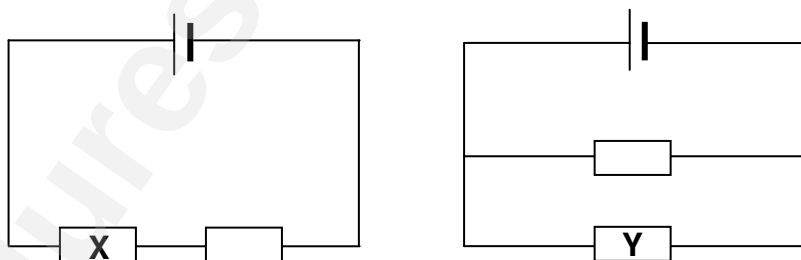
- 1.7 Three charged spheres **X**, **Y** and **Z**, supported by insulating threads of equal length, hang from a beam, as shown in the diagram below. Sphere **X** is negatively charged. Sphere **X** attracts sphere **Y**, but repels sphere **Z**.



Which ONE of the following conclusions is CORRECT?

- A Sphere **Y** is positively charged and sphere **Z** is negatively charged.
- B Sphere **Y** is positively charged and sphere **Z** is positively charged.
- C Sphere **Y** is negatively charged and sphere **Z** is negatively charged.
- D Sphere **Y** is negatively charged and sphere **Z** is positively charged. (2)

- 1.8 In the circuit diagrams below, the cells and resistors are identical. The cells have negligible internal resistances.



The power dissipated in resistor **X** is **P**. The power dissipated in resistor **Y** is ...

- A $\frac{1}{4}P$.
- B $\frac{1}{2}P$.
- C $2P$.
- D $4P$. (2)

1.9 Which ONE of the following actions will NOT cause an **increase** in the induced emf in a coil if the coil is rotated in a uniform magnetic field?

- A Rotating the coil faster
- B Increasing the strength of the magnetic field
- C Increasing the number of turns of the coil
- D Replacing the coil with a coil of lower resistance

(2)

1.10 A learner writes the following statements about the emission spectrum of light in a notebook:

- (i) An emission spectrum is formed when certain frequencies of electromagnetic radiation pass through a cold gas.
- (ii) The lines in the emission spectrum of an atom have the same frequency as the corresponding lines in the atom's absorption spectrum.
- (iii) An emission spectrum is formed when the atom makes transitions from a high-energy state to a lower energy state.

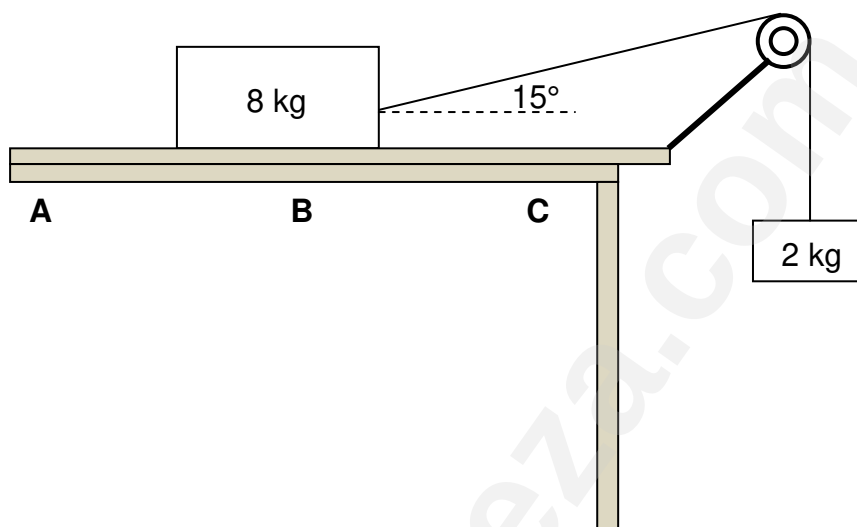
Which ONE of the following combinations of the statements above is CORRECT?

- A (i) only
- B (ii) only
- C (ii) and (iii) only
- D (i) and (iii) only

(2)
[20]

QUESTION 2 (Start on a new page.)

A block, of mass 8 kg, is placed on a rough horizontal surface. The 8 kg block, which is connected to a 2 kg block by means of a light inextensible string passing over a light frictionless pulley, starts sliding from point **A**, as shown below.



- 2.1 State Newton's Second Law in words. (2)
- 2.2 Draw a labelled free-body diagram for the 8 kg block. (4)
- 2.3 When the 8 kg block reaches point **B**, the angle between the string and the horizontal is 15° and the acceleration of the system is $1,32 \text{ m}\cdot\text{s}^{-2}$.
- 2.3.1 Give a reason why the system is NOT in equilibrium. (1)
- 2.3.2 Use the 2 kg mass to calculate the tension in the string. (3)
- 2.3.3 Calculate the kinetic frictional force between the 8 kg block and the horizontal surface. (4)
- 2.4 As the 8 kg block moves from **B** to **C**, the kinetic frictional force between the 8 kg block and the horizontal surface is not constant.
- Give a reason for this statement. (1)

The horizontal surface on which the 8 kg block is moving, is replaced by another horizontal surface made from a different material.

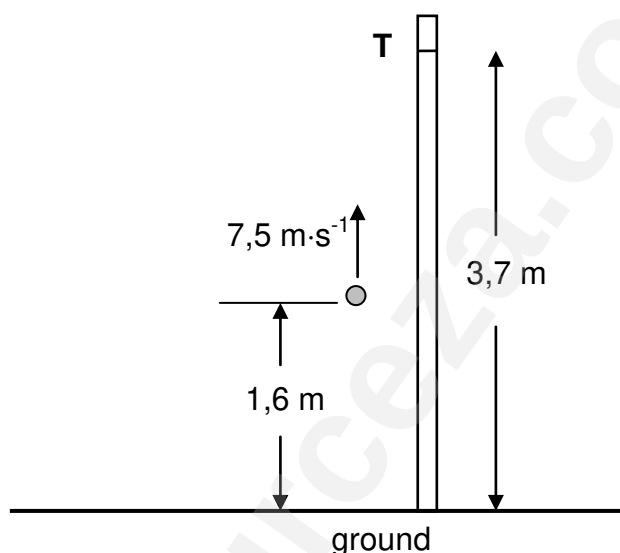
- 2.5 Will the kinetic frictional force, calculated in QUESTION 2.3.3 above, change? Choose from: YES or NO. Give a reason for the answer. (2)

[17]

QUESTION 3 (Start on a new page.)

In a competition, participants must attempt to throw a ball vertically upwards past point **T**, marked on a tall vertical pole. Point **T** is 3,7 m above the ground. Point **T** may, or may not, be the highest point during the motion of the ball.

One participant throws the ball vertically upwards at a velocity of $7,5 \text{ m}\cdot\text{s}^{-1}$ from a point that is 1,6 m above the ground, as shown in the diagram below. Ignore the effects of air resistance.



- 3.1 In which direction is the net force acting on the ball while it moves towards point **T**?
Choose from: UPWARDS or DOWNWARDS. Give a reason for the answer. (2)
- 3.2 Calculate the time taken by the ball to reach its highest point. (3)
- 3.3 Determine, by means of a calculation, whether the ball will pass point **T** or not. (6)
- 3.4 Draw a velocity-time graph for the motion of the ball from the instant it is thrown upwards until it reaches its highest point.

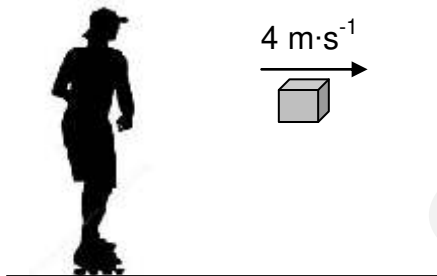
Indicate the following on the graph:

- The initial velocity and final velocity
- Time taken to reach the highest point

(2)
[13]

QUESTION 4 (Start on a new page.)

Initially a girl on roller skates is at rest on a smooth horizontal pavement. The girl throws a parcel, of mass 8 kg, horizontally to the right at a speed of $4 \text{ m}\cdot\text{s}^{-1}$. Immediately after the parcel has been thrown, the girl-roller-skate combination moves at a speed of $0,6 \text{ m}\cdot\text{s}^{-1}$. Ignore the effects of friction and rotation.



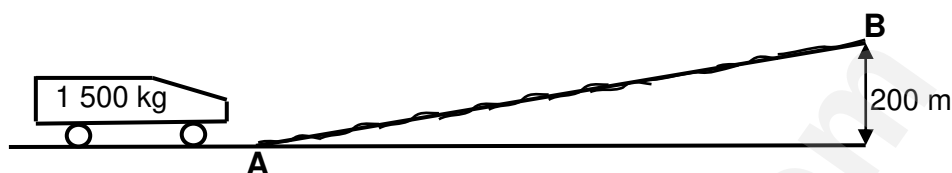
- 4.1 Define the term *momentum* in words. (2)
- 4.2 Will the girl-roller-skate combination move TO THE RIGHT or TO THE LEFT after the parcel is thrown?
NAME the law in physics that can be used to explain your choice of direction. (2)

The total mass of the roller skates is 2 kg.

- 4.3 Calculate the mass of the girl. (5)
- 4.4 Calculate the magnitude of the impulse that the girl-roller-skate combination is experiencing while the parcel is being thrown. (3)
- 4.5 Without any further calculation, write down the change in momentum experienced by the parcel while it is being thrown. (2)
- [14]**

QUESTION 5 (Start on a new page.)

The diagram below, not drawn to scale, shows a vehicle with a mass of 1 500 kg starting from rest at point **A** at the bottom of a rough incline. Point **B** is 200 m vertically above the horizontal.



The total work done by force **F** that moves the vehicle from point **A** to point **B** in 90 s is $4,80 \times 10^6$ J.

5.1 Define the term *non-conservative force*. (2)

5.2 Is force **F** a conservative force? Choose from: YES or NO. (1)

5.3 Calculate the average power generated by force **F**. (3)

The speed of the vehicle when it reaches point **B** is $25 \text{ m}\cdot\text{s}^{-1}$.

5.4 State the work-energy theorem in words. (2)

5.5 Use **energy principles** to calculate the total work done on the vehicle by the frictional forces. (5)
[13]

QUESTION 6 (Start on a new page.)

The alarm of a vehicle parked next to a straight horizontal road goes off, emitting sound with a wavelength of 0,34 m. A patrol car is moving at a constant speed on the same road. The driver of the patrol car hears a sound with a frequency of 50 Hz **lower than** the sound emitted by the alarm. Take the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$.

6.1 State the Doppler effect in words. (2)

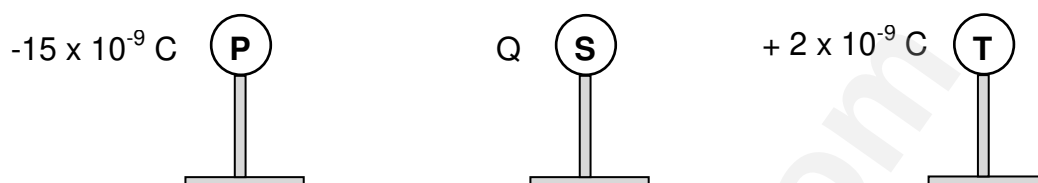
6.2 Is the patrol car driving TOWARDS or AWAY FROM the parked vehicle? Give a reason for the answer. (2)

6.3 Calculate the frequency of the sound emitted by the alarm. (3)

6.4 The patrol car moves a distance of x metres in 10 seconds. Calculate the distance x . (6)
[13]

QUESTION 7 (Start on a new page.)

Three small identical metal spheres, **P**, **S** and **T**, on insulated stands, are **initially neutral**. They are then charged to carry charges of $-15 \times 10^{-9} \text{ C}$, Q and $+2 \times 10^{-9} \text{ C}$ respectively, as shown below.

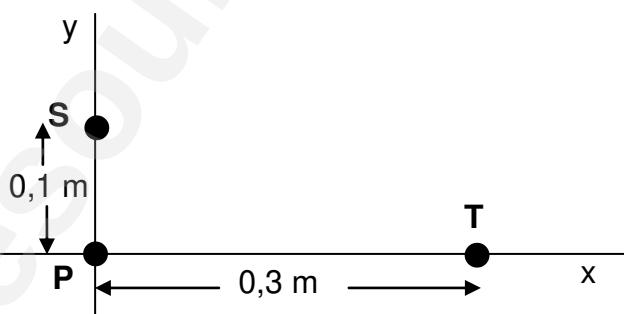


The charged spheres are brought together so that all three spheres touch each other at the same time, and are then separated. The charge on each sphere, after separation, is $-3 \times 10^{-9} \text{ C}$.

7.1 Determine the value of charge Q . (2)

7.2 Draw the electric field pattern associated with the charged spheres, **S** and **T**, **after they are separated** and returned to their original positions. (3)

The spheres, each with the **new charge** of $-3 \times 10^{-9} \text{ C}$, are now placed at points on the x -axis and the y -axis, as shown in the diagram below, with sphere **P** at the origin.



7.3 State Coulomb's law in words. (2)

Calculate the magnitude of the:

7.4 Net electrostatic force acting on sphere **P** (5)

7.5 Net electric field at the origin due to charges **S** and **T** (3)

7.6 ONE of the charged spheres, **P** and **T**, experienced a very small increase in mass **after it was charged initially**.

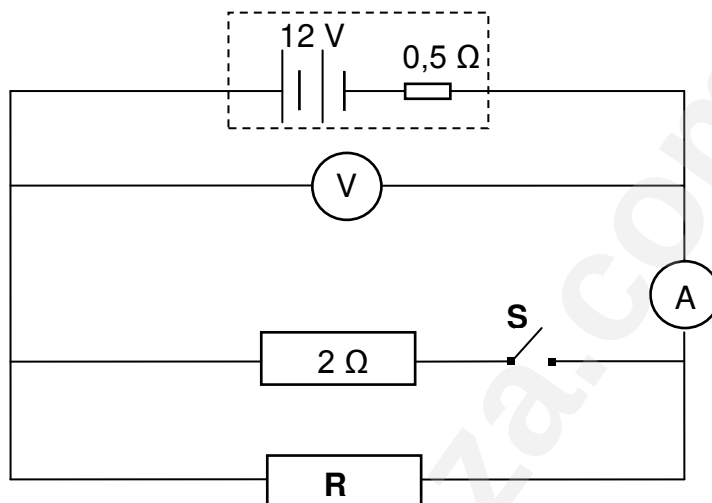
7.6.1 Which sphere, **P** or **T**, experienced this very small increase in mass? (1)

7.6.2 Calculate the increase in mass by the sphere in QUESTION 7.6.1. (3)

[19]

QUESTION 8 (Start on a new page.)

The battery in the circuit diagram below has an emf of 12 V and an internal resistance of $0,5 \Omega$. Resistor **R** has an unknown resistance.



8.1 What is the meaning of the following statement?

The emf of the battery is 12 V.

(2)

The reading on the ammeter is 2 A when switch **S** is OPEN.

8.2 Calculate the:

8.2.1 Reading on the voltmeter

(3)

8.2.2 Resistance of resistor **R**

(2)

Switch **S** is now CLOSED.

8.3 How does this change affect the reading on the voltmeter? Choose from: INCREASES, DECREASES or REMAINS THE SAME.

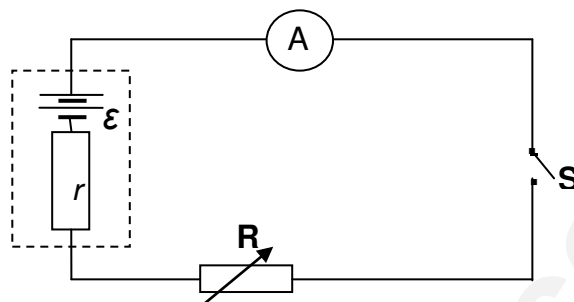
Explain the answer.

(4)

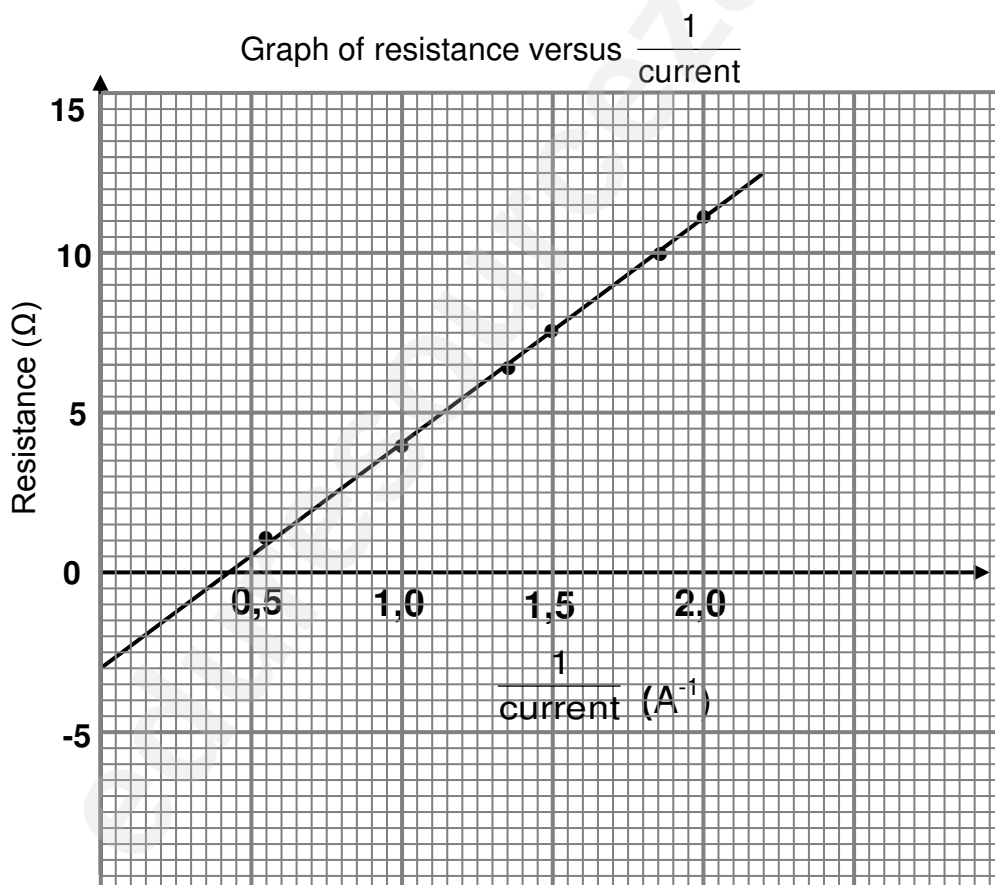
[11]

QUESTION 9 (Start on a new page.)

Learners perform an experiment to determine the emf (ε) and the internal resistance (r) of a battery using the circuit below.



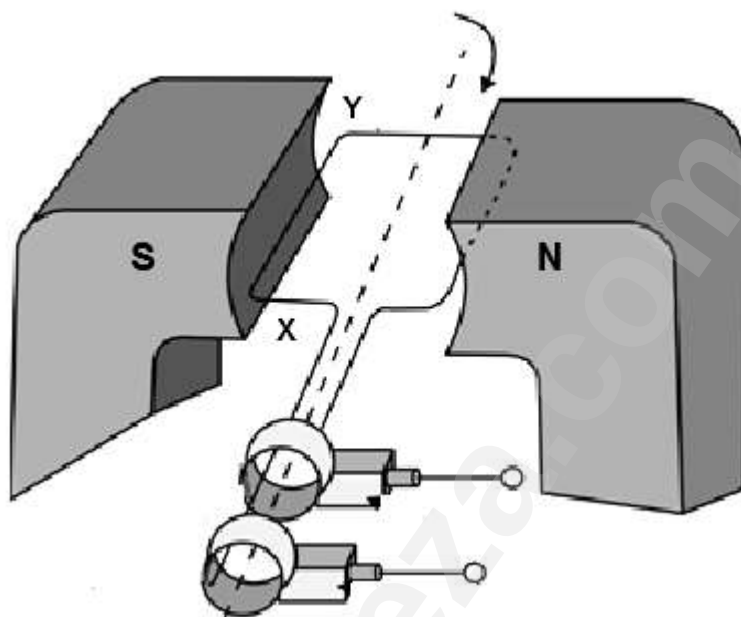
The learners use their recorded readings of current and resistance, together with the equation $R = \frac{\varepsilon}{I} - r$, to obtain the graph below.



- 9.1 Which variable has to be kept constant in the experiment? (1)
- 9.2 Refer to the **graph**.
- 9.2.1 Write down the value of the internal resistance of the cell. (2)
- 9.2.2 Calculate the emf of the battery. (3)
- [6]**

QUESTION 10 (Start on a new page.)

10.1 In the simplified AC generator below, the coil is rotated clockwise.



10.1.1 In which direction does the induced current flow in the coil?

Choose from: **X to Y** or **Y to X**.

(1)

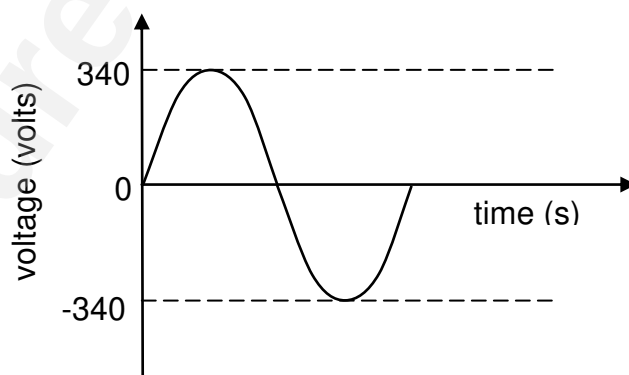
10.1.2 On which principle or law is the working of the generator based?

(1)

10.1.3 State the energy conversion that takes place while the generator is in operation.

(2)

10.2 The voltage output for an AC generator is shown below.



10.2.1 Write down the maximum (peak) output voltage of the generator.

(1)

A stove is connected to the generator above, and delivers an average power of 1 600 W.

10.2.2 Calculate the rms voltage delivered to the stove.

(3)

10.2.3 Calculate the resistance of the stove.

(3)

[11]

QUESTION 11 (Start on a new page.)

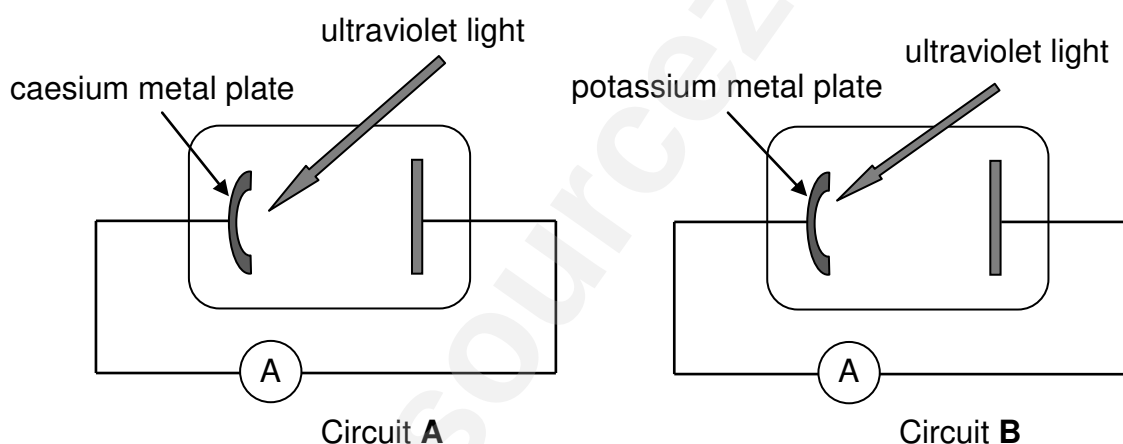
The threshold frequencies of caesium and potassium metals are given in the table below.

METAL	THRESHOLD FREQUENCY
Caesium	$5,07 \times 10^{14} \text{ Hz}$
Potassium	$5,55 \times 10^{14} \text{ Hz}$

11.1 Define the term *work function* in words. (2)

11.2 Which ONE of the two metals in the table has the higher work function? Give a reason for the answer by referring to the information in the table. (2)

The simplified diagrams below show two circuits, **A** and **B**, containing photocells. The photocell in circuit **A** contains a caesium metal plate, while the photocell in circuit **B** contains a potassium metal plate.



Ultraviolet light with the same intensity and wavelength of $5,5 \times 10^{-7} \text{ m}$ is incident on the metal plate in EACH of the photocells and the ammeter in circuit **A** registers a current.

11.3 By means of a calculation, determine whether the ammeter in circuit **B** will also register a current. (3)

11.4 Calculate the maximum kinetic energy of an ejected electron in circuit **A**. (5)

11.5 How will the maximum kinetic energy of the ejected electron, calculated in QUESTION 11.4, change when the intensity of the incident light increases?

Choose from: INCREASES, DECREASES or REMAINS THE SAME. (1)
[13]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}} / P_{\text{gemid}} = F v_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max/maks})}$ or/of $E = W_0 + K_{\text{max/maks}}$ where/waar	
$E = hf$ and/en $W_0 = hf_0$ and/en $E_{k(\text{max/maks})} = \frac{1}{2} mv_{\text{max/maks}}^2$ or/of $K_{\text{max/maks}} = \frac{1}{2} mv_{\text{max/maks}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ε) = $I(R + r)$ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

NOVEMBER 2018

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 29 pages.
Hierdie nasien riglyne bestaan uit 29 bladsye.**

QUESTION 1/VRAAG 1

- 1.1 C /D ✓✓ (2)
- 1.2 C ✓✓ (2)
- 1.3 C ✓✓ (2)
- 1.4 B ✓✓ (2)
- 1.5 B ✓✓ (2)
- 1.6 A ✓✓ (2)
- 1.7 A ✓✓ (2)
- 1.8 D ✓✓ (2)
- 1.9 D ✓✓ (2)
- 1.10 C ✓✓ (2)
- [20]**

QUESTION 2/VRAAG 2

2.1

When a (non-zero) resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object.

✓✓

Wanneer 'n (nie-nul) resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die (netto) krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/OF

The (non-zero) resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force.

✓✓ (2 or 0)

Die (nie-nul) netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum.

ACCEPT/AANVAAR

Acceleration is directly proportional to the net force and inversely proportional to the mass of the object.

Versnelling direk eweredig is aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.

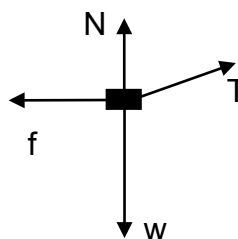
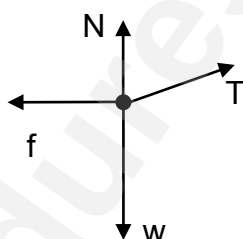
NOTE/LET WEL

If any of the underlined key words in the **correct context** is omitted deduct 1 mark.

Indien enige van die onderstreepte sleutel woorde in die **korrekte konteks** uitgelaat is, trek 1 punt af.

(2)

2.2



Notes/Aantekeninge

- Mark is awarded for label and arrow
Punt word toegeken vir byskrif en pyltjie
- Do not penalise for length of arrows
Moenie vir die lengte van die pyltjies penaliseer nie.
- If T is not shown but $T_{\parallel}$ and $T_{\perp}$ are shown, give 1 mark for both
Indien T nie aangetoon is nie maat $T_{\parallel}$ en $T_{\perp}$ is getoon. Ken 1 punt toe vir beide.
- If force(s) do not make contact with body/Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{3}{4}$
- Deduct 1 mark for any additional force /Trek 1 punt af vir enige addisionele krag

(4)

	Accept the following symbols /Aanvaar die volgende simbole.
N	F_N ; Normal; Normal force /Normaal; Normaalkrag ✓
f	F_f / f_k / frictional force/wrywingskrag/kinetic frictional force/ kinetiese wrywingskrag ✓
w	F_g ; mg; Weight; $F_{\text{Earth on block}}$; F_w / Gewig ;Gravitational force / Gravitasiëkrag/ 78,4 N ✓
T	Tension/Spanning; F_T / F_A , F /16,96 N ✓

2.3.1 The 2/8 kg block /system is accelerating/Die 2/8 kg blok / sisteem is besig om te versnel ✓

OR/OF

The acceleration is not zero / $a \neq 0$ ($\text{m} \cdot \text{s}^{-2}$) / $a = 1,32 \text{ m} \cdot \text{s}^{-2}$ / Die versnelling is nie nul nie ✓

OR/OF

Velocity is /increasing/changing/not constant/Snelheid neem toe/ verander/is nie konstant nie ✓

OR/OF

F_{net} is not equal to zero / F_{net} is nie gelyk aan nul nie / $F_{\text{net}} \neq 0$ (N) ✓

OR/OF

The acceleration is changing / Die versnelling verander ✓

Accept/Aanvaar

An unbalanced force is acting on it / 'n Ongebalanseerde krag werk in op die liggaam ✓

(1)

2.3.2 **For 2 kg/Vir die 2 kg massa**

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ mg - T = ma \end{array} \right\} \checkmark$$

1 mark for any
1 punt vir

$$(2)(9,8) - T = 2(1,32) \checkmark$$

$$T = 16,96 \text{ N} \checkmark$$

$$F_{\text{net}} = ma$$

$$mg + T = ma$$

$$(2)(-9,8) + T = 2(-1,32) \checkmark$$

$$T = 16,96 \text{ N} \checkmark$$

(3)

2.3.3 **POSITIVE MARKING FROM 2.3.2/POSITIEWE NASIEN VANAF 2.3.2**

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ T \cos 15^\circ - f = ma \end{array} \right\} \checkmark$$

$$T_x = T \cos 15^\circ$$

$$= 16,96 \cos 15^\circ$$

$$= 16,38 \text{ N} (16,382 \text{ N}) \rightarrow$$

$$16,382 - f \checkmark = (8)(1,32) \checkmark$$

$$f = 5,82 \text{ N (to the left/na links)} \checkmark$$

OR/OF

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ T \cos 15^\circ + f = ma \end{array} \right\} \checkmark$$

$$\begin{aligned} T_x &= T \cos 15^\circ \\ &= 16,96 \cos 15^\circ \\ &= 16,38 \text{ N } (16,382 \text{ N}) \end{aligned}$$

$$\begin{aligned} -16,382 + f &= (8)(-1,32) \checkmark \\ f &= 5,82 \text{ N (to the left/na links)} \checkmark \end{aligned}$$

(4)

2.4

ANY ONE/ENIGE EEN

Normal force changes/decreases $\checkmark$ / *Normaalkrag verander/neem af*

The angle (between string and horizontal) changes/increases. / *Die hoek (tussen die toutjie en die horisontaal) verander/neem toe*

The vertical component of the tension changes/increases / *Die vertikale komponent van die spanning verander / neem toe.*

(1)

2.5

Yes $\checkmark$ / *Ja*

The frictional force (coefficient of friction) depends on the nature of the surfaces in contact. $\checkmark$

Die wrywingskrag (wrywingskoëffisiënt) is afhanklik van die aard van die oppervlakte in kontak met mekaar.

ACCEPT/AANVAAR

The nature of the surface changes / μ_k changes

Die aard van die oppervlakte verander / μ_k verander

(2)

[17]

QUESTION 3/VRAAG 3

3.1

Downwards/Afwaarts ✓

The only force acting on the object is the gravitational force/weight which acts downwards. ✓ / Die enigste krag wat op die voorwerp inwerk is die gravitasiekrag/gewig wat afwaarts inwerk.

ACCEPT/AANVAAR:

The only force acting is gravitational/weight. ✓ / Die enigste krag wat inwerk is gravitasie/gewig

OR/OF

Gravitational force/weight acts downwards. ✓ / Gravitasiekrag/gewig werk afwaarts

OR/OF

The ball is in free-fall / Die bal in vry-val ✓

OR/OF

(Gravitational) acceleration is downwards / (Gravitasionele) versnelling is afwaarts

(2)

3.2

OPTION 1/OPSIE 1

Upward positive/Opwaarts positief

$$v_f = v_i + a\Delta t \quad \checkmark$$

$$0 = 7,5 + (-9,8)\Delta t \quad \checkmark$$

$$\Delta t = 0,77 \text{ s} \quad \checkmark$$

Downward positive/Afwaarts positief

$$v_f = v_i + a\Delta t \quad \checkmark$$

$$0 = -7,5 + (9,8)\Delta t \quad \checkmark$$

$$\Delta t = 0,77 \text{ s} \quad \checkmark$$

OPTION 2/OPSIE 2

Upward positive

Opwaarts positief

At highest point v_f is zero

By hoogste punt is v_f nul

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = (7,5)^2 + (2)(-9,8)\Delta y$$

$$\Delta y = 2,87 \text{ (2,869) m}$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark$$

$$2,87 = \frac{7,5 + 0}{2} \Delta t \quad \checkmark$$

$$\Delta t = 0,77 \text{ s} \quad \checkmark$$

OPTION 2/OPSIE 2

Downward positive

Afwaarts positief

At highest point v_f is zero

By hoogste punt is v_f nul

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = (-7,5)^2 + (2)(9,8)\Delta y$$

$$\Delta y = -2,87 \text{ (-2,869) m}$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark$$

$$-2,87 = \frac{-7,5 + 0}{2} \Delta t \quad \checkmark$$

$$\Delta t = 0,77 \text{ s} \quad \checkmark$$

OPTION 3/OPSIE 3 Upward positive Opwaarts positief $F_{\text{net}}\Delta t = m(v_f - v_i) \checkmark$ $mg\Delta t = m(v_f - v_i)$ $(-9,8)\Delta t = 0 - 7,5 \checkmark$ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s}) \checkmark$	OPTION 3/OPSIE 3 Downward positive Afwaarts positief $F_{\text{net}}\Delta t = m(v_f - v_i) \checkmark$ $mg\Delta t = m(v_f - v_i)$ $(9,8)\Delta t = 0 - (-7,5) \checkmark$ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s}) \checkmark$
OPTION 4/OPSIE 4 Upward positive Opwaarts positief <u>(Top to Bottom / Bo na onder)</u> $v_f = v_i + a\Delta t \checkmark$ $-7,5 = 0 + (-9,8)\Delta t \checkmark$ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s}) \checkmark$	OPTION 4/OPSIE 4 Downward positive Afwaarts positief <u>(Top to Bottom / Bo na onder)</u> $v_f = v_i + a\Delta t \checkmark$ $7,5 = 0 + (9,8)\Delta t \checkmark$ $\therefore \Delta t = 0,76531 \text{ s } (0,77 \text{ s}) \checkmark$
OPTION 5/OPSIE 5 Upward positive Opwaarts positief <u>(Top to Bottom / Bo na onder)</u> $v_f^2 = v_i^2 + 2a\Delta y$ $(7,5)^2 = (0)^2 + 2(-9,8)\Delta y$ $\Delta y = -2,87 \text{ m}$ $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $-2,87 = (0)\Delta t + \frac{1}{2}(-9,8)(\Delta t)^2 \checkmark$ $\Delta t = 0,765 \text{ s } \checkmark$	OPTION 5/OPSIE 5 Downward positive Afwaarts positief <u>(Top to Bottom / Bo na onder)</u> $v_f^2 = v_i^2 + 2a\Delta y$ $(7,5)^2 = (0)^2 + 2(9,8)\Delta y$ $\Delta y = 2,87 \text{ m}$ $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $2,87 = (0)\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$ $\Delta t = 0,765 \text{ s } \checkmark$

(3)

NOTES for marking QUESTION 3.3 AANTEKENINGE vir merk van VRAAG 3.3	
Formula mark/Formule punt	✓
Substitution mark /Vervangingspunt	✓✓
Mark for height/distance / Punt vir hoogte/afstand	✓
Mark for comparison/Punt vir vergelyking	✓
Mark for conclusion/Punt vir gevolgtrekking	✓

3.3

OPTION 1/OPSIE 1

Upward positive/Opwaarts positief

At highest point v_f is zero/By hoogste punt is v_f nul

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$0 \checkmark = (7,5)^2 + (2)(-9,8)\Delta y \quad \checkmark$$

$$\Delta y = 2,87 \text{ (2,869) m} \quad \checkmark$$

This is higher than height needed to reach point T (2,1 m) ✓ therefore the ball will pass point T. ✓

Dit is hoer as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.

Downward positive/Afwaarts positief

At highest point v_f is zero/By hoogste punt is v_f nul

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$0 \checkmark = (-7,5)^2 + (2)(9,8)\Delta y \quad \checkmark$$

$$\Delta y = -2,87 \text{ (-2,869) m} \quad \checkmark$$

This is higher than height needed to reach point T (2,1 m) ✓ therefore the ball will pass the target. ✓

Dit is hoer as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.

OPTION 2/OPSIE 2 (POSITIVE MARKING FROM 3.2)

Upward positive/Opwaarts positief

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \checkmark$$

$$\Delta y = (7,5)(0,77) \quad \checkmark + \frac{1}{2}(-9,8)(0,77)^2 \quad \checkmark$$

$$\Delta y = 2,87 \text{ m (2,86 m)} \quad \checkmark$$

This is higher than height needed to reach point T (2,1 m) ✓ therefore the ball will pass point T. ✓

Dit is hoer as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.

Downward positive/Afwaarts positief

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \checkmark$$

$$\Delta y = (-7,5)(0,77) \quad \checkmark + \frac{1}{2}(9,8)(0,77)^2 \quad \checkmark$$

$$\Delta y = -2,87 \text{ m (2,869 m)} \quad \checkmark$$

This is higher than the height needed to reach point T (2,1 m) ✓ therefore the ball will pass point T. ✓

Dit is hoer as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.

OPTION 3/OPSIE 3

$$\begin{aligned}(E_{\text{mech}})_{\text{Top/Bo}} &= (E_{\text{mech}})_{\text{Ground/Grond}} \\ (E_P + E_K)_{\text{Top}} &= (E_P + E_K)_{\text{Bottom/Onder}} \\ (mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} &= (mgh + \frac{1}{2}mv^2)_{\text{Bottom/Onder}} \\ (9,8)(h) + 0 &\checkmark = 0 + (\frac{1}{2})(7,5)^2 \checkmark \\ h &= 2,87 \text{ m } (2,869 \text{ m}) \checkmark\end{aligned}$$

1 mark for any
1 punt vir enige

This is higher than height needed to pass the target (2,1 m) ✓ therefore the ball will pass the target. ✓

Dit is hoer as die hoogte benodig om punt T (2,1 m) verby te gaan dus sal die bal punt T verbygaan.

OPTION 4/OPSIE 4

$$\begin{aligned}W_{\text{net}} &= \Delta E_K \\ mg\Delta x \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark \\ (9,8)\Delta x \cos 180^\circ &\checkmark = 0 - \frac{1}{2}(7,5)^2 \checkmark \\ \Delta x &= 2,87 \text{ m } (2,869 \text{ m}) \checkmark\end{aligned}$$

This is higher than point height needed to pass point T (2,1 m) ✓ therefore the ball will pass point T. ✓

Dit is hoer as die hoogte benodig om punt T (2,1 m) verby te gaan dus sal die bal punt T verbygaan.

OPTION 5/OPSIE 5

Upward positive/Opwaarts positief

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul
 $v_f^2 = v_i^2 + 2a\Delta y \checkmark$
 $0 \checkmark = [(7,5)^2 + (2)(-9,8)(y_f - 1,6)] \checkmark$
 $y_f = 4,47 \text{ (4,469) m} \checkmark$

Yes ✓✓

OR/OF

This point (4,47m) is higher than point T ✓✓ (or even the required height of 2,1 m) therefore the ball will pass point T.

Ja ✓✓

Dit is hoer as die hoogte benodig om punt T (2,1 m) te bereik dus sal die bal punt T verbygaan.

Downward positive/Afwaarts positief

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul
 $v_f^2 = v_i^2 + 2a\Delta y \checkmark$
 $0 \checkmark = [(-7,5)^2 + (2)(9,8)\{y_f - (-1,6)\}] \checkmark$
 $y_f = -4,47 \text{ (-4,469) m} \checkmark$
 height is/hoogte is 4,47 m.

This point (4,47 m) is higher than point T ✓✓ (or even the required height of 2,1 m) therefore the ball will pass point T.

Hierdie punt (4,47 m) is hoer as punt T (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt T verbygaan.

OPTION 6/OPSIE 6 (POSITIVE MARKING FROM 3.2)

Upward positive/Opwaarts positief

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
 Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$(y_f - 1,6) = (7,5)(0,77) \checkmark + \frac{1}{2} (-9,8)(0,77)^2 \checkmark$$

$$y_f = 4,47 \text{ m } (4,469 \text{ m}) \checkmark$$

This point (4,47m) is higher than point T $\checkmark \checkmark$ (or even the required height of 2,1 m) therefore the ball will pass point T.

Hierdie punt (4,47 m) is hoer as punt T (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt T verbygaan.

Downward positive/Afwaarts positief

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
 Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$\{y_f - (-1,6)\} = (-7,5)(0,765) \checkmark + \frac{1}{2} (9,8)(0,765)^2 \checkmark$$

$$y_f = -4,47 \text{ m } (-4,469 \text{ m}) \checkmark$$

This point (4,47m) is higher than point T $\checkmark \checkmark$ (or even the required height of (2,1m) therefore the ball will pass point T.

Hierdie punt (4,47 m) is hoer as punt T (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt T verbygaan.

OPTION 7/OPSIE 7 (POSITIVE MARKING FROM 3.2)

Upward positive/Opwaarts positief

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$= \left(\frac{0 + 7,5}{2} \right) (0,77) \checkmark \checkmark$$

$$= 2,89 \text{ m } \checkmark$$

This is higher than height needed to pass the target (2,1 m) therefore the ball will pass the target. $\checkmark$

Dit is hoer as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.

OPTION 7/OPSIE 7 (POSITIVE MARKING FROM 3.2)

Downward positive/Afwaarts positief

MARKING FROM 3.2

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$= \frac{0 - 7,5}{2} (0,77) \checkmark \checkmark$$

$$= -2,89 \text{ m } \checkmark$$

Height /Hoogte is 2,89m

This is higher than height needed to pass the target (2,1 m) therefore the ball will pass the target. $\checkmark$

Dit is hoer as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.

OPTION 8/OPSIE 8

Upward positive/Opwaarts positief

At highest point v_f is zero/By hoogste punt is v_f nul

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$0 \checkmark = v_i^2 - (2)(9,8)(2,1) \checkmark$$

$$v_i = 6,42 \text{ m}\cdot\text{s}^{-1} \checkmark$$

This is the actual velocity needed to reach the target.

The given velocity is greater than the actual velocity needed. $\checkmark$

The ball will pass the target. $\checkmark$

Dit is die werklike snelheid benodig is om die teiken te bereik

Die gegewe snelheid is groter as die werklike snelheid benodig

Die bal sal die teiken verbygaan.

Downward positive/Afwaarts positief

At highest point v_f is zero

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$0 \checkmark = v_i^2 + (2)(9,8)(-2,1) \checkmark$$

$$v_i = 6,42 \text{ m}\cdot\text{s}^{-1} \checkmark$$

This is the actual velocity needed to pass the target.

The given velocity is greater than the actual velocity needed. $\checkmark$

The ball will reach the target. $\checkmark$

Dit is die werklike snelheid benodig is om die teiken te verby te gaan.

Die gegewe snelheid is groter as die werklike snelheid benodig

Die bal sal die teiken verbygaan.

OPTION 9/OPSIE 9

$$W_{nc} = \Delta E_p + \Delta E_k \checkmark$$

$$0 = mgh_f - mgh_i + \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$0 \checkmark = (9,8)h_f - (9,8)(1,6) + \frac{1}{2}(0)^2 - \frac{1}{2}(7,5)^2 \checkmark$$

$$0 = (9,8)h_f - 43,805$$

$$\therefore h_f = 4,47 \text{ m} \checkmark$$

$\therefore$ The ball will pass point **T** $\checkmark\checkmark$

Die bal sal punt T verbygaan.

OPTION 10/OPSIE 10

POSITIVE MARKING FROM 3.2 / POSITIEWE NASIEN VANAF 3.2

Upward positive/Opwaarts positief

$$\Delta t(\text{max. height/maks. hoogte}) = 0,77 \text{ s}$$

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$2,1 \checkmark = (7,5) \Delta t + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$$

$$\therefore \Delta t = 0,36 \text{ s} \checkmark$$

$\therefore \Delta t(\text{max height/maks. hoogte}, 0,77 \text{ s}) > \Delta t(\text{to pass point T/ om T verby te gaan}, 0,36 \text{ s}) \checkmark$

$\therefore$ The ball passed point **T** $\checkmark$

Die bal het punt T verbygegaan.

Downward positive/Afwaarts positief

$$\Delta t(\text{max height}) = 0,77 \text{ s}$$

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$2,1 \checkmark = (7,5) \Delta t + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$$

$$\therefore \Delta t = 0,36 \text{ s} \checkmark$$

$\therefore \Delta t(\text{max height}, 0,77 \text{ s}) > \Delta t(\text{to reach point T}, 0,36 \text{ s}) \checkmark$

$\therefore$ The ball passed point **T** $\checkmark$

Die bal het punt T verbygegaan

OPTION 11/OPSIE 11

Upward positive/Opwaarts positief

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$(3,7 - 1,6) \checkmark = 7,5 \Delta t + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$$

$$\Delta t = 0,375 \text{ s} \checkmark$$

The time to pass point **T** is less than time to reach maximum height $\checkmark$. Ball will pass point **T**. $\checkmark$

Die tyd om punt T verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt T verbygaan

Downward positive/Afwaarts positief

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$(3,7 - 1,6) \checkmark = -7,5 \Delta t + \frac{1}{2} (9,8) \Delta t^2 \checkmark$$

$$\Delta t = 0,375 \text{ s} \checkmark$$

The time to reach point **T** is less than time to reach maximum height $\checkmark$. Ball will pass point **T**. $\checkmark$

Die tyd om punt T verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt T verbygaan

OPTION 12/OPSIE 12

Upward positive/Opwaarts positief

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (7,5)^2 \checkmark + 2(-9,8)(2,1) \checkmark$$

$$v_f = 3,88 \text{ m}\cdot\text{s}^{-1} \checkmark$$

Velocity at **T** is $3,88 \text{ m}\cdot\text{s}^{-1}$ therefore the ball still moving towards its maximum height $\checkmark\checkmark$

Snelheid by T is $3,88 \text{ m}\cdot\text{s}^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte

Downward positive/Afwaarts positief

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (-7,5)^2 \checkmark + 2(9,8)(-2,1) \checkmark$$

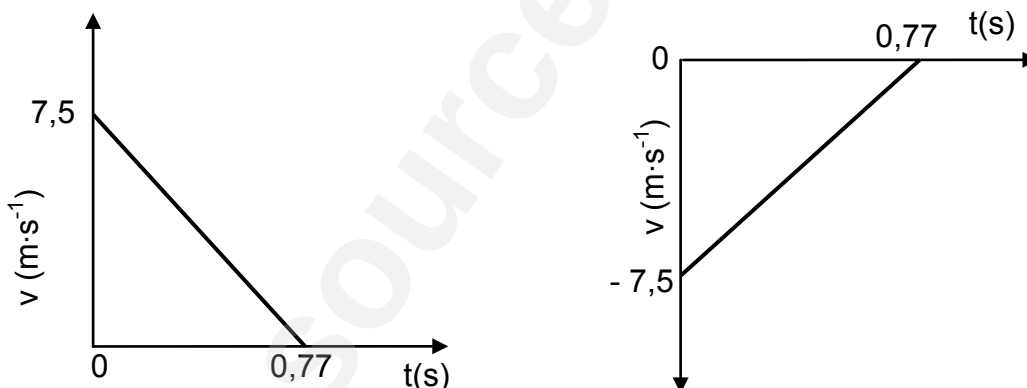
$$v_f = -3,88 \text{ m}\cdot\text{s}^{-1} \checkmark$$

Velocity at **T** is $-3,88 \text{ m}\cdot\text{s}^{-1}$ therefore the ball is still moving towards its maximum height $\checkmark\checkmark$

Snelheid by T is $-3,88 \text{ m}\cdot\text{s}^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte

(6)

3.4 POSITIVE MARKING FROM 3.2 / POSITIEWE NASIEN VANAF 3.2



Notes/Notas:	
Initial velocity and time for final velocity shown <i>Beginsnelheid en tyd vir finale snelheid aangedui.</i>	$\checkmark$
Correct straight line (including orientation) drawn <i>Korrekte reguitlyn (insluitend oriëntasie) geteken.</i>	$\checkmark$

(2)
[13]

QUESTION 4/VRAAG 4

- 4.1 Momentum is the product of the mass of an object and its velocity $\checkmark\checkmark$
Momentum is die produk van die massa van 'n voorwerp en sy snelheid.
[NOTE/LET WEL: 2 or/of 0]

(2)

- 4.2  To the left/Na links $\checkmark$
 Newton's third law/Newton se derde wet $\checkmark$

ACCEPT/AANVAAR:

Principle of conservation of linear momentum / law of action-reaction

Beginsel van behoud van lineêre momentum/wet van aksie-reaksie

Newton's third law **and** Newton's second law/Newton se derde wet **en**

Newton se tweede wet

(2)

NOTE: For QUESTION 4.3 and 4.4 motion to the right has been taken as positive. Candidates may use the opposite direction.

LET WEL: Vir VRAAG 4.3 en 4.4 word beweging na regs as positief geneem. Kandidaat mag die teenoorgestelde rigting gebruik.

4.3

OPTION 1/OPSIE 1

$$\sum p_i = \sum p_f$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{2f} + m_2 v_{2f}$$

mass of girl is m / massa van meisie is m

Allocate mark if 0 is substituted on left hand side/Ken punt toe indien 0 aan linkerkant vervang is.

$$\{(m+2)(0)\} + \{8(0)\} = \{(m+2)(-0,6)\} + (8)(4)$$

$$m = 51,33 \text{ kg}$$

OPTION 2/OPSIE 2

$$\sum p_i = \sum p_f$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{2f} + m_2 v_{2f}$$

$$0 = m_1 v_{1f} + m_2 v_{2f}$$

$$0 = (8)(4) + m_2(-0,6)$$

$$\therefore m_2 = 53,33 \text{ kg}$$

$$\therefore m_{\text{girl}} = 53,33 - 2$$

$$\therefore m_{\text{girl}} = 51,33 \text{ kg}$$

NOTE: Penalise only once for the incorrect sign of the 0,6.
LET WEL: Penaliseer slegs eenmaal die die inkorrekte teken van 0,6

OPTION 3/OPSIE 3

$$\Delta p_{\text{girl}} = -\Delta p_{\text{parcel}}$$

$$m(v_f - v_i) = -m(v_{f-} - v_{i-})$$

$$(m+2)(-0,6 - 0) = -8(4 - 0)$$

$$m = 51,33 \text{ kg}$$

(5)

4.4

POSITIVE MARKING FROM 4.3/POSITIEWE NASIEN VANAF 4.3

$$\text{Impulse} = \Delta p = m(v_f - v_i)$$

$$= (51,33 + 2)(-0,6 - 0)$$

$$= -32 \text{ N}\cdot\text{s} / \text{kg}\cdot\text{m}\cdot\text{s}^{-1}$$

Magnitude of impulse/Grootte van die impuls is $32 \text{ N}\cdot\text{s} / 32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$

OR/OF

$$\text{Impulse} = \Delta p_{\text{parcel/pakket}} = m(v_f - v_i)$$

$$\Delta p = (8)(4 - 0) = 32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$$

$$\therefore \Delta p_{\text{girl/meisie}} = 32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$$

(3)

4.5

POSITIVE MARKING FROM 4.4 /POSITIEWE NASIEN VANAF 4.4

$32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} / \text{N}\cdot\text{s}$ to the right/opposite direction /na regs /teenoorgestelde rigting

(2)

[14]

QUESTION 5/VRAAG 5

- 5.1 A force is non-conservative if the work it does on an object which is moving between two points depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig op 'n voorwerp wat tussen twee punte beweeg van die pad afhang.

OR/OF

A force is non-conservative if the work it does on an object depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhang van die pad wat dit neem.

OR/OF

A force is non-conservative if the work it does in moving an object around a closed path is non-zero. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg nie-nul is.

(2)

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If the word work is omitted 0 marks
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien die woord arbeid uitgelaat is 0 punte.*

- 5.2 No/Nee ✓

(1)

- 5.3

OPTION 1/ OPSIE 1

$$P = \frac{W}{\Delta t} \checkmark$$

$$= \frac{4,8 \times 10^6}{(90)} \checkmark$$

$$= 53\,333,33 \text{ W}$$

$$= 5,33 \times 10^4 \text{ W (53,33 kW)} \checkmark$$

OPTION 2/ OPSIE 2

$$\Delta x = \left(\frac{v_f + v_i}{2} \right) \Delta t$$

$$= \left(\frac{0 + 25}{2} \right) (90)$$

$$= 1\,125 \text{ m}$$

$$W_F = F \Delta x \cos \theta$$

$$4,80 \times 10^6 = F(1\,125) \cos 0^\circ$$

$$F = 4\,266,667 \text{ N}$$

$$P_{\text{ave}} = F v_{\text{ave}} \checkmark$$

$$= (4\,266,667)(12,5) \checkmark$$

$$= 53\,333,33 \text{ W} \checkmark$$

(3)

- 5.4 The net/total work done on an object is equal to the change in the object's kinetic energy ✓✓

Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie.

OR/OF

The work done on an object by a net force ✓ is equal to the change in the object's kinetic energy. ✓

Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.

(2)

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

- 5.5 **OPTION 1/OPSIE 1**

$$W_{\text{net}} = \Delta K \checkmark$$

$$W_w + W_f + W_F = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$$

$$mg\Delta x \cos\theta + W_f + W_F = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$$

$$(1\,500)(9,8)200\cos 180^\circ \checkmark + W_f + 4,8 \times 10^6 \checkmark = \frac{1}{2} (1\,500)(25^2 - 0) \checkmark$$

$$-2\,940\,000 + W_f + 4,8 \times 10^6 = 468\,750$$

$$W_f = -1\,391\,250 \text{ J}$$

$$= -1,39 \times 10^6 \text{ J} \checkmark$$

OR/OF

$$W_{\text{net}} = \Delta K \checkmark$$

$$W_w + W_f + W_F = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$$

$$-\Delta E_p + W_f + W_F = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$$

$$-(1\,500)(9,8)(200 - 0) \checkmark + W_f + 4,8 \times 10^6 \checkmark = \frac{1}{2} (1\,500)(25^2 - 0) \checkmark$$

$$-2\,940\,000 + W_f + 4,8 \times 10^6 = 468\,750$$

$$W_f = -1\,391\,250 \text{ J}$$

$$= -1,39 \times 10^6 \text{ J} \checkmark$$

(5)

NOTE/LET WEL

0 can be omitted in above substitutions.

0 kan in bogenoemde vervangings weggelaat word.

OPTION 2/OPSIE 2

$$W_{nc} = \Delta K + \Delta U$$

$$W_{nc} = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2 + mgh_f - mgh_i$$

$$= \frac{1}{2} m (v_f^2 - v_i^2) + mg(h_f - h_i)$$

$$W_{nc} = \frac{1}{2} mv_f^2 + mgh_f - \frac{1}{2} mv_i^2 - mgh_i$$

$$W_f + W_F = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2 + mgh_f - mgh_i$$

$$W_f + 4,8 \times 10^6 \checkmark = \left[\frac{1}{2} (1\,500)(25)^2 + -0 \right] \checkmark + \left[(1\,500)(9,8)(200) - 0 \right] \checkmark$$

$$W_f = -1,39 \times 10^6 \text{ J } (-1,40 \times 10^6 \text{ J}) \checkmark$$

1 mark for any of these/
 1 punt vir enige van hierdie

OR/OF

$$W_{nc} = \Delta K + \Delta U$$

$$W_{nc} = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2 + mgh_f - mgh_i$$

$$= \frac{1}{2} m (v_f^2 - v_i^2) + mg(h_f - h_i)$$

$$W_{nc} = \frac{1}{2} mv_f^2 + mgh_f - \frac{1}{2} mv_i^2 - mgh_i$$

$$W_f + 4,8 \times 10^6 \checkmark = \left[\frac{1}{2} (1\,500)(25)^2 \checkmark + (1\,500)(9,8)(200) \checkmark \right] - [0 + 0]$$

$$W_f = -4,8 \times 10^6 + 3,4 \times 10^6$$

$$= -1,39 \times 10^6 \text{ J } (-1,40 \times 10^6 \text{ J}) \checkmark$$

1 mark for any of these/
 1 punt vir enige van hierdie

(5)

ACCEPT THE FOLLOWING FOR: /AANVAAR DIE VOLGENDE VIR: $\left(\frac{3}{5}\right)$

POSITIVE MARKING FROM 5.3/POSITIEWE NASIEN VANAF 5.3

$$v_f = v_i + a\Delta t$$

$$25 = 0 + a(90)$$

$$a = 0,277... \text{ m} \cdot \text{s}^{-2}$$

$$F_{net} = ma$$

$$= (1\,500)(0,2777...) = 416,66... \text{ N}$$

$$F + (w_{||}) + (-f_k) = 416,666...$$

$$4\,266,6667 - 1\,500(9,8)\sin\theta - f_k = 416,666...$$

$$f_k = 1\,236,6667 \text{ N}$$

$$W_f = f_k \Delta x \cos\theta \checkmark$$

$$= (1\,236,6667)(1\,125)(\cos 180^\circ) \checkmark$$

$$= -1\,391\,250 \text{ J } \checkmark$$

(5)

[13]

QUESTION 6/VRAAG 6

- 6.1 The change in frequency (or pitch), of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓

Die verandering in frekwensie (of toonhoogte) (golflengte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting het.

OR/OF

An (apparent) change in observed/detected frequency (pitch), as a result of the relative motion between a source and an observer ✓✓ (listener).

'n (Skynbare) verandering in waargenome frekwensie (toonhoogte), (golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar

(2)

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

- 6.2 Away from/Weg vanaf ✓

Observed frequency lower/Waargenome frekwensie is laer ✓

(2)

- 6.3

$$v = f\lambda \quad \checkmark$$

$$340 = f(0,34) \quad \checkmark$$

$$f = 1\,000 \text{ Hz} \quad \checkmark$$

(3)

- 6.4

POSITIVE MARKING FROM 6.3/POSITIEWE NASIEN VANAF 6.3

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \checkmark$$

OR/OF

$$f_L = \frac{v - v_L}{v} f_s$$

$$950 = \frac{340 - v_L}{340 + 0} 1\,000 \quad \checkmark$$

$$v_L = 17 \text{ m} \cdot \text{s}^{-1}$$

$$\begin{aligned} \text{distance/afstand } x &= v\Delta t \\ &= (17)(10) \quad \checkmark \\ &= 170 \text{ m} \quad \checkmark \end{aligned}$$

OR/OF

$$f_L = \frac{v - v_L}{v} f_s \quad \checkmark$$

$$950 = \frac{340 - \frac{x}{10}}{340 + 0} (1000) \quad \checkmark$$

$$\text{distance/afstand } x = 170 \text{ m} \quad \checkmark$$

ACCEPT/AANVAAR

$$v_L = \Delta f \lambda \checkmark$$

$$= (50) \checkmark \checkmark (0,34) \checkmark$$

$$= 17 \text{ m} \cdot \text{s}^{-1}$$

$$\text{distance/afstand } x = v \Delta t$$

$$= (17)(10) \checkmark$$

$$= 170 \text{ m} \checkmark$$

(6)

[13]

QUESTION 7/VRAAG 7

7.1

$$Q_{\text{net/netto}} = \frac{Q_1 + Q_2 + Q_3}{3}$$

$$-3 \times 10^{-9} = \frac{-15 \times 10^{-9} + Q + 2 \times 10^{-9}}{3} \checkmark$$

$$Q = +4 \times 10^{-9} \text{ C} \checkmark$$

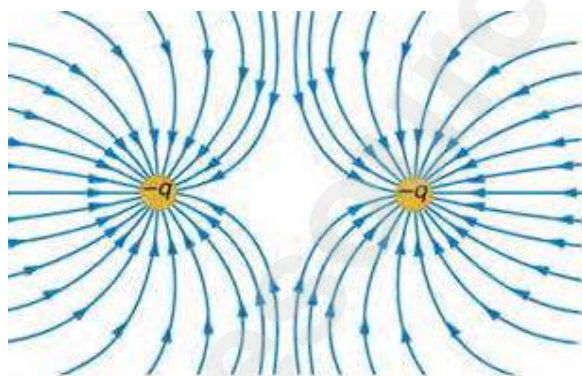
NOTE/LET WEL

✓ for addition of the three correct charges

✓ correct answer

(2)

7.2



NOTES/NOTAS

Correct shape /Korrekte vorm ✓

Correct direction/Korrekte rigting ✓

Lines must not cross and must touch spheres ✓

Lyne moet nie kruis nie en moet die sfere raak

(3)

7.3

The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes) of the charges and inversely proportional to the square of the distance (r) between them ✓✓

Die grootte van die elektrostatiese krag uitgeoefen deur een puntlading (Q_1) op 'n ander puntlading (Q_2) is direk eweredig aan die produk van die (groottes) van die ladings en omgekeerde eweredig aam die kwadraat van die afstand (r) tussen hulle.

(2)

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If masses used (0/2)

Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien massas gebruik word, (0/2)

7.4

OPTION 1/OPSIE 1

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F_{SP} = \frac{(9 \times 10^9)(3 \times 10^{-9})(3 \times 10^{-9})}{(0,1)^2} \checkmark$$

$$= 8,1 \times 10^{-6} \text{ N downwards/afwaarts}$$

$$F_{TP} = \frac{(9 \times 10^9)(3 \times 10^{-9})(3 \times 10^{-9})}{(0,3)^2} \checkmark$$

$$= 9 \times 10^{-7} \text{ N left/links } (0,9 \times 10^{-6} \text{ N to the left/na links})$$

$$F_{\text{net}}^2 = (F_{SP})^2 + (F_{TP})^2$$

$$F_{\text{net}} = \sqrt{(F_{SP})^2 + (F_{TP})^2} \quad \checkmark \text{ for either}$$

$$F_{\text{net}} = \sqrt{(8,1 \times 10^{-6})^2 + (0,9 \times 10^{-6})^2}$$

$$F_{\text{net}} = 8,15 \times 10^{-6} \text{ N } \checkmark$$

OPTION 2/OPSIE 2

$$E_s = \frac{kQ}{r^2} \checkmark$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,1)^2}$$

$$= 2700 \text{ N.C}^{-1}$$

$$E_T = \frac{kQ}{r^2}$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,3)^2}$$

$$= 300 \text{ N.C}^{-1}$$

✓ both substitutions
beide vervangings

$$E_{\text{net}} = \sqrt{E_s^2 + E_T^2}$$

$$= \sqrt{(2700)^2 + (30)^2} \checkmark$$

$$= 2716,62 \text{ N.C}^{-1}$$

$$F = Eq$$

$$= (2716,62)(3 \times 10^{-9}) \checkmark$$

$$= 8,15 \times 10^{-6} \text{ N } \checkmark$$

(5)

7.5

POSITIVE MARKING FROM 7.4 / POSITIEWE NASIEN VANAF 7.4

OPTION 1/OPSIE 1

$$E = \frac{F}{q} \checkmark$$

$$= \frac{8,15 \times 10^{-6}}{3 \times 10^{-9}} \checkmark$$

$$= 2,72 \times 10^3 \text{ N.C}^{-1} \checkmark$$

(3)

OPTION 2/OPSIE 2

$$E_s = \frac{kQ}{r^2} \checkmark$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,1)^2} \checkmark$$

$$= 2\,700 \text{ N.C}^{-1}$$

$$E_T = \frac{kQ}{r^2}$$

$$= \frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,3)^2} \checkmark$$

$$= 300 \text{ N.C}^{-1}$$

$$E_{\text{net}} = \sqrt{E_s^2 + E_T^2}$$

$$= \sqrt{(2700)^2 + (30)^2}$$

$$= 2\,716,62 \text{ N.C}^{-1} \checkmark$$

NOTE/LET WEL

Mark Allocation/Puntetoekenning

- ✓ correct formula/korrekte formula
- ✓ both substitutions/beide vervangings
- ✓ correct answer/korrekte antwoord

If calculation done in 7.4 award full marks for answer written here. / Indien berekening in 7.4 gedoen is, moet volle punte vir die antwoord wat hier geskryf is, toegeken word.

7.6.1 Sphere/Sfeer P or/of T ✓

(1)

7.6.2 **SPHERE P/SFEER P**

$$n_e = \frac{Q}{q_e} \text{ or/of } n_e = \frac{Q}{e}$$

$$= \frac{-15 \times 10^{-9}}{-1,6 \times 10^{-19}} \checkmark = 9,38 \times 10^{10}$$

mass gained/massa gewin = $n_e m_e$
 m gained /gewin = $(9,38 \times 10^{10})(9,11 \times 10^{-31}) \checkmark$
 $= 8,55 \times 10^{-20} \text{ kg} \checkmark$

SPHERE T/SFEER T

$$n_e = \frac{Q}{q_e} \text{ or/of } n_e = \frac{Q}{e}$$

$$= \frac{-5 \times 10^{-9}}{-1,6 \times 10^{-19}} \checkmark = 3,125 \times 10^{10}$$

mass gained/massa gewin = $n_e m_e$
 m gained /gewin = $(3,125 \times 10^{10})(9,11 \times 10^{-31}) \checkmark$
 $= 2,85 \times 10^{-20} \text{ kg} \checkmark$

(3)

[19]

QUESTION 8/VRAAG 8

- 8.1 The battery supplies 12 J per coulomb/12 J per unit charge. ✓✓
Die battery verskaf 12 J per coulomb lading

OR /OF

The potential difference of the battery in an open circuit is 12 V. ✓✓
Die potensiaal verskil van die battery in 'n oop stroombaan is 12 V

OR/OF

The battery does 12 J of work per coulomb of charge. ✓✓
Die battery verrig 12 J arbeid per coulomb lading

OR/OF

Maximum work done by the battery per unit charge is 12 J
Maksimum arbeid verrig deur die battery per eenheidslading is 12 J

OR/OF

Maximum energy supplied by the battery per unit charge is 12 J
Maksimum energie verskaf deur die battery per eenheidslading is 12 J

OR/OF

The battery supplies 12 J of energy per coulomb/ 12 J of energy per unit charge
Die battery verskaf 12 J energie per coulomb/12 J energie per eenheidslading

OR/OF

The greatest potential difference that can be generated by a battery is 12V
Die grootste potensiaalverskil wat deur 'n battery gelewer word, is 12 V

OR/OF

The total energy transferred by a battery to a unit electric charge is 12 J
Die totale energie oorgedra deur die battery aan 'n eenheid elektriese lading is 12 J

OR/OF

The total amount of electric energy supplied by the battery per coulomb/per unit charge is 12 J
Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheid lading is 12 J

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af*

8.2.1

OPTION 1/OPSIE 1

$$V_{\text{lost/verlore}} = I r \quad \checkmark$$

$$= (2) (0,5)$$

$$= 1 \text{ V}$$

$$V_{\text{ext/eks}} = \text{Emf/emk} - V_{\text{lost/verlore}}$$

$$= (12 - 1) \quad \checkmark$$

$$= 11 \text{ V} \quad \checkmark$$

OPTION 2/OPSIE 2

$$\begin{aligned}\varepsilon &= I(R + r) \checkmark \\ 12 &= V_{\text{ext/eks}} + (2)(0,5) \checkmark \\ V_{\text{ext/eks}} &= 11 \text{ V} \checkmark\end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}\varepsilon &= I(R + r) \checkmark \\ 12 &= 2(R + 0,5) \\ R &= 5,5 \Omega \\ V &= IR \\ &= 2(5,5) \checkmark \\ &= 11 \text{ V} \checkmark\end{aligned}$$

(3)

8.2.2

POSITIVE MARKING FROM 8.2.1/POSITIEWE NASIEN VANAF 8.2.1

OPTION 1/OPSIE 1

$$\begin{aligned}R &= \frac{V}{I} \\ &= \frac{11}{2} \checkmark \\ &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}0,5:R \\ 1:11 \quad \left. \vphantom{\begin{matrix} 0,5:R \\ 1:11 \end{matrix}} \right\} \checkmark \\ R &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}\frac{1}{0,5} &= \frac{11}{R} \checkmark \\ R &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 4/OPSIE 4

$$\begin{aligned}V_{\text{total}} &= IR_{\text{total}} \\ 12 &= (2)R_{\text{total}} \\ R_{\text{total}} &= 6 \Omega \\ R &= 6 - 0,5 \checkmark \\ &= 5,5 \Omega \checkmark\end{aligned}$$

OPTION 5/OPSIE 5

$$\begin{aligned}\varepsilon &= I(R + r) \\ 12 &= 2(R + 0,5) \checkmark \\ R &= 5,5 \Omega \checkmark\end{aligned}$$

(2)

- 8.3  Decreases /Neem af ✓
 Total resistance decreases /Totale weerstand neem af ✓
 Current increases/Stroom neem toe ✓
 "Lost volts" increases, ✓(emf the same)/"Verlore volts" neem toe, (emk dieselfde)
 External potential difference decreases/eksterne potensiaal verskil neem af

OR/OF

Decreases /Neem af ✓
 Total resistance decreases /Totale weerstand neem af ✓
 Current increases/Stroom neem toe ✓
 $\varepsilon = V_{\text{ext/eks}} + Ir$
 Ir increases/Ir neem toe ✓
 ε is constant/is konstant
 $\therefore V_{\text{ext/eks}}$ decreases/neem af

(4)
[11]

QUESTION 9/VRAAG 9

- 9.1 Temperature/Temperatuur ✓ (1)

- 9.2.1 $r = 3 \Omega$ or/of 1,5 Ω ✓✓

Accept for one mark only: /Aanvaar vir slegs een punt

$r = -3 \Omega$ ✓ or/of -1,5 Ω

(2)

- 9.2.2 $\varepsilon = \text{slope (gradient) of the graph/helling(gradient) van die grafiek} \checkmark$

$$\varepsilon = \frac{7,5 - (-3)}{1,5 - 0} \checkmark$$

$$= 7 \text{ V} \checkmark$$

Accept any correct values from the graph
 Aanvaar enige korrekte waardes vanaf die grafiek

OR/OF

POSITIVE MARKING FROM 9.2.1 / POSITIEWE NASIEN VANAF 9.2.1

$$R = \frac{\varepsilon}{I} - r \checkmark$$

$$7,5 = 1,5\varepsilon - 3 \checkmark$$

$$\varepsilon = 7 \text{ V} \checkmark$$

Accept any correct values on the line from the graph
 Aanvaar enige korrekte waardes op die lyn vanaf die grafiek

OR/OF

$$\varepsilon = I(R + r) \checkmark$$

$$= 0,5(11 + 3) \checkmark$$

$$\varepsilon = 7 \text{ V} \checkmark$$

(3)
[6]

QUESTION 10/VRAAG 10

10.1.1 Y to/na X ✓ (1)

10.1.2 Faraday's Law Electromagnetic Induction ✓
 Faraday se wet van Elektromagnetiese Induksie

OR/OF

Electromagnetic induction/Faraday's Law ✓
 Elektromagnetiese induksie/Faraday se wet (1)

10.1.3 Mechanical (kinetic) energy ✓ to electrical energy ✓
 Meganiese (kinetiese) energie na elektriese energie (2)

10.2.1 340 V ✓
 Accept / Aanvaar (1)
 -340 V

10.2.2 **POSITIVE MARKING FROM 10.2.1/POSITIEWE NASIEN VANAF 10.2.1**

$$V_{\text{rms/wgk}} = \frac{V_{\text{max/maks}}}{\sqrt{2}} \checkmark$$

$$= \frac{340}{\sqrt{2}} \checkmark$$

$$V_{\text{rms/wgk}} = 240,42 \text{ V} \checkmark$$

(3)

10.2.3 **POSITIVE MARKING FROM 10.2.2 / POSITIEWE NASIEN VANAF 10.2.3**

OPTION 1/OPSIE 1

$$P_{\text{ave/gemid}} = \frac{V_{\text{rms/wgk}}^2}{R} \checkmark$$

$$1\,600 = \frac{(240,42)^2}{R} \checkmark$$

$$R = 36,13 \, \Omega \text{ (36,126 } \Omega) \checkmark$$

OR/OF

$$R = 36,12 \, \Omega \text{ (36,124 } \Omega)$$

OPTION 2/ OPSIE 2

$$P_{\text{ave/gemid}} = \frac{V_{\text{rms/wgk}}^2}{R} = \frac{V_{\text{max/maks}}^2}{2R} = \frac{V_{\text{max/maks}}^2}{2R} \checkmark$$

$$1\,600 = \frac{(340)^2}{2R} \checkmark$$

$$R = 36,13 \, \Omega \text{ (36,125 } \Omega) \checkmark$$

OPTION 3/OPSIE 3	OPTION 4/OPSIE 4
$P_{\text{ave/gemid}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}}$ $1600 = (240,416) I_{\text{rms/wgk}}$ $I_{\text{rms/wgk}} = 6,66 \text{ A}$ $R = \frac{V_{\text{rms}}}{I_{\text{rms}}} \checkmark$ $= \frac{240,416}{6,66} \checkmark$ $= 36,1 \Omega (36,09 \Omega) \checkmark$	$P_{\text{ave/gemid}} = \frac{V_{\text{max/maks}} I_{\text{max/maks}}}{2}$ $1600 = \frac{340 I_{\text{max/maks}}}{2}$ $I_{\text{max/maks}} = 9,412 \text{ A}$ $R = \frac{V_{\text{max}}}{I_{\text{max}}} \checkmark$ $= \frac{340}{9,412} \checkmark$ $= 36,12 \Omega \checkmark$
(Do not penalise if rms is omitted in $R = \frac{V_{\text{rms}}}{I_{\text{rms}}}$ / Moenie penaliseer indien wgk uitgelaat is nie.)	(Do not penalise if max is omitted in $R = \frac{V_{\text{max}}}{I_{\text{max}}}$ / Moenie penaliseer indien maks uitgelaat

(3)
[11]

QUESTION 11/VRAAG 11

- 11.1 Work function of a metal is the minimum energy needed to eject an electron from the metal surface ✓✓
 Arbeidsfunksie van 'n metaal is die minimum energie benodig om 'n elektron uit die oppervlakte van 'n metaal vry te stel.

(2)

NOTE/LET WEL

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

- 11.2 Potassium / Kalium / K ✓

f_0 for potassium is greater than f_0 for caesium ✓
 f_0 vir kalium is groter as f_0 vir sesium

OR/OF

Work function is directly proportional to threshold frequency ✓
 Arbeidsfunksie is direk eweredig aan die drumpel frekwensie

ACCEPT/AANVAAR

$$W_0 = hf_0$$

$$W_0 \propto f_0$$

(2)

- 11.3 **OPTION 1/OPSIE 1**

$$c = f\lambda \checkmark$$

$$3 \times 10^8 = f(5,5 \times 10^{-7}) \checkmark$$

$$f = 5,45 \times 10^{14} \text{ Hz}$$

$$f_{\text{uv}} < f_0 \text{ of K(potassium)}$$

∴ Ammeter in circuit **B** will not show a reading ✓

∴ Ammeter in stroombaan **B** sal nie 'n lesing toon nie.

OPTION 2/OPSIE 2

$$E = \frac{hc}{\lambda} = \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5,5 \times 10^{-7}} \\ = 3,6164 \times 10^{-19} \text{ J}$$

$$W_0 = hf_0 = (6,63 \times 10^{-34})(5,55 \times 10^{14}) = 3,68 \times 10^{-19} \text{ J}$$

$$W_0 > E \text{ or/of } hf_0 > hf$$

∴ The ammeter will not register a current / *ammeter sal nie lesing registreer* ✓

Mark allocation / Punttoekening

- ✓ both correct formulae/*beide korrekte formules*: $E = \frac{hc}{\lambda}$ and $W_0 = hf_0$
- ✓ both substitutions/*beide vervangings*: $\frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5,5 \times 10^{-7}}$ and/en $(6,63 \times 10^{-34})(5,55 \times 10^{14})$
- ✓ correct conclusion

OPTION 3/OPSIE 3

$$c = f_0 \lambda_0 \quad \checkmark$$

$$3 \times 10^8 = (5,55 \times 10^{14}) \lambda \quad \checkmark$$

$$\lambda_0 = 5,41 \times 10^{-7} \text{ m}$$

$$\lambda_0 \text{ (threshold wavelength)} < \lambda \text{ (incident wavelength)}$$

$$\lambda_0 \text{ (drumpelgolflengte)} < \lambda \text{ (invallende golflengte)}$$

∴ the ammeter will not register a current / *ammeter sal nie lesing registreer* ✓

(3)

11.4

OPTION 1/OPSIE 1

$$E = W_0 + E_{k(\max)}$$

$$hf = hf_0 + \frac{1}{2}mv_{\max}^2$$

$$h \frac{c}{\lambda} = h \frac{c}{\lambda_0} + E_{k(\max)}$$

NOTE: If E_K of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.

LET WEL: Indien E_k van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord

$$\frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5,5 \times 10^{-7}} \checkmark = \frac{(6,63 \times 10^{-34})(5,07 \times 10^{14})}{5,5 \times 10^{-7}} + E_{k(\max)} \checkmark$$

$$E_K = 2,55 \times 10^{-20} \text{ J} \quad \checkmark \quad (\text{Range/Gebied: } 2,52 \times 10^{-20} - 2,6 \times 10^{-20} \text{ J})$$

OPTION 2/OPSIE 2

POSITIVE MARKING FROM 11.3/POSITIEWE NASIEN VANAF 11.3

$$\left. \begin{aligned} E &= W_0 + E_{k(\max)} \\ hf &= hf_0 + \frac{1}{2}mv_{\max}^2 \\ h\frac{c}{\lambda} &= h\frac{c}{\lambda_0} + E_{k(\max)} \end{aligned} \right\} \checkmark$$

NOTE: If E_K of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.

LET WEL: Indien E_k van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord

$$(6,63 \times 10^{-34})(5,45 \times 10^{14}) \checkmark\checkmark = (6,63 \times 10^{-34})(5,07 \times 10^{14}) + E_{k(\max)} \checkmark$$

$$E_K = 2,52 \times 10^{-20} \text{ J } \checkmark \quad (\text{Range/Gebied: } 2,52 \times 10^{-20} - 2,6 \times 10^{-20} \text{ J})$$

(5)

11.5 Remains the same/Bly dieselfde $\checkmark$

(1)
[13]

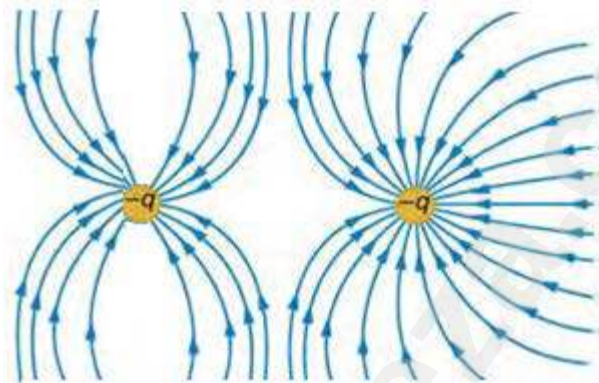
TOTAL/TOTAAL: 150

ADDENDUM

QUESTION 7.2

Accept the following electric field diagram which would be formed if the effect of the third charge is considered.

Aanvaar die volgende elektrieseveld diagram wat gevorm sal word indien die effek van die derde lading in ag geneem is.





basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2019

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 A car is moving at a **constant velocity**.

Which ONE of the following statements about the forces acting on the car is CORRECT?

- A The net force acting on the car is zero.
- B There are no forces acting on the car.
- C The weight of the car is equal to the normal force acting on the car.
- D There is a non-zero net force acting on the car. (2)

1.2 A ball is projected vertically upwards. Ignore air resistance.

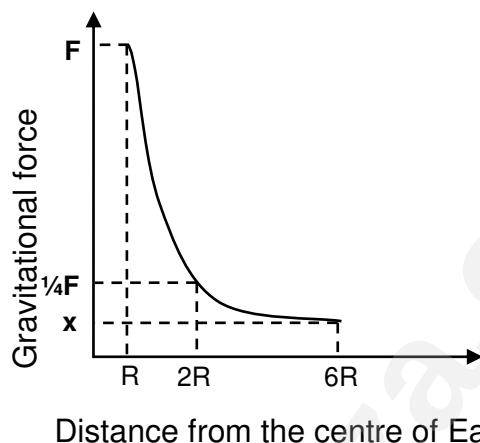
Which ONE of the following statements about the acceleration of the ball at its maximum height is CORRECT?

The acceleration is equal to ...

- A zero.
- B g and is directed downwards.
- C g and is directed upwards.
- D g and is directed horizontally. (2)

- 1.3 The graph below, not drawn to scale, shows the relationship between the gravitational force on a given mass and its distance from the centre of Earth.

The magnitude of the force on the mass at a distance R from the centre of Earth is F .



Which ONE of the following is the CORRECT representation of the magnitude of force x shown on the graph?

- A $6F$
- B $12F$
- C $\frac{1}{6}F$
- D $\frac{1}{36}F$

(2)

- 1.4 Ball M, moving at speed v to the right, collides with a stationary ball N on a smooth horizontal surface. Immediately after the collision, ball M comes to rest and ball N moves to the right with speed v .

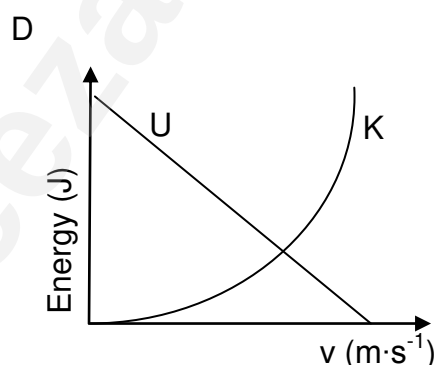
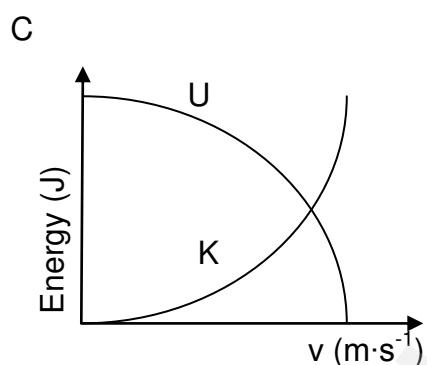
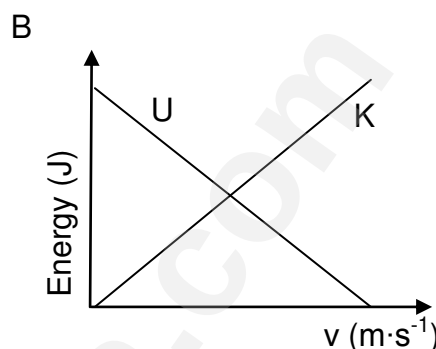
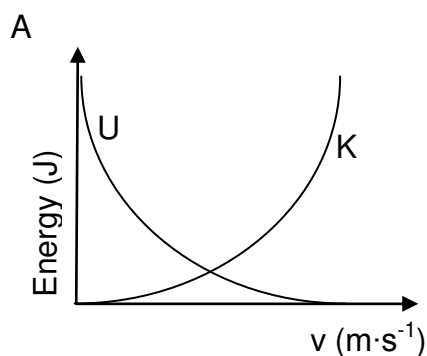
Which ONE of the following statements about the collision of the balls is CORRECT?

- A Total momentum is conserved and the masses of the balls are unequal.
- B Total kinetic energy is conserved and the masses of the balls are unequal
- C Total momentum and total kinetic energy are conserved and the masses of the balls are equal.
- D Total momentum is conserved but total kinetic energy is not conserved and the masses of the balls are equal.

(2)

- 1.5 A small stone is dropped from rest and undergoes free fall.

Which ONE of the graphs below shows the CORRECT relationship between the gravitational potential energy (U) and speed v and the kinetic energy (K) and speed v , respectively, for the stone? The graphs are NOT drawn to scale.



(2)

- 1.6 A stationary passenger at a railway station listens to a train approaching at constant speed.

Which ONE of the following is CORRECT for the sound of the approaching train heard by the stationary passenger?

- A Lower pitch, lower frequency
- B Higher pitch, lower frequency
- C Higher pitch, higher frequency
- D Lower pitch, higher frequency

(2)

- 1.7 Particle P has charge Q and particle R has charge $2Q$. They are separated by a small distance, r .

Which ONE of the statements below about the electrostatic forces, F_{PR} , which P exerts on R and F_{RP} , which R exerts on P, is CORRECT?

A $F_{PR} = \frac{1}{2}F_{RP}$

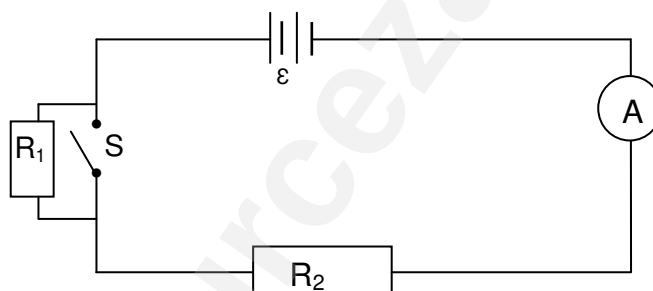
B $F_{PR} = F_{RP}$

C $F_{PR} = 2F_{RP}$

D $F_{PR} = -F_{RP}$

(2)

- 1.8 A battery of emf $\mathcal{E}$ and negligible internal resistance is connected in a circuit, as shown below. The resistances of R_1 and R_2 are high.



Which ONE of the following combinations about the ammeter readings will be CORRECT when switch S is open and when switch S is closed?

	SWITCH OPEN	SWITCH CLOSED
A	Ammeter reads only the current in R_1	Ammeter reads only the current in R_2
B	Ammeter reads only the current in R_2	Ammeter reads the current in both R_1 and R_2
C	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in both R_1 and R_2
D	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in R_2 only

(2)

- 1.9 The direction of the induced current in the coil of a generator depends on the ...

- A length of the coil.
 B speed of rotation of the coil.
 C direction of the magnetic field.
 D strength of the magnetic field.

(2)

1.10 The work function of zinc is greater than that of magnesium.

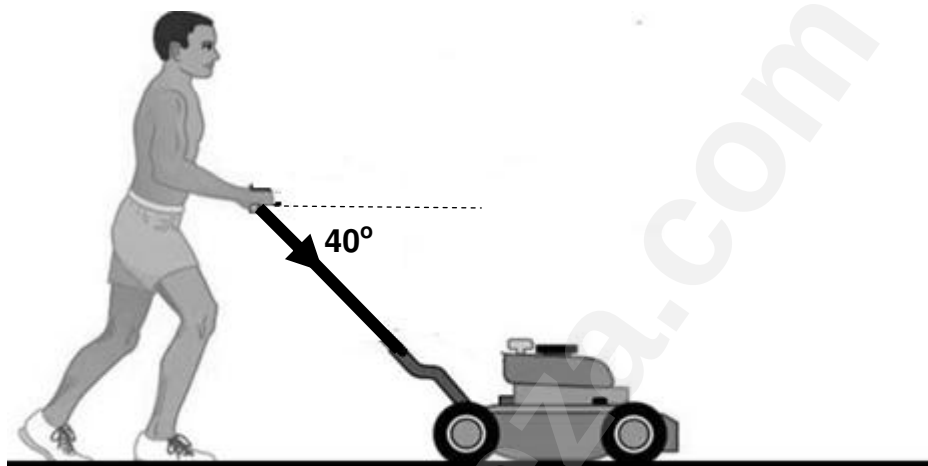
Which ONE of the following statements about the threshold frequencies of the metals is CORRECT?

- A The threshold frequency of zinc is greater than that of magnesium.
- B The threshold frequency of zinc is smaller than that of magnesium.
- C Both zinc and magnesium have the same threshold frequency.
- D The threshold frequencies of zinc and magnesium are independent of their work functions.

(2)
[20]

QUESTION 2 (Start on a new page.)

- 2.1 A person pushes a lawn mower of mass 15 kg at a **constant speed** in a straight line over a flat grass surface with a force of 90 N. The force is directed along the handle of the lawn mower. The handle has been set at an angle of 40° to the horizontal. Refer to the diagram below.



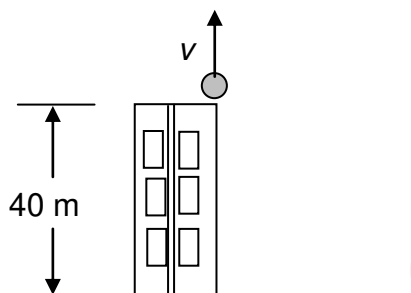
- 2.1.1 Draw a labelled free-body diagram for the lawn mower. (4)
- 2.1.2 Why is it CORRECT to say that the moving lawn mower is in equilibrium? (1)
- 2.1.3 Calculate the magnitude of the frictional force acting between the lawn mower and the grass (3)

The lawn mower is now brought to a stop.

- 2.1.4 Calculate the magnitude of the constant force that must be applied through the handle in order to accelerate the lawn mower *from rest* to $2 \text{ m}\cdot\text{s}^{-1}$ in a time of 3 s. Assume that the frictional force between the lawn mower and grass remains the same as in QUESTION 2.1.3. (6)
- 2.2 Planet **Y** has a radius of $6 \times 10^5 \text{ m}$. A 10 kg mass weighs 20 N on the surface of planet **Y**. (4)
- Calculate the mass of planet **Y**. [18]

QUESTION 3 (Start on a new page.)

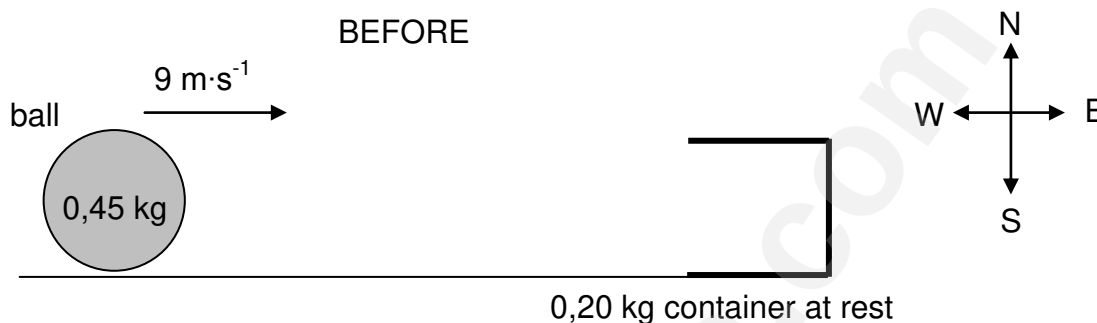
A ball is thrown vertically upwards, with velocity v , from the edge of a roof of a 40 m tall building. The ball takes 1,53 s to reach its maximum height. Ignore air resistance.



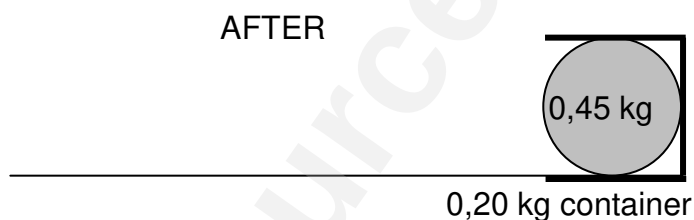
- 3.1 Define the term *free fall*. (2)
- 3.2 Calculate the:
- 3.2.1 Magnitude of the initial velocity v of the ball (3)
- 3.2.2 Maximum height reached by the ball above the edge of the roof (3)
- 3.3 Take the edge of the roof as reference point. Determine the position of the ball relative to the edge of the roof after 4 s. (3)
- 3.4 Will any of the answers to QUESTIONS 3.2 and 3.3 change if the height of the building is 30 m? Choose from YES or NO. (3)
- Give a reason for the answer. [14]

QUESTION 4 (Start on a new page.)

A soccer player kicks a ball of mass $0,45 \text{ kg}$ to the east. The ball travels horizontally at a velocity of $9 \text{ m}\cdot\text{s}^{-1}$ along a straight line, without touching the ground, and enters a container lying at rest on its side, as shown in the diagram below. The mass of the container is $0,20 \text{ kg}$.



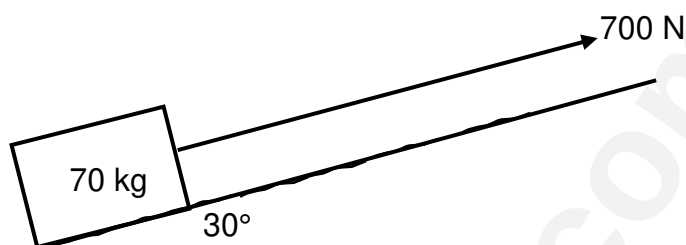
The ball is stuck in the container after the collision. The ball and container now move together along a straight line towards the east. Ignore friction and rotational effects.



- 4.1 State the principle of conservation of linear momentum in words. (2)
- 4.2 Calculate the magnitude of the velocity of the ball-container system immediately after the collision. (4)
- 4.3 Determine, by means of a suitable calculation, whether the collision between the ball and container is elastic or inelastic. (5)
- [11]**

QUESTION 5 (Start on a new page.)

A 70 kg box is initially at rest at the bottom of a ROUGH plane inclined at an angle of 30° to the horizontal. The box is pulled up the plane by means of a light inextensible rope, held parallel to the plane, as shown in the diagram below. The force applied to the rope is 700 N.



5.1 What is the name given to the force in the rope? (1)

5.2 Give a reason why the mechanical energy of the system will NOT be conserved as the box is pulled up the plane. (1)

The box is pulled up over a distance of 4 m along the plane. The kinetic frictional force between the box and the plane is 178,22 N.

5.3 Draw a labelled free-body diagram for the box as it moves up the plane. (4)

5.4 Calculate the work done on the box by the frictional force over the 4 m. (3)

5.5 Use energy principles to calculate the speed of the box after it has moved 4 m. (5)

5.6 When the box is 4 m up the incline, the rope accidentally breaks, causing the box to slide back down to the bottom of the inclined plane.

What will be the total work done by friction when the box moves up and then down to the bottom of the inclined plane?

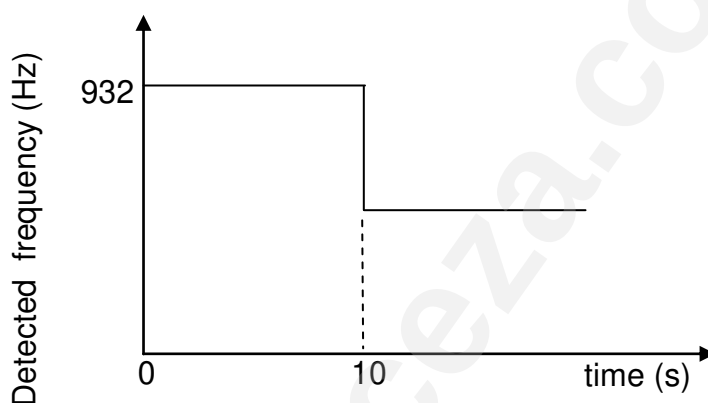
(1)
[15]

QUESTION 6 (Start on a new page.)

- 6.1 A patrol car is moving at a constant speed towards a stationary observer. The driver switches on the siren of the car when it is 300 m away from the observer.

The observer records the detected frequency of the sound waves of the siren as the patrol car *approaches*, *passes* and *moves away* from him.

The information obtained is shown in the graph below.



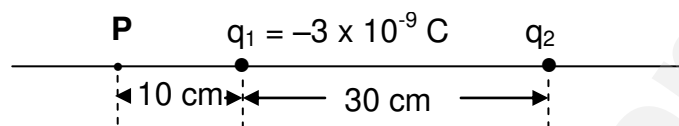
- 6.1.1 Calculate the speed of the patrol car. (2)
- 6.1.2 State the Doppler effect. (2)
- 6.1.3 The detected frequency suddenly changes at $t = 10$ s. Give a reason for this change. (2)

Take the speed of sound in air as $340 \text{ m} \cdot \text{s}^{-1}$.

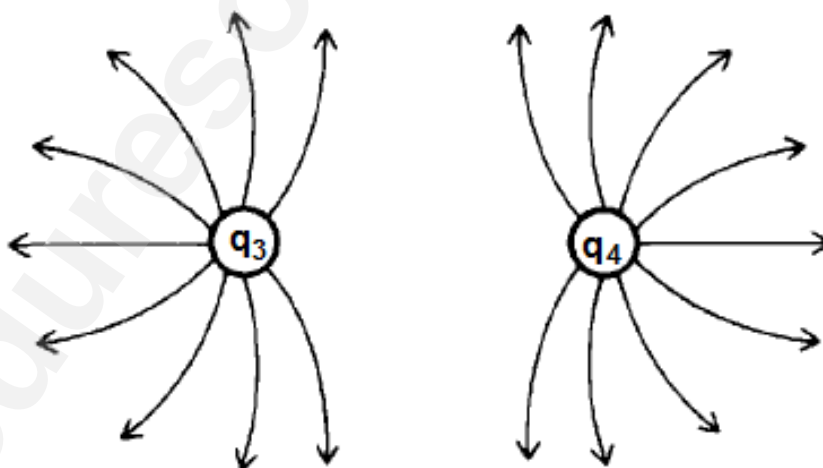
- 6.1.4 Calculate the frequency of the sound emitted by the siren. (4)
- 6.2 State TWO applications of the Doppler effect. (2)
- [12]**

QUESTION 7 (Start on a new page.)

Two point charges, q_1 and q_2 , are placed 30 cm apart along a straight line. Charge $q_1 = -3 \times 10^{-9}$ C. Point **P** is 10 cm to the left of q_1 , as shown in the diagram below. The **net** electrostatic field at point **P** is **zero**.



- 7.1 Define the term *electric field at a point*. (2)
- 7.2 State, giving reasons, whether point charge q_2 is positive or negative. (3)
- 7.3 Calculate the magnitude of charge q_2 . (4)
- 7.4 State Coulomb's law in words. (2)
- 7.5 Calculate the magnitude of the electrostatic force exerted by charge q_1 on charge q_2 . (3)
- 7.6 The two charges are now brought into contact with each other and are then separated. A learner draws the electric field pattern for the new charges q_3 and q_4 **after** contact, as shown below.



Is the diagram CORRECT? Give a reason for the answer.

(2)
[16]

QUESTION 8 (Start on a new page.)

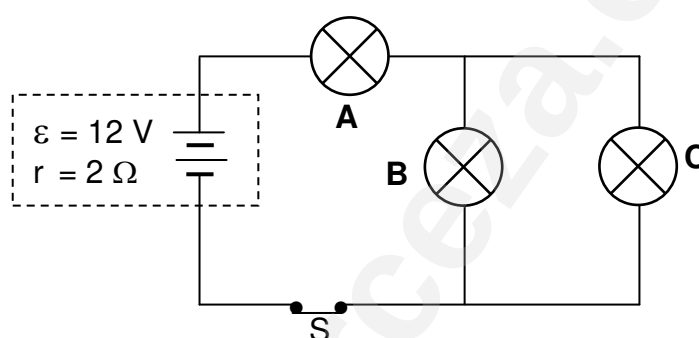
8.1 Three identical light bulbs, **A**, **B** and **C**, are each rated at 6 W, 12 V.

8.1.1 Define the term *power*. (2)

8.1.2 Calculate the resistance of EACH bulb when used as rated. (3)

The light bulbs are connected in a circuit with a battery having an emf (ϵ) of 12 V and internal resistance (r) of $2\ \Omega$. Refer to the diagram below.

Assume that the resistance of each light bulb is the same as that calculated in QUESTION 8.1.2. Switch S is closed.

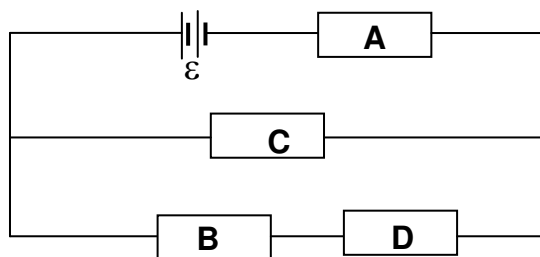


8.1.3 Calculate the total current in the circuit. (5)

8.1.4 Calculate the potential difference across light bulb **C**. (3)

8.1.5 Explain why light bulb **C** in the circuit will NOT burn at its maximum brightness. (3)

8.2 Resistors **A**, **B**, **C** and **D** are connected to a battery having emf (ϵ) and negligible internal resistance, as shown in the diagram below.



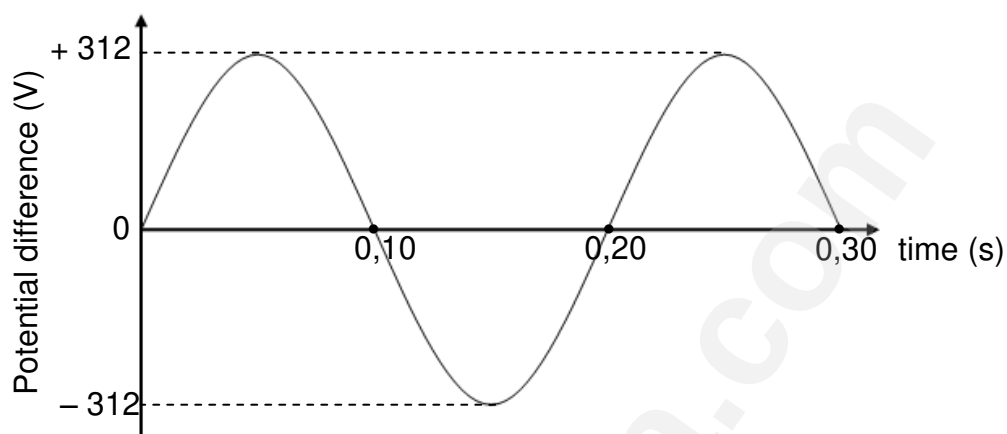
8.2.1 Give a reason why the current in resistor **A** is greater than that in resistor **C**. (2)

8.2.2 Resistor **C** is removed. How will the current in resistor **B** compare to the current in **A**? Give a reason for the answer. (2)

[20]

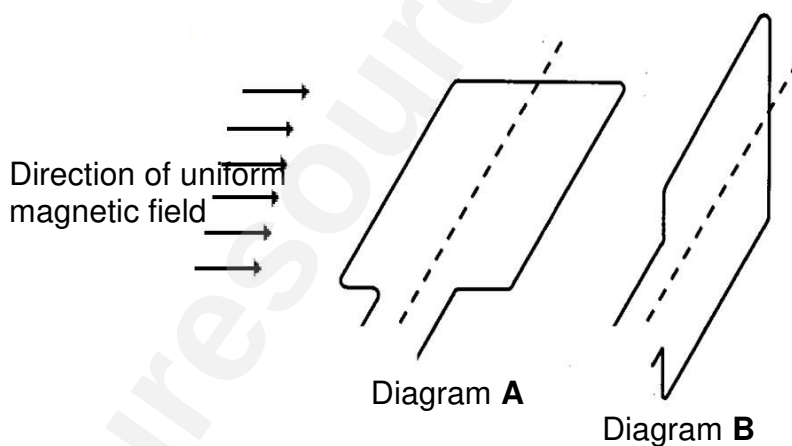
QUESTION 9 (Start on a new page.)

The diagram below shows the voltage output of a generator.



9.1 Does this generator have split rings or slip rings? (1)

9.2 Which ONE of the diagrams below, **A** or **B**, shows the position of the generator's coil at time = 0,10 s?



9.3 Calculate the root mean square (rms) voltage for this generator. (3)

9.4 A device with a resistance of $40\ \Omega$ is connected to this generator.

Calculate the:

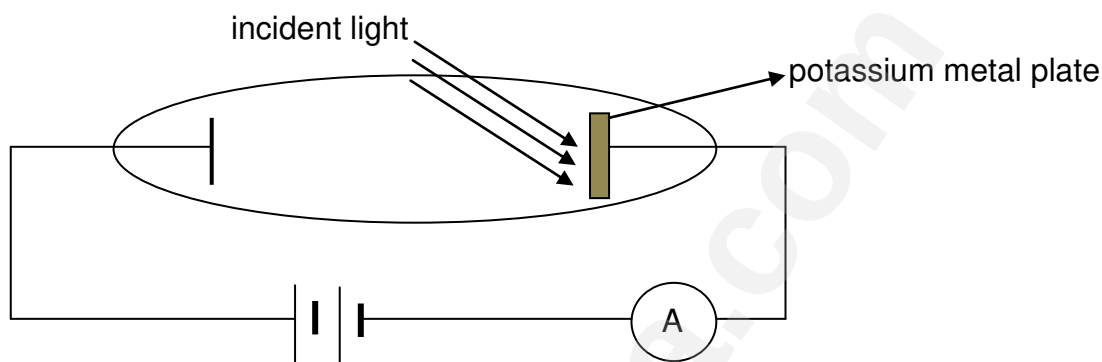
9.4.1 Average power delivered by the generator to the device (3)

9.4.2 Maximum current delivered by the generator to the device (4)

[12]

QUESTION 10 (Start on a new page.)

A potassium metal plate is irradiated with light of wavelength $5 \times 10^{-7} \text{ m}$ in an arrangement, as shown below. The threshold frequency of potassium is $5,55 \times 10^{14} \text{ Hz}$.



- 10.1 Define the term *threshold frequency*. (2)
- 10.2 Calculate the energy of a photon incident on the metal plate. (3)
- 10.3 Using a suitable calculation, prove that the ammeter will show a reading. (4)
- 10.4 The intensity of the light is now increased. Explain why this change causes an increase in the ammeter reading. (3)
- [12]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max/maks})}$ or/of $E = W_0 + K_{\text{max/maks}}$ where/waar	
$E = hf$ and/en $W_0 = hf_0$ and/en $E_{k(\text{max/maks})} = \frac{1}{2} mv_{\text{max/maks}}^2$ or/of $K_{\text{max/maks}} = \frac{1}{2} mv_{\text{max/maks}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or / of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ϵ) = $I(R + r)$ emk (ϵ) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
--	---



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN**

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

2019

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

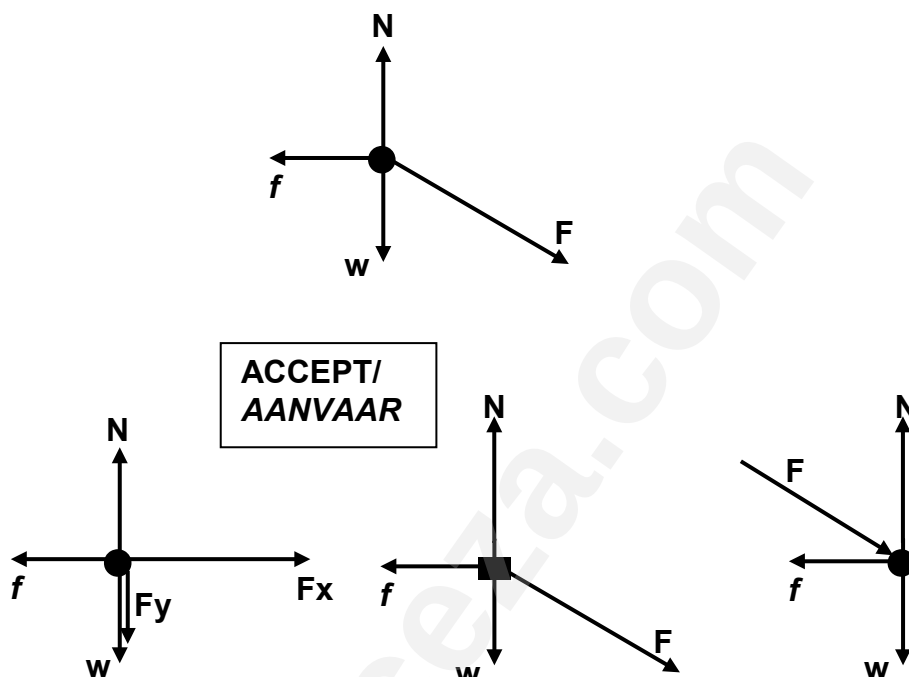
**These marking guidelines consist of 28 pages./
Hierdie nasienriglyne bestaan uit 28 bladsye.**

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | A ✓✓ | (2) |
| 1.2 | B ✓✓ | (2) |
| 1.3 | D ✓✓ | (2) |
| 1.4 | C ✓✓ | (2) |
| 1.5 | C ✓✓ | (2) |
| 1.6 | C ✓✓ | (2) |
| 1.7 | D ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | A ✓✓ | (2) |
| | | [20] |

QUESTION 2/VRAAG 2

2.1.1



Accepted labels/Aanvaarde benoemings	
F	$F_A/90\text{ N}/F_{90}$
w	$F_g / F_w/\text{weight} / mg / \text{gravitational force}$ $F_g / F_w/\text{gewig} / mg / \text{gravitasiekrag}$
f	(Kinetic) Friction / $F_f / f_k / \text{wrywing} / F_w$
N	$F_{\text{Normal}} / \text{Normal}/\text{Normaal} / F_N$

Notes/Aantekeninge

- Mark awarded for label and arrow / Punt toegeken vir benoeming en pyltjie
- Do not penalise for length of arrows since drawing is not to scale. / Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie
- Any other additional force(s) / Enige ander addisionele krag(te) Max/Maks $\frac{3}{4}$
- If force(s) do not make contact with body / Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{3}{4}$
- Deduct 1 mark for an arrow/arrows omitted / trek 1 punt af indien pyl/pyle weggelaat

(4)

2.1.2

It is moving at constant speed in a straight line/, the acceleration is zero/ the net force (resultant) acting on it is zero/it is moving at constant velocity ✓
 Dit beweeg teen konstante spoed in 'n reguit lyn / versnelling is nul / netto krag (resultant) wat daarop inwerk is nul/ dit beweeg teen konstante snelheid

(1)

2.1.3

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ F_{\text{net}} = 0 \\ F_x = f \\ F_x - f = 0 \\ F \cos 40^\circ - f = 0 \end{array} \right\} \begin{array}{l} \checkmark \text{ any one} \\ \text{enige een} \end{array}$$

$$\frac{90 \cos 40^\circ - f = 0}{f = 68,94 \text{ N}} \checkmark$$

OR/OF

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ F_{\text{net}} = 0 \\ F_x = f \\ F_x - f = 0 \\ F \cos 320^\circ - f = 0 \end{array} \right\} \begin{array}{l} \checkmark \text{ any one} \\ \text{enige een} \end{array}$$

$$\frac{90 \cos 320^\circ - f = 0}{f = 68,94 \text{ N}} \checkmark$$

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ F_{\text{net}} = 0 \\ F_x = f \\ F_x - f = 0 \\ F \sin 50^\circ - f = 0 \end{array} \right\} \begin{array}{l} \checkmark \text{ any one} \\ \text{enige een} \end{array}$$

$$\frac{90 \sin 50^\circ - f = 0}{f = 68,94 \text{ N}} \checkmark$$

(3)

NOTE:

1 mark for formula/equation, 1 mark substitution with zero, 1 mark answer.
 LW: 1 punt vir formule/vergelyking, 1 punt substitusie, 1 punt antwoord.

2.1.4

**POSITIVE MARKING FROM 2.1.3 / POSITIEWE NASIEN VANAF 2.1.3
 OPTION 1/OPSIE 1**

$$v_f = v_i + a\Delta t$$

$$\frac{2 = 0}{a = 0,67 \text{ m}\cdot\text{s}^{-2}} \checkmark + \frac{a(3)}{\checkmark}$$

$$F_{\text{net}} = ma \checkmark$$

$$F \cos 40^\circ - \checkmark - 68,94 \checkmark = 15(0,67)$$

$$F = 103,11 \text{ N} \checkmark (103,05 \text{ N} - 103,11 \text{ N})$$

$$F_{\text{net}} = ma \checkmark$$

$$F \cos 320^\circ - f = 15(0,67)$$

$$\frac{F \cos 320^\circ \checkmark - 68,94 \checkmark}{F = 103,11 \text{ N} \checkmark} = 15(0,67)$$

**POSITIVE MARKING FROM 2.1.3 / POSITIEWE NASIEN VANAF 2.1.3
 OPTION 2/OPSIE 2**

$$F_{\text{net}} \cdot \Delta t = \Delta p \checkmark$$

$$\frac{F \cos 40^\circ \checkmark - (68,94) \checkmark}{F = 103,11 \text{ N} \checkmark} (3) \checkmark = \frac{15(2 - 0) \checkmark}{\checkmark}$$

$$F = 103,11 \text{ N} \checkmark$$

POSITIVE MARKING FROM 2.1.3 / POSITIEWE NASIEN VANAF 2.1.3
OPTION 3/OPSIE 3

$$F_{\text{net}} = ma$$

$$F_x - f_k = ma$$

✓ any one
 enige een

$$F_x - 68,94 \checkmark = 15 \frac{(2-0) \checkmark}{3 \checkmark}$$

$$F_x = 78,94 \text{ N}$$

$$\tan \theta = \frac{F_y}{F_x}$$

$$\tan 40^\circ = \frac{F_y}{78,94}$$

$$F_y = 66,24 \text{ N}$$

$$F^2 = F_x^2 + F_y^2$$

$$F^2 = (78,94)^2 + (66,24)^2 \checkmark$$

$$F = 103,05 \text{ N} \checkmark$$

POSITIVE MARKING FROM 2.1.3 / POSITIEWE NASIEN VANAF 2.1.3
OPTION 4/OPSIE 4

$$\Delta x = \frac{v_i + v_f}{2} \Delta t$$

$$= \frac{(2+0) \checkmark}{2} (3) \checkmark$$

$$\Delta x = 3 \text{ m}$$

$$W_{\text{net}} = \Delta K$$

$$W_F + W_f = \Delta K \checkmark$$

$$F \Delta x \cos \theta + f \Delta x \cos \theta = \Delta K$$

$$F(3) \cos 40^\circ \checkmark + 68,94(3) \cos 180^\circ \checkmark = \frac{1}{2} (15)(2^2) - \frac{1}{2} (15)(0)^2$$

$$F = 103,06 \text{ N} \checkmark$$

(6)

2.2

OPTION 1/OPSIE 1

$$F = G \frac{m_1 m_2}{r^2} \checkmark$$

$$20 \checkmark = (6,67 \times 10^{-11}) \frac{m_{\text{planet}} (10)}{(6 \times 10^5)^2} \checkmark$$

$$m_{\text{planet}} = 1,08 \times 10^{22} \text{ kg} \checkmark$$

OPTION 2/OPSIE 2

$$w = mg$$

$$20 = (10)(g) \checkmark$$

$$g = 2 \text{ m} \cdot \text{s}^{-2}$$

$$g = \frac{GM}{R^2}$$

$$2 = \frac{(6,67 \times 10^{-11})M}{(6 \times 10^5)^2} \checkmark$$

$$M = 1,08 \times 10^{22} \text{ kg} \checkmark$$

✓ Any one
Enige een

(4)
[18]

QUESTION 3/VRAAG 3

- 3.1 Motion of an object under the influence of gravity/gravitational force (weight) only✓✓.

Beweging van 'n voorwerp slegs onder die invloed van gravitasie/gravitasie krag (gewig).

OR/OF

Motion in which the only force acting on the object is gravity/weight. ✓✓

Beweging waar die enigste krag wat op die voorwerp inwerk, gravitasie/gewig is.

ACCEPT/AANVAAR

Vertical motion in which friction/air resistance is absent. ✓✓

Vertikale beweging waar wrywing/lugweerstand afwesig is.

Motion in air with an acceleration of $9,8 \text{ m}\cdot\text{s}^{-2}$. ✓✓

Beweging in lug met 'n versnelling van $9,8 \text{ m}\cdot\text{s}^{-2}$.

NOTE: 2 OR ZERO/ 2 of nul

(2)

- 3.2.1

OPTION 1/OPSIE 1

Upwards positive/Opwaarts positief:

$$v_f = v_i + a\Delta t \checkmark$$

$$0 = v_i + (-9,8)(1,53) \checkmark$$

$$\therefore v_i = 14,99 \text{ m}\cdot\text{s}^{-1} (15 \text{ m}\cdot\text{s}^{-1}) \checkmark$$

Downwards positive/Afwaarts positief

$$v_f = v_i + a\Delta t \checkmark$$

$$0 = v_i + (9,8)(1,53) \checkmark$$

$$\therefore v_i = -14,99 \text{ m}\cdot\text{s}^{-1}$$

$$v_i = 14,99 \text{ m}\cdot\text{s}^{-1} (15 \text{ m}\cdot\text{s}^{-1}) \checkmark$$

OPTION 2/OPSIE 2

$$F_{\text{net}} = ma$$

$$= 9,8 \text{ (m)}$$

$$F_{\text{net}} \Delta t = m\Delta v \checkmark$$

$$(9,8)(m)(1,53) = (m)(v_f - 0) \checkmark$$

$$v_f = 14,99 \text{ m}\cdot\text{s}^{-1} (15 \text{ m}\cdot\text{s}^{-1}) \checkmark$$

OPTION 3/OPSIE 3

Upwards positive/Opwaarts positief:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$0 = v_i(3,06) + \frac{1}{2}(-9,8)(3,06)^2 \checkmark$$

$$v_i = 14,99 \text{ m}\cdot\text{s}^{-1} \checkmark (15 \text{ m}\cdot\text{s}^{-1})$$

Downwards positive/Afwaarts positief

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$0 = v_i(3,06) + \frac{1}{2}(9,8)(3,06)^2 \checkmark$$

$$v_i = 14,99 \text{ m}\cdot\text{s}^{-1} \checkmark (15 \text{ m}\cdot\text{s}^{-1})$$

NOTE: initial and final velocities can be swapped if starting from top, as long as sign of g is changed accordingly.

LW: v_f en v_i kan omgeruil word indien van bopunt begin, solank teken van g dienoreenkomstig verander word.

(3)

3.2.2

OPTION 1/OPSIE 1

POSITIVE MARKING FROM 3.2.1/ Positiewe nasien vanaf 3.2.1

Upwards positive/Opwaarts positief:

$$\begin{aligned}\Delta y &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= 14,99 (1,53) + \frac{1}{2} (-9,8)(1,53)^2 \checkmark \\ &= 11,47 \text{ m} \checkmark (11,46-11,48)\end{aligned}$$

Maximum height is/Maksimum hoogte is 11,47 m

Downwards positive/Afwaarts positief

$$\begin{aligned}\Delta y &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= -14,99 (1,53) + \frac{1}{2} (9,8)(1,53)^2 \checkmark \\ &= -11,47 \text{ m} (11,46-11,48)\end{aligned}$$

Maximum height is /Maksimum hoogte is 11,47 m ✓

OPTION 2/OPSIE 2

POSITIVE MARKING FROM 3.2.1/ Positiewe nasien vanaf 3.2.1

Upwards positive/Opwaarts positief:

$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \checkmark \\ 0 &= (14,99)^2 + 2(-9,8)(\Delta y) \checkmark \\ \Delta y &= 11,47 \text{ m} \checkmark (11,46-11,48)\end{aligned}$$

Maximum height reached is/Maksimum hoogte bereik is 11,47 m

Downwards positive/Afwaarts positief:

$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \checkmark \\ 0 &= (-14,99)^2 + 2(9,8)(\Delta y) \checkmark \\ \Delta y &= -11,47 \text{ m} (11,46-11,48)\end{aligned}$$

Maximum height reached is/Maksimum hoogte bereik is 11,47 m ✓

OPTION 3/OPSIE 3

POSITIVE MARKING FROM 3.2.1/ Positiewe nasien vanaf 3.2.1

Upwards positive/Opwaarts positief:

$$\begin{aligned}\Delta y &= \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark \\ &= \left(\frac{(14,99 + 0)}{2} \right) (1,53) \checkmark\end{aligned}$$

$$\Delta y = 11,47 \text{ m} \checkmark$$

Maximum height reached is /Maksimum hoogte bereik is 11,47 m

Downwards positive/Afwaarts positief:

$$\begin{aligned}\Delta y &= \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark \\ &= \left(\frac{(-14,99 + 0)}{2} \right) (1,53) \checkmark\end{aligned}$$

$$\Delta y = -11,47 \text{ m} (11,46-11,48)$$

Maximum height reached is /Maksimum hoogte bereik is 11,47 m ✓

OPTION 4/OPSIE 4
POSITIVE MARKING FROM 3.2.1

$$\Delta E = \Delta K + \Delta U$$

$$\frac{1}{2} m v_i^2 + m g h_i = \frac{1}{2} m v_f^2 + m g h_f$$

1 mark for any✓
1 punt vir enige

$$\frac{1}{2} (14,994)^2 + (9,8)(0) = 0 + 9,8 h_f \checkmark$$

$$h_f = 11,47 \text{ m} \checkmark (11,46-11,48)$$

Maximum height reached is /Maksimum hoogte bereik is 11,47 m

OR/OF

$$\Delta K = - \Delta U \checkmark$$

$$\frac{1}{2} m (v_f^2 - v_i^2) = - m g (h_f - h_i)$$

$$\frac{1}{2} (0 - 14,99^2) = - 9,8 (h_f - 0) \checkmark$$

$$h_f = 11,47 \text{ m} (11,46-11,48)$$

Maximum height reached is /Maksimum hoogte bereik is 11,47 m✓

(3)

3.3

OPTION 1/OPSIE 1
POSITIVE MARKING FROM 3.2.1

Upwards positive/Opwaarts positief:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= (14,99) (4) + \frac{1}{2} (- 9,8)(4)^2 \checkmark$$

$$= -18,4 \text{ m}$$

Position is 18,4 m downwards (below the edge of the roof) ✓ / Posisie is 18,4 m afwaarts (onder die kant van die dak).

Downwards positive/Afwaarts positief

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= (-14,99) (4) + \frac{1}{2} (9,8)(4)^2 \checkmark$$

$$= 18,4 \text{ m}$$

Position is 18,4 m downwards (below the edge of the roof) ✓ / Posisie is 18,4 m afwaarts (onder die kant van die dak)

OPTION 2/OPSIE 2

POSITIVE MARKING FROM 3.2.1

Upwards positive/Opwaarts positief:

$$v_f = v_i + a\Delta t$$

$$= (14,99) + (-9,8) (4)$$

$$= -24,2 \text{ m}\cdot\text{s}^{-1}$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$(-24,2)^2 = (14,99)^2 + 2(-9,8)(\Delta y)$$

$$\Delta y = -18,4 \text{ m}$$

Ball is 18,4 m downwards (below the edge of the roof) / Bal is 18,4 m afwaarts (onder die kant van die dak)

Downwards positive/Afwaarts positief:

$$v_f = v_i + a\Delta t$$

$$= (-14,99) + (9,8) (4)$$

$$= 24,2 \text{ m}\cdot\text{s}^{-1}$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$(24,2)^2 = (-14,99)^2 + 2(9,8)(\Delta y)$$

$$\Delta y = 18,4 \text{ m}$$

Ball is 18,4 m downwards (below the edge of the roof) / Bal is 18,4 m afwaarts (onder die kant van die dak)

OPTION 3/OPSIE 3

POSITIVE MARKING FROM 3.2.1

Upwards positive/Opwaarts positief:

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$= \left(\frac{(14,99 - 24,2)}{2} \right) (4)$$

$$v_f = v_i + a\Delta t$$

$$= (14,99) + (-9,8) (4)$$

$$= -24,2 \text{ m}\cdot\text{s}^{-1}$$

$$\Delta y = -18,4 \text{ m}$$

Ball is 18,4 m downwards (below the edge of the roof) / Bal is 18,4 m afwaarts (onder die kant van die dak).

Downwards positive/Afwaarts positief:

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$= \left(\frac{(-14,99 + 24,2)}{2} \right) (4)$$

$$v_f = v_i + a\Delta t$$

$$= (-14,99) + (9,8) (4)$$

$$= 24,2 \text{ m}\cdot\text{s}^{-1}$$

$$\Delta y = 18,4 \text{ m}$$

Ball is 18,4 m downwards (below the edge of the roof) / Bal is 18,4 m afwaarts (onder die kant van die dak).

OPTION 4/OPSIE 4

Total time to return to starting point/*totale tyd terug na beginpunt*

$$= 2(1,53) = 3,06 \text{ s}$$

∴ time from reference point to ground/*tyd vanaf verwysingspunt tot by grond*

$$= (4 - 3,06) = 0,94 \text{ s}$$

$$\Delta y = v_i \Delta t + \frac{1}{2} (g) \Delta t^2 \checkmark$$

$$= (14,99)(0,94) + \frac{1}{2}(9,8)(0,94)^2 \checkmark$$

$$= 18,43 \text{ m} \checkmark \text{ downwards (below the edge of the roof) /afwaarts (onder die kant van die dak.}$$

(3)

3.4

No/Nee✓

The motion of the ball is only dependent on its initial velocity✓✓/the initial velocity depends on the time taken to reach maximum height.

Die beweging van die bal is slegs afhanklik van sy beginsnelheid./die aanvanklike snelheid hang af van die tyd wat dit neem om maksimum hoogte te bereik.

ACCEPT for 1 mark/ AANVAAR vir 1 punt:

The ball will still be in the air.✓

Die bal sal nog steeds in die lug wees.

OR/OF

The ball is still falling.✓

Die bal is steeds besig om te val.

OR/OF

The ball would not have reached the ground.✓

Die bal sal nog nie die grond bereik het nie.

OR/OF

The motion of the ball is independent of the height of the building. ✓

Die beweging van die bal is onafhanklik van die hoogte van die gebou.

NOTE: If learners gave separate answers for 3.2 and 3.3, mark them together. Thus, if one answer is correct and the other incorrect 0/3

LW: Indien leerders twee afsonderlike antwoorde gee vir 3.2 en 3.3, sien as geheel na. Dus, indien een verkeerd is, 0/3

(3)

[14]

QUESTION 4/VRAAG 4

- 4.1 The total (linear) momentum in a isolated/closed system remains constant./ is conserved ✓✓

Die totale lineêre momentum in 'n geslote sisteem bly konstant/behoue.

OR/OF

In an isolated/closed system the total momentum before a collision is equal to the total momentum after the collision. ✓✓

In 'n geslote/geïsoleerde sisteem is die totale momentum voor die botsing gelyk aan die totale momentum na die botsing.

NOTE/LET WEL:

-1 for each key word/phrase omitted.

-1 vir elke sleutel woorde/frase weggelaat.

Take the whole statement in context /Vat die hele stelling in konteks.

(2)

- 4.2

OPTION 1/OPSIE 1

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ m_1 v_{1i} + m_2 v_{2i} &= m_1 v_{1f} + m_2 v_{2f} \\ m_1 v_{1i} + m_2 v_{2i} &= (m_1 + m_2) v_f \end{aligned} \right\} \begin{array}{l} \text{1 mark for any} \\ \text{1 punt vir enige} \end{array}$$

$$\{0,45(9) + 0,20(0)\} \checkmark = (0,45 + 0,20)v \checkmark$$

$$v = 6,23 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OR

$$\Delta p_{\text{ball/bal}} = - \Delta p_{\text{cont/houer}} \checkmark$$

$$0,45(v - 9) \checkmark = - 0,2(v - 0) \checkmark$$

$$v = 6,23 \text{ m} \cdot \text{s}^{-1} \checkmark$$

If – sign omitted from formula 0/4
 Indien – teken weggelaat uit formula 0/4

OPTION 2/OPSIE 2

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ p_{f \text{ Total}} &= p_{i \text{ Total}} \end{aligned} \right\} \begin{array}{l} \text{1 mark for any} \\ \text{1 punt vir enige} \end{array}$$

(Thus change in total momentum = 0 /Dus verandering in momentum is=0))

$$0 \checkmark = (0,65v_f) - (9)(0,45) \checkmark$$

$$v_f = 6,23 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(4)

4.3

POSITIVE MARKING FROM 4.2/POSITIEWE NASIEN VANAF 4.2

$K = \frac{1}{2} mv^2$ ✓ (or $E_K = \frac{1}{2} mv^2$)

Total kinetic energy before collision: / *Totale kinetiese energie voor botsing:*

$\frac{1}{2} (0,45)(9)^2 + 0$ ✓ = 18,225J

Total kinetic energy after collision: / *Totale kinetiese energie na botsing:*

$\frac{1}{2} (0,45 + 0,20)(6,23)^2$ ✓ = 12,614J

$\sum K_{\text{before/voor}} \neq \sum K_{\text{after/na}}$

Collision is inelastic. / *Botsing is onelasties* ✓ ✓

If start with / *indien begin met* $\sum E_{Ki} = \sum E_{Kf}$ 4/5 max/maks

No calculation / *geen berekening*: 0

Do not accept a conclusion of inelastic collision based on any other calculation (such as that of momentum or mechanical energy). / *Moet geen afleiding van 'n onelastiese botsing aanvaar wat op enige ander berekening gebaseer is nie (soos byvoorbeeld momentum of meganiese energie).*

(5)
[11]

QUESTION 5/VRAAG 5

5.1 Tension/Spinning✓

(1)

5.2 There is friction/ tension in the system ✓
Daar is wrywing/spanning in die sisteem
 OR/OF
 Friction/tension is a non-conservative force ✓
Wrywing/spanning 'n 'n nie-konserwatiewekrag
 OR/OF
 The system is not isolated because there is friction/tension ✓
Die sisteem is nie geïsoleerd nie omdat daar wrywing/spanning is

OR/OF

The internal energy increases because of friction ✓
Die interne energie neem toe as gevolg van wrywing.

OR

The applied force is non-conservative✓

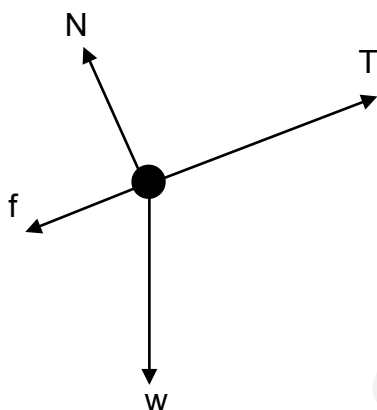
Die toegepaste krag is nie-konservatief

OR

It is not an isolated system✓

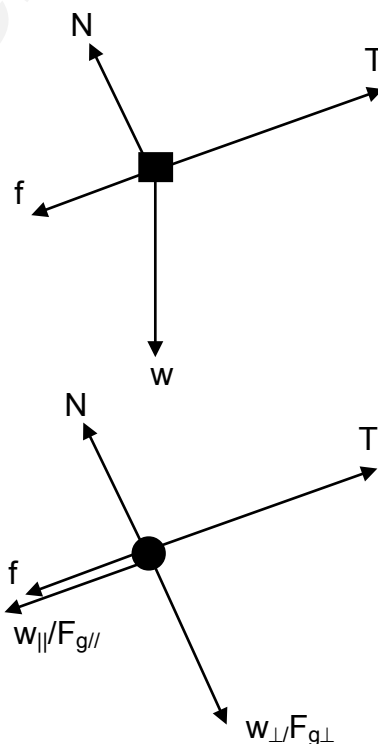
(1)

5.3



NOTE: maximum $\frac{3}{4}$ if friction and tension are not on a straight line
 LW: maksimum $\frac{3}{4}$ indien wrywing en spanning nie in 'n reguitlyn nie.

ACCEPT/AANVAAR



NOTE: maximum $\frac{3}{4}$ if N and $w_{\perp}$ are not on a straight line
 LW: maksimum $\frac{3}{4}$ indien N en $w_{\perp}$ nie in 'n reguitlyn nie.

Accepted labels/Aanvaarde benoemings		
w	F_g/F_w /weight/mg/gravitational force F_g/F_w /gewig/mg/gravitasiekrag	✓
f	Friction/ F_f/f_k /178,22 N/wrywing/ F_w	✓
N	Normal (force)/ F_{normal} / F_N / $F_{normaal}$ / $F_{reaction}$ /reaksie	✓
T	F_T/F_A / $F_{applied}$ /toegepas/700 N/Tension	✓

Notes/Aantekeninge

- Mark awarded for label and arrow / Punt toegeken vir benoeming en pyltjie
- Do not penalise for length of arrows since drawing is not to scale. / Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie
- Any other additional force(s) / Enige ander addisionele krag(te) Max/Maks $\frac{3}{4}$
- If force(s) do not make contact with body / Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks: $\frac{3}{4}$

Deduct 1 mark for an arrow/arrows omitted / trek 1 punt af indien pyl/pyle weggelaat

(4)

5.4

$$W = F\Delta x \cos\theta \checkmark$$

$$W_f = [178,22(4)\cos 180^\circ] \checkmark$$

$$= -712,88 \text{ J} \checkmark$$

(3)

5.5

OPTION 1/OPSIE 1

POSITIVE MARKING FROM QUESTIONS 5.4 POSITIEWE NASIEN VANAF VRAE 5.4

$$\left. \begin{aligned} W_{\text{net}} &= \Delta E_K \\ W_f + W_g + W_T &= \Delta K \\ W_f + mgsin\theta\Delta x \cos\theta + W_T &= \Delta K \end{aligned} \right\} \begin{array}{l} 1 \text{ mark for any one} \checkmark / \\ 1 \text{ punt vir enige een} \end{array}$$

$$-712,88 + (70)(9,8)(\sin 30^\circ)(4) \cos 180^\circ \checkmark + (700 \times 4 \times \cos 0^\circ) \checkmark = \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m}\cdot\text{s}^{-1} \checkmark$$

NOTE: W_g can be obtained using any of the following formulae:
 LW: w_g kan verkry word deur enige een van die volgende formules:

$$\begin{aligned} W_{\text{gravity/gravitasie}} &= mg\Delta x \cos\theta \\ &= (70)(9,8)(4) \cdot (\cos 120^\circ) \end{aligned}$$

$$\therefore -712,88 + (70)(9,8)(4)\cos 120^\circ \checkmark + (700 \times 4 \times \cos 0^\circ) \checkmark = \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m}\cdot\text{s}^{-1} \checkmark$$

$$\begin{aligned} W_{\text{gravity/gravitasie}} &= -\Delta mgh = -mg(h_f - h_0) \\ &= mg\Delta y \cos\theta \\ &= ((70)(9,8) 4(\sin 30^\circ) \cdot \cos 180^\circ \\ W_{\text{gravity/gravitasie}} &= mgsin\theta\Delta x \cos\theta \\ &= (70)(9,8)(\sin 30^\circ)(4) \cdot \cos 180^\circ \end{aligned}$$

OPTION 2/OPSIE 2

POSITIVE MARKING FROM 5.4 / POSITIEWE NASIEN VANAF 5.4

$$W_{nc} = \Delta E_K + \Delta E_p \checkmark$$

$$W_T + W_f = \Delta E_K + \Delta E_p$$

$$(700)(4) \cos 0^\circ \checkmark + (-712,88) = [(70)(9,8) 4(\sin 30^\circ) - 0] \checkmark + \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 3

$$F_{net} = F_T - [mg \sin \theta + f_k]$$

$$= 700 - [(70 \times 9,8 \sin 30^\circ) + 178,22] \checkmark$$

$$= 178,78 \text{ N}$$

$$W_{net} = \Delta E_K \checkmark$$

$$F_{net} \cdot \Delta x \cos \theta = \Delta E_K$$

$$(178,78)(4) \cos 0^\circ \checkmark = \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(5)

5.5

WHERE EQUATIONS OF MOTION ARE USED: / WAAR

BEWEGINGSVERGELYKING GEBRUIK: MAX/MAKS $\frac{1}{5}$

$$F_{net} = ma$$

$$F_T - [mg \sin \theta + f_k] = ma$$

$$700 - [(70 \times 9,8 \sin 30^\circ) + 178,22] \checkmark = 70a$$

$$a = 2,554 \text{ ms}^{-2}$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$= 0 + 2(2,554)(4)$$

$$v_f = 4,52 \text{ m} \cdot \text{s}^{-1}$$

5.6

POSITIVE MARKING FROM 5.4/POSITIEWE NASIEN VANAF 5.4

$$2(-712,88) = -1425,76 \text{ J} \checkmark$$

OR/OF

Double the answer (in question 5.4). $\checkmark$

Dubbel die antwoord (in vraag 5.4)

(1)

[15]

QUESTION 6/VRAAG 6

6.1.1

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$300 = v_i (10) \checkmark$$

$$v_i = 30 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$v = \frac{d}{t} = \frac{300}{10} \checkmark = 30 \text{ m} \cdot \text{s}^{-1} \checkmark$$

NOTE/LET WEL:

Accept/Aanvaar $\Delta x = v_i \Delta t$

(2)

6.1.2

The change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of sound propagation. ✓✓

Die verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/OF

An (apparent) change in observed/detected frequency (pitch), (wavelength) as a result of the relative motion between a source and an observer (listener). ✓✓

'n Skynbare verandering in waargenome frekwensie (toonhoogte), (golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar.

NOTE/LET WEL:

-1 for each key word/phrase omitted.

-1 vir elke sleutel woorde/frase weggelaat

(2)

6.1.3

Car/source (just) passes observer ✓✓

Motor beweeg net verby die waarnemer

Accept:

Car moves away from observer ✓✓

No relative motion between car and observer ✓✓

Car and observer at the same place/position ✓✓

Aanvaar:

Motor beweeg verby waarnemer

Geen relatiewe beweging tussen motor en waarnemer

Motor en waarnemer by dieselfde plek/posisie.

(2)

6.1.4

POSITIVE MARKING FROM 6.1.1/POSITIEWE NAISEN VANF 6.1.1

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \checkmark \quad \text{OR/OF} \quad f_L = \frac{v}{v - v_s} f_s$$

$$932 = \frac{340}{340 - 30} f_s \quad \checkmark$$

$$f_s = 849,76 \text{ Hz} \quad \checkmark$$

(4)

Notes/Aantekeninge:

- Any other Doppler formula, e.g. /Enige ander Doppler formula b.v.

$$f_L = \frac{v - v_L}{v - v_s} f_s \quad \text{Max/Maks. } \frac{3}{4}$$

Marking rule 1.5: No penalisation if zero substitutions are omitted.

Nasienreël 1.5. Geen penalisering indien nul vervangings uitgelaat word

6.2

Doppler / Blood flow meter

Dopplervloeimeter/ bloedvloeimeter

Measuring the heartbeat of a foetus

Meting van hartklop van 'n fetus

Radar

Sonar

Used to determine whether stars are receding or approaching earth/

Gebruik om te bepaal of sterre na of weg van die aarde beweeg

Any 2 ✓✓
 Enige 2

(2)
[12]

QUESTION 7/VRAAG 7

- 7.1 The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓

Die elektriese veld by 'n punt is die elektrostatische krag wat per eenheid positiewe lading wat by daardie punt geplaas word, ervaar word. ✓✓

NOTE/LET WEL:

-1 for each key word/phrase omitted. If definition of electric field: 0/2

-1 vir elke sleutel woorde/frase weggelaat. Indien definisie van elektriese veld 0/2

(2)

- 7.2 q_2 is positive_✓

The electric field due to q_1 points to the right because q_1 is negative. ✓ Since the net field is zero, field due to q_2 must point to the left away from q_2 , ✓ hence q_2 is positive.

q_2 is positief

Die elektriese veld as gevolg van q_1 is na regs gerig omdat q_1 negatief is. Aangesien die net veld nul is, moet die veld as gevolg van q_2 na links weg van q_2 wees.

OR/OF

q_2 is positive_✓

Since E_{net} is zero, E_1 and E_2 are in opposite directions ✓ therefore q_1 and q_2 are oppositely charged. ✓

q_2 is positief ✓

Omdat E_{net} nul is, is E_1 en E_2 in teenoorgestelde rigtings ✓ daarom is q_1 en q_2 teenoorgesteld gelaai. ✓

(3)

7.3

$$E = k \frac{Q}{r^2} \checkmark$$

$$E_{\text{net}} = 0$$

$$\therefore k \frac{q_1}{r_1^2} = k \frac{q_2}{r_2^2} \text{ OR}$$

$$\frac{q_1}{r_1^2} = \frac{q_2}{r_2^2}$$

$$\frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,1)^2} \checkmark = \frac{(9 \times 10^9)q_2}{(0,4)^2} \checkmark$$

$$q_2 = + 4,8 \times 10^{-8} \text{ C} \checkmark$$

1 mark for formula
 1 mark for equating the two fields
 1 mark for both substitutions
 1 mark for answer
 1 punt vir vergelyking
 1 punt vir twee velde gelyk gestel
 1 punt vir altwee substitusies
 1 punt vir antwoord

(4)

7.4

The electrostatic force (of attraction/repulsion) between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. ✓✓
Die elektrostatiese krag(aantekking/afstotend) tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

(2)

NOTE/LET WEL:

-1 for each key word/phrase omitted. If masses used instead of charges 0
 -1 vir elke sleutel woorde/frase weggelaat Indien massas gebruik 0

7.5

POSITIVE MARKING FROM 7.3/POSITIEWE NASIEN VANAF 7.3

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F = \frac{(9 \times 10^9)(3 \times 10^{-9})(4,8 \times 10^{-8})}{(0,3)^2} \checkmark$$

$$= 1,44 \times 10^{-5} \text{ N} \checkmark$$

(3)

7.6

POSITIVE MARKING FROM 7.2 AND 7.3/POSITIEWE NASIEN van 7.2 en 7.3

YES/JA ✓

Both charges are equal and positive ✓

Beide ladings is gelyk en positief

Accept calculation which shows charges the same and positive/ *Aanvaar berekening wat toon dat ladings dieselfde en positief is.*

If the answer is YES, mark according to the memo, if NO check 7.2 first for sign of charge. If stated NEGATIVE at 7.2, then answer is:

No✓, the direction is incorrect. ✓

Positiewe nasien vanaf 7.2: Indien antwoord vir 7.2 NEGATIEF, dan is hierdie antwoord: Nee ✓, die rigting is verkeerd. ✓

(2)

[16]

QUESTION 8/VRAAG 8

- 8.1.1 The rate at which (electrical) energy is converted (to other forms) (in a circuit)
 The rate at which energy is used/Energy used per second
 The rate at which work is done ✓✓
 (2 or zero)
Die tempo waarteen elektriese energie omgesit word (in ander vorms) in 'n stroombaan.
Die tempo waarteen energie verbruik word.
Die tempo waarteen arbeid verrig word.
 (2 of nul)

(2)

8.1.2	$P = \frac{V^2}{R} \checkmark$ $6 = \frac{(12)^2}{R} \checkmark$ $R = 24 \Omega \checkmark$	$W = \frac{V^2 \Delta t}{R} \checkmark$ $6 = \frac{(12)^2 (1)}{R} \checkmark$ $R = 24 \Omega \checkmark$	$P = VI$ $6 = (12)(I)$ $\therefore I = 0,5 \text{ A}$ $P = I^2 R \checkmark$ $6 = (0,5)^2 R \checkmark$ $R = 24 \Omega \checkmark$	$P = VI \checkmark$ $6 = (12)(I)$ $\therefore I = 0,5 \text{ A}$ $V = IR$ $12 = (0,5)R \checkmark$ $R = 24 \Omega \checkmark$
-------	---	--	--	---

(3)

- 8.1.3 **POSITIVE MARKING FROM 8.1.2/POSITIEWE NASIEN VANAF 8.1.2**
OPTION 1/OPSIE 1

$$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{24} + \frac{1}{24} \checkmark$$

$$R_{//} = 12 \Omega$$

$$R_{\text{ext}} = (R_s + R_{//})$$

$$R_{\text{ext}} = (24 + 12) \checkmark$$

$$= 36 \Omega$$

$$V = IR$$

OR

$$\varepsilon = I(R + r)$$

$$12 = I(36 + 2) \checkmark$$

$$I = 0,32 \text{ A} \checkmark (0,316 \text{ A})$$

$$R_{\text{tot}} = \left(R_s + \frac{R_1 R_2}{R_1 + R_2} \right)$$

$$R_{\text{tot}} = \left\{ 24 + \frac{(24)(24)}{48} \right\} \checkmark$$

$$= 36 \Omega$$

$$\checkmark \text{ any one}$$

$$\text{Enige 1}$$

**POSITIVE MARKING FROM 8.1.2/POSITIEWE NASIEN VANAF 8.1.2
 OPTION 2/OPSIE 2**

$$R_{\text{ext}} = (R_s + R_{//})$$

$$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{24} + \frac{1}{24} \checkmark$$

$$R_{//} = 12 \Omega$$

$$R_{\text{ext}} = (24 + 12) \checkmark$$

$$= 36 \Omega$$

$$P = I^2 R = \frac{V^2}{R} \checkmark$$

$$I^2 (36 + 2) = \frac{(12)^2}{38} \checkmark$$

$$I = 0,32 \text{ A} \checkmark (0,316) \checkmark$$

$$R_{\text{ext}} = R_s + \frac{R_1 R_2}{R_1 + R_2}$$

$$R_{\text{ext}} = \left\{ 24 + \frac{(24)(24)}{48} \right\} \checkmark$$

$$= 36 \Omega$$

$$I^2 R = \frac{V^2}{R}$$

$$I^2 R^2 = V^2$$

$$V = IR$$

$$12 = I(38) \checkmark$$

$$I = 0,316 \text{ A} \checkmark$$

(5)

8.1.4

**POSITIVE MARKING FROM 8.1.3
 POSITIEWE NASIEN VANAF 8.1.3
 OPTION 1/OPSIE 1**

$$V = IR$$

$$V = I(R_A + r)$$

$$= 0,316(26) \checkmark$$

$$= 8,216 \text{ V} (8,32 \text{ V})$$

$$V_{//} = (12 - 8,216) \checkmark$$

$$= 3,784 \text{ V} (3,68 \text{ V})$$

$$\therefore V_C = 3,78 \text{ V} (3,68 \text{ V}) \checkmark$$

**POSITIVE MARKING FROM 8.1.3
 POSITIEWE NASIEN VANAF 8.1.3
 OPTION 2/OPSIE 2**

$$V = IR$$

For the parallel portion (or from 8.1.3):
Vir die parallel gedeelte (of vanaf 8.1.3)

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \text{ OR } R = \frac{R_1 R_2}{R_1 + R_2}$$

$$R = \frac{(24)(24)}{48}$$

$$= 12 \Omega$$

$$V_{//} = V_C \checkmark$$

$$V = IR_{//}$$

$$= (0,316)(12) \checkmark$$

$$= 3,79 \text{ V} (3,84 \text{ V}) \checkmark$$

(3)

**POSITIVE MARKING FROM 8.1.3
 POSITIEWE NASIEN VANAF 8.1.3
 OPTION 3/OPSIE 3**

$$I_A = I_B + I_C$$

$$= 2 I_B$$

$$0,316 = 2 I_B \checkmark$$

$$I_B = 0,158 \text{ A}$$

$$V = 0,158 (24) \checkmark$$

$$= 3,79 \text{ V} \checkmark$$

(3)

8.1.5 **OPTION 1/OPSIE 1**

The power rating (output voltage) of the bulb is 6 W, 12 V. /Die gloeilamp is gemerk 6W ; 12 V

$$P = \frac{V^2}{R}$$

[For a given resistance, power is directly proportional to V^2] ✓

[of Vir 'n gegewe resistor is drywing direk eweredig aan V^2] ✓

Since the potential difference across light bulb C is less than the operating voltage, ✓ the output/power will be less, ✓ / Omdat die potensiaalverskil oor gloeilamp C minder is as die benodigde spanning sal die uitset/drywing minder wees.

OPTION 2/OPSIE 2

$$P = \frac{V^2}{R}$$

The potential difference across light bulb C is less than the operating voltage.

✓ Thus for the same resistance, ✓ brightness decreases.

Die potensiaalverskil oor gloeilamp C is minder as die benodigde potensiaalverskil. Dus vir dieselfde weerstand, sal die helderheid afneem.

OPTION 3/OPSIE 3

$$P = I^2 R$$

For a given resistance ✓, power is directly proportional to I^2 Since current decreases ✓, brightness decreases.]

[vir 'n gegewe resistor is drywing direk eweredig aan I^2 Omdat stroom afneem sal die helderheid afneem]

OPTION 4/OPSIE 4

$$P = I^2 R$$

In the circuit, the total current in light bulb C is less than the optimum current required (0,5 A). ✓ Thus for the same resistance, ✓ the power will be less ✓ hence brightness will decrease.

In die stroombaan is die totale stroom in gloeilamp C minder as die optimum stroom benodig (0,5 A). Dus vir dieselfde weerstand, is die drywing minder en die helderheid sal afneem.

OPTION 5/OPSIE 5

$$P = IV$$

[Power is directly proportional/equal to product of V and I. ✓

Since current decreases ✓, brightness decreases/

drywing is direk eweredig/gelyk aan produk van V en I. Omdat stroom afneem sal die helderheid afneem]]

OR/OF

The voltage across light bulb C, as well as the current in the bulb are all less ✓ than the optimum values ✓ hence power is less ✓ and brightness is less.

Die potensiaalverskil oor gloeilamp C sowel as die stroom in die gloeilamp is almal minder as die optimum waardes, dus is die drywing minder en die helderheid minder.

NOTE: No mark if only equation is given.

(3)

- 8.2.1 The total current passes through resistor A. ✓ For the parallel portion, the current branches, therefore only a portion of the total current passes through resistor C. ✓

Die totale stroom vloei deur resistor A. Vir die parallelle gedeelte verdeel die stroom, dus vloei slegs 'n gedeelte van die stroom deur resistor C.

(2)

ACCEPT for 1 mark: Resistor C is connected parallel to resistors B and D together. Current is dividing ✓ at the junction.

AANVAAR vir 1 punt: Resistor C is in parallel geskakel met B en D saam. Die stroom breek op ✓ by die koppeling.

- 8.2.2 The current in B is equal ✓ to the current in A. The circuit becomes a series circuit. ✓

Die stroom in B is gelyk aan die stroom in A. Die stroombaai word 'n serie stroombaai.

(2)

[21]

QUESTION 9/VRAAG 9

9.1 Slip rings/*Sleep ringe* ✓ (1)

9.2 B ✓ (1)

9.3

$$\begin{aligned}
 V_{\text{rms/wgk}} &= \frac{V_{\text{max/maks}}}{\sqrt{2}} \checkmark \\
 &= \frac{312}{\sqrt{2}} \checkmark \\
 &= 220,62 \text{ V} \checkmark
 \end{aligned}$$

(3)

9.4.1 **POSITIVE MARKING FROM 9.3/POSITIEWE NASIEN VANAF 9.3**
OPTION 1/OPSIE 1

$$\begin{aligned}
 P_{\text{aver / gemid}} &= \frac{V_{\text{rms / wgk}}^2}{R} \checkmark \\
 &= \frac{(220,62)^2}{40} \checkmark \\
 &= 1216,83 \text{ W} \checkmark
 \end{aligned}$$

POSITIVE MARKING FROM 9.3/POSITIEWE NASIEN VANAF 9.3
OPTION 2/OPSIE 2

$$\begin{aligned}
 I_{\text{rms}} &= \frac{V_{\text{rms / wgk}}}{R} \\
 &= \frac{(220,62)}{40} \\
 &= 5,515 \\
 P_{\text{ave}} &= I_{\text{rms}}^2 R \\
 &= (5,515)^2 (40) \checkmark \\
 &= 1216,61 \text{ W} \checkmark
 \end{aligned}$$

OR

$$\begin{aligned}
 P_{\text{ave}} &= V_{\text{rms}} I_{\text{rms}} \\
 &= (220,62)(5,515) \checkmark \\
 &= 1216,72 \text{ W} \checkmark
 \end{aligned}$$

✓ for any/ *vir enige*

OPTION 3/OPSIE 3

$$I_{\max} = \frac{V_{\max}}{R}$$

$$= \frac{312}{40}$$

$$= 7,80 \text{ A}$$

$$P_{\text{ave}} = \frac{I_{\max} V_{\max}}{2}$$

$$= \frac{(7,8)(312)}{2} \quad \checkmark$$

$$= 1216,80 \text{ W} \quad \checkmark$$

✓ for any/ vir enige

(3)

9.4.2

OPTION 1/OPSIE 1

$$I_{\max/\text{maks}} = \frac{V_{\max/\text{maks}}}{R} \quad \checkmark$$

$$= \frac{312}{40} \quad \checkmark$$

$$= 7,8 \text{ A} \quad \checkmark$$

Accept/ Aanvaar: $I = \frac{V}{R}$

POSITIVE MARKING FROM 9.3 AND 9.4.1/POSITIEWE NASIEN VANAF 9.3 EN 9.4.1

OPTION 2/OPSIE 2

$$P_{\text{ave/gemid}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}}$$

$$1\,216,83 = 220,62 I_{\text{rms/wgk}} \quad \checkmark$$

$$I_{\text{rms/wgk}} = 5,515 \text{ A}$$

$$I_{\text{rms/wgk}} = \frac{I_{\max/\text{maks}}}{\sqrt{2}}$$

$$5,515 = \frac{I_{\max/\text{maks}}}{\sqrt{2}} \quad \checkmark$$

$$I_{\max/\text{maks}} = 7,8 \text{ A} \quad \checkmark$$

✓ for any/ vir enige

OPTION 3/OPSIE 3

$$P_{\text{ave/gemid}} = I_{\text{rms/wgk}}^2 R$$

$$1\,216,83 = I_{\text{rms/wgk}}^2 (40) \quad \checkmark$$

$$I_{\text{rms/wgk}} = 5,515 \text{ A}$$

$$I_{\text{rms/wgk}} = \frac{I_{\max/\text{maks}}}{\sqrt{2}}$$

$$5,515 = \frac{I_{\max/\text{maks}}}{\sqrt{2}} \quad \checkmark$$

$$I_{\max/\text{maks}} = 7,8 \text{ A} \quad \checkmark$$

✓ for any/ vir enige

(4)
[12]

QUESTION 10/VRAAG 10

- 10.1 The minimum frequency of light needed to eject electrons from a metal (surface) ✓✓.

Minimum frekwensie van lig benodig om elektrone vanaf 'n metaal (oppervlak) vry te stel.

NOTE/LET WEL:

-1 for each key word/phrase omitted.

-1 vir elke sleutel woorde/frase weggelaat.

(2)

10.2

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$E = h \frac{c}{\lambda}$ $= \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5 \times 10^{-7}} \checkmark$ $= 3,98 \times 10^{-19} \text{ J} \checkmark$	$c = f\lambda$ $3 \times 10^8 = f(5 \times 10^{-7})$ $f = 6 \times 10^{14} \text{ Hz}$ $E = hf$ $= (6,63 \times 10^{-34})(6 \times 10^{14}) \checkmark$ $= 3,98 \times 10^{-19} \text{ J} \checkmark$
NOTE: do not penalise if v is used in place of c.	

✓ Both equations
 Beide vergelykings

(3)

10.3

OPTION 1/OPSIE 2
POSITIVE MARKING FROM QUESTION 10.2/POSITIEWE NASIEN VANAF VRAAG 10.2 $E = W_0 + E_{\text{kmax}}$ $hf = W_0 + \frac{1}{2}mv_{\text{max}}^2$ $h \frac{c}{\lambda} = W_0 + E_{\text{K(max/maks)}}$ $h \frac{c}{\lambda} = hf_0 + E_{\text{K(max/maks)}}$ $3,98 \times 10^{-19} = (6,63 \times 10^{-34})(5,55 \times 10^{14}) + E_{\text{K(max/maks)}} \checkmark$ $E_{\text{K(max/maks)}} = 3,0 \times 10^{-20} \text{ J} \checkmark$ $E_{\text{K(max/maks)}} > 0 \checkmark$ (The electrons emitted from the metal plate have kinetic energy to move between the plates, hence the ammeter registers a reading. Die elektrone vrygestel vanaf die metaalplaat het kinetiese energie om tussen die plate te beweeg en gevolglik registreer die ammeter 'n lesing)

1 mark any one/1 punt vir enige

OPTION 2/OPSIE 2

POSITIVE MARKING FROM QUESTION 10.2/POSITIEWE NASIEN VANAF VRAAG 10.2

$$W_0 = hf_0 \checkmark$$

$$= (6,63 \times 10^{-34})(5,55 \times 10^{14}) \checkmark$$

$$= 3,68 \times 10^{-19} \text{ J}$$

$$E_{\text{photon}} > W_0 \checkmark$$

(The energy of the incident photon is greater than the work function of potassium. From the equation $hf = W_0 + E_{K\text{max}}$, the ejected photoelectrons will move between the plates, $\checkmark$ hence the ammeter registers a reading.

Die energie van die invallende foton is hoër as die arbeidsfunksie van kalium. Vanaf die vergelyking $hf = hf_0 + E_{K(\text{maks})}$, sal die vrygestelde foto-elektrone tussen die plate te beweeg en gevolglik registreer die ammeter 'n lesing.)

OPTION 3/OPSIE 3

$$c = f\lambda \checkmark$$

$$3 \times 10^8 = f(5 \times 10^{-7}) \checkmark$$

$$f = 6 \times 10^{14} \text{ Hz}$$

$$f > f_0 \checkmark$$

The frequency of the incident photon is higher than the threshold frequency. From the equation $hf = hf_0 + E_{K(\text{max})}$, the ejected photoelectrons will be able to move between the plates $\checkmark$ (for the given frequency), hence the ammeter registers a reading.

Die frekwensie van die invallende foton is hoër as die drumpelfrekwensie. Vanaf die vergelyking $hf = hf_0 + E_{K(\text{maks})}$, sal die vrygestelde foto-elektrone tussen die plate kan beweeg en gevolglik registreer die ammeter 'n lesing.)

10.4

The increase in intensity increases the number of photons per second. $\checkmark$
Soos die intensiteit toeneem, neem die aantal fotone per sekonde toe.

Since each photon releases one electron $\checkmark$ the number of ejected electrons per second increases. $\checkmark$

Aangesien elke foton een elektron vrystel, neem die aantal vrygestelde elektrone per sekonde toe.

ACCEPT: Flow of electrons per unit time increases $\checkmark$ (1 mark)

AANVAAR: vloeï van elektrone per eenheidstyd neem toe (1 punt)

This causes the current /ammeter reading to increase.

Dit veroorsaak dat die stroom/ammeterlesing toeneem.

(4)

(3)
 [12]

TOTAL/TOTAAL:

150



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2019

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

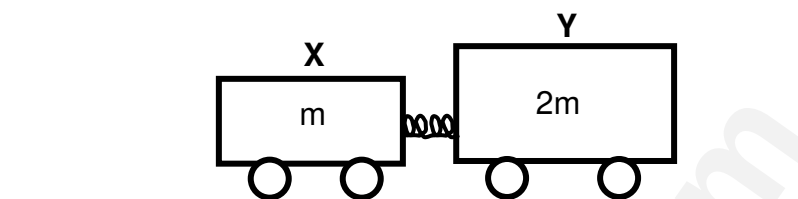
1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E. Each question has only ONE correct answer.

- 1.1 Which physical quantity is equal to the rate of change of momentum?
A Mass
B Impulse
C Net force
D Acceleration (2)
- 1.2 The gravitational acceleration on the surface of a planet of radius R is g .
The gravitational acceleration at a height of $2R$ above the surface of the same planet is ...
A $\frac{g}{9}$
B $\frac{g}{4}$
C $4g$
D $9g$ (2)
- 1.3 A ball falls from the edge of a table. Ignore the effects of air friction.
Which ONE of the physical quantities associated with the ball during the fall remains constant?
A Weight
B Momentum
C Kinetic energy
D Gravitational potential energy (2)

- 1.4 Two trolleys, **X** and **Y**, of masses m and $2m$ respectively, are held together by a compressed spring between them. Initially they are stationary on a horizontal floor, as shown below. Ignore the effects of friction.



The spring is now released and falls to the floor while the trolleys move apart.

The magnitude of the MOMENTUM of trolley **X** while it moves away is ...

- A zero.
- B half the magnitude of the momentum of trolley **Y**.
- C twice the magnitude of the momentum of trolley **Y**.
- D the same as the magnitude of the momentum of trolley **Y**. (2)

- 1.5 An object is dropped from rest and after falling a distance x , its momentum is p . Ignore the effects of air friction.

The momentum of the object, after it has fallen a distance $2x$, is ...

- A p
- B $\sqrt{2}p$
- C $\frac{p}{2}$
- D $2p$ (2)

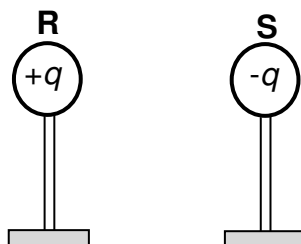
- 1.6 A police car, with its siren on, is travelling at a constant speed TOWARDS a stationary sound detector. The siren emits sound waves of frequency f and speed v .

Which ONE of the following combinations best describes the frequency and speed of the detected sound waves?

	FREQUENCY	SPEED
A	Less than f	v
B	Less than f	Less than v
C	Greater than f	Less than v
D	Greater than f	v

(2)

- 1.7 Two identical spheres, **R** and **S**, on insulated stands, carrying charges of $+q$ and $-q$ respectively, are placed a distance apart. Sphere **R** exerts an electrostatic force of magnitude F on sphere **S**.



The two spheres are now brought into contact and returned to their original positions.

The magnitude of the electrostatic force that sphere **R** exerts on sphere **S** is now ...

A zero

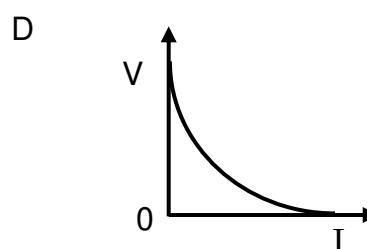
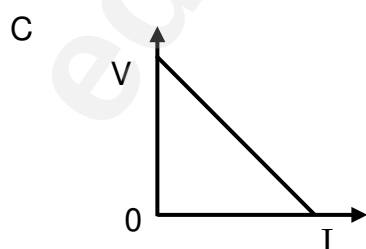
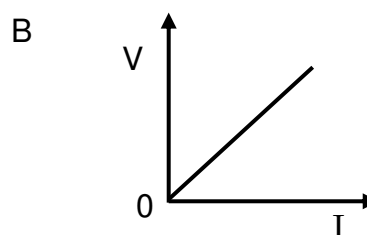
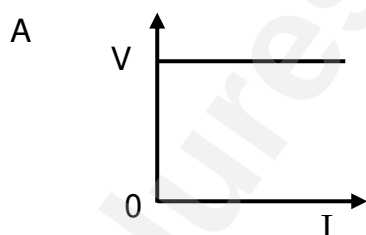
B $\frac{F}{2}$

C F

D $2F$

(2)

- 1.8 Which ONE of the graphs below best represents the relationship between potential difference (V) and current (I) for an ohmic conductor?



(2)

- 1.9 Which ONE of the following combinations regarding the energy conversions in electric motors and electric generators is CORRECT?

	ENERGY CONVERSION IN MOTORS	ENERGY CONVERSION IN GENERATORS
A	Mechanical to electrical	Electrical to mechanical
B	Mechanical to electrical	Mechanical to electrical
C	Electrical to mechanical	Electrical to mechanical
D	Electrical to mechanical	Mechanical to electrical

(2)

- 1.10 Consider the statements below regarding the photoelectric effect.

The photoelectric effect proves that ...

- (i) light energy is quantised.
- (ii) light has a particle nature.
- (iii) light has a wave nature.

Which of the statements above is/are CORRECT?

- A (i) only
- B (ii) only
- C (i) and (ii) only
- D (i) and (iii) only

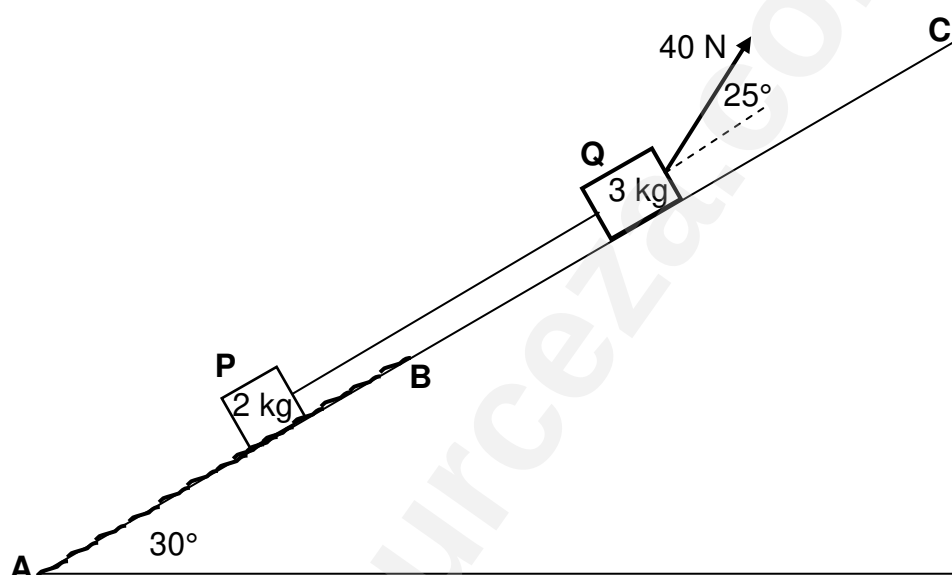
(2)
[20]

QUESTION 2 (Start on a new page.)

Block **P**, of mass 2 kg, is connected to block **Q**, of mass 3 kg, by a light inextensible string. Both blocks are on a plane inclined at an angle of 30° to the horizontal.

Block **Q** is pulled by a constant force of 40 N at an angle of 25° to the incline.

Block **P** moves on a rough section, **AB**, of the incline, while block **Q** moves on a frictionless section, **BC**, of the incline. See diagram below.



An average constant frictional force of 2,5 N acts on block **P** as it moves from **A** to **B** up the incline.

- 2.1 State Newton's Second Law in words. (2)
- 2.2 Draw a labelled free-body diagram for block **P**. (4)
- 2.3 Calculate the magnitude of the acceleration of block **P** while block **P** is moving on section **AB**. (8)
- 2.4 If block **P** has now passed point **B**, how will its acceleration compare to that calculated in QUESTION 2.3? Choose from GREATER THAN, SMALLER THAN or EQUAL TO.

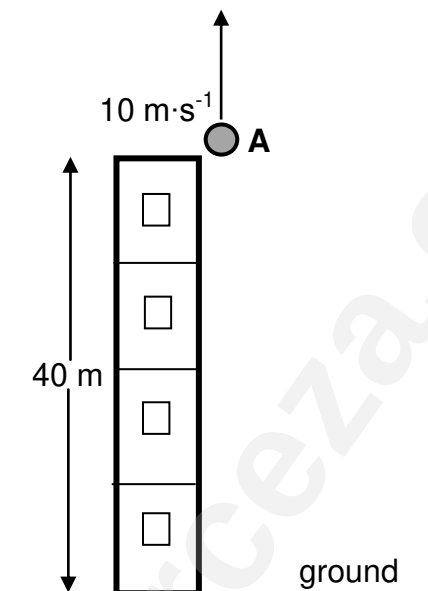
Give a reason for the answer.

(2)
[16]

QUESTION 3 (Start on a new page.)

Stone **A** is thrown vertically upwards with a speed of $10 \text{ m}\cdot\text{s}^{-1}$ from the edge of the roof of a 40 m high building, as shown in the diagram below.

Ignore the effects of air friction. Take the ground as reference.

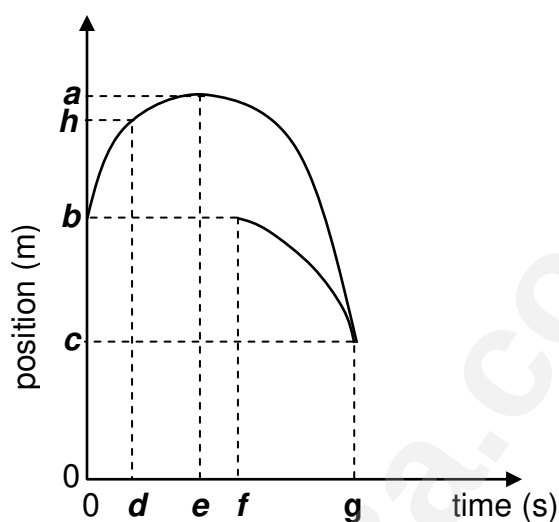


- 3.1 Define the term *free fall*. (2)
- 3.2 Calculate the maximum HEIGHT ABOVE THE GROUND reached by stone **A**. (4)
- 3.3 Write down the magnitude and direction of the acceleration of stone **A** at this maximum height. (2)

Stone **B** is dropped from rest from the edge of the roof, x seconds after stone **A** was thrown upwards.

- 3.4 Stone **A** passes stone **B** when the two stones are 29,74 m *above the ground*. Calculate the value of x . (6)

- 3.5 The graphs of position versus time for part of the motion of both stones are shown below.



Which of labels **a** to **h** on the graphs above represents EACH of the following?

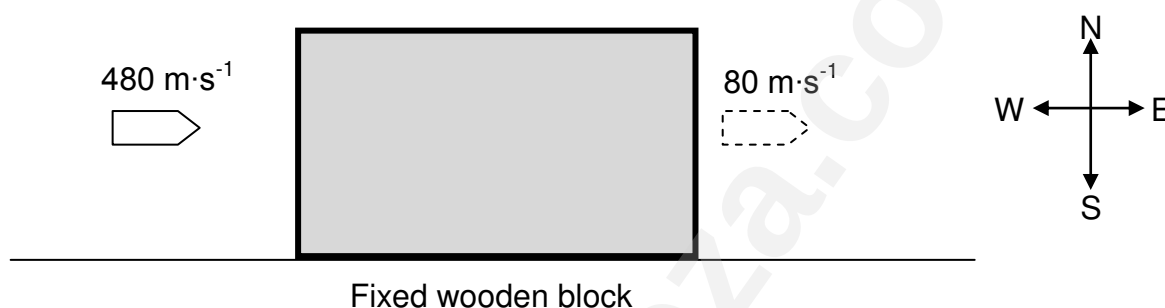
- | | | |
|-------|--|-------------|
| 3.5.1 | The time at which stone A has a positive velocity | (1) |
| 3.5.2 | The maximum height reached by stone A | (1) |
| 3.5.3 | The time when stone B was dropped | (1) |
| 3.5.4 | The height at which the stones pass each other | (1) |
| | | [18] |

QUESTION 4 (Start on a new page.)

A bullet moves east at a velocity of $480 \text{ m}\cdot\text{s}^{-1}$. It hits a wooden block that is fixed to the floor. The bullet takes $0,01 \text{ s}$ to move through the stationary block and emerges from the block at a velocity of $80 \text{ m}\cdot\text{s}^{-1}$ east. See the diagram below.

Ignore the effects of air resistance.

Consider the block-bullet system as an isolated system.



- 4.1 Explain what is meant by an *isolated system* as used in Physics. (2)

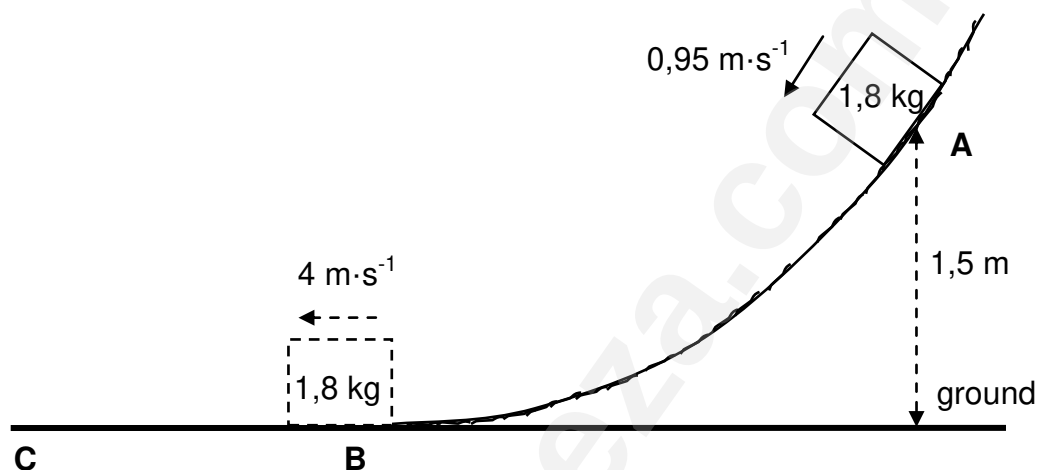
The magnitude of the momentum of the bullet before it enters the block is $24 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$.

- 4.2 Calculate the:
- 4.2.1 Mass of the bullet (3)
- 4.2.2 Average net force exerted by the wooden block on the bullet (5)
- [10]**

QUESTION 5 (Start on a new page.)

An object of mass $1,8 \text{ kg}$ slides down a rough curved track and passes point **A**, which is $1,5 \text{ m}$ above the ground, at a speed of $0,95 \text{ m}\cdot\text{s}^{-1}$.

The object reaches point **B** at the bottom of the track at a speed of $4 \text{ m}\cdot\text{s}^{-1}$.



- 5.1 Define the term *conservative force*. (2)
- 5.2 Name the conservative force acting on the object. (1)
- 5.3 Is mechanical energy conserved as the object slides from point **A** to point **B**? Choose from YES or NO. Give a reason for the answer. (2)
- 5.4 Calculate the gravitational potential energy of the object when it was at point **A**. (3)
- 5.5 Using energy principles, calculate the work done by friction on the object as it slides from point **A** to point **B**. (4)

Surface **BC** in the diagram above is frictionless.

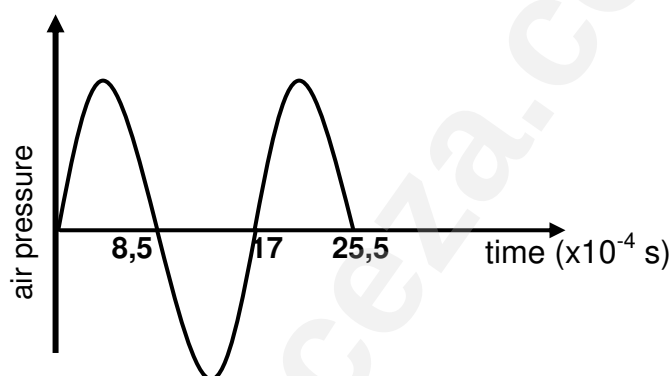
- 5.6 What is the value of the net work done on the object as it slides from point **B** to point **C**? (1)
- [13]**

QUESTION 6 (Start on a new page.)

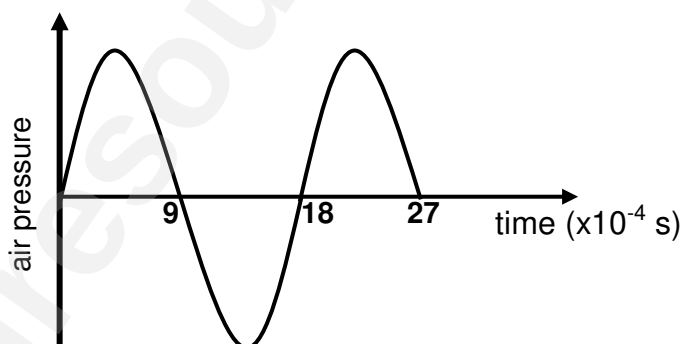
The siren of a police car, which is travelling at a constant speed along a straight horizontal road, emits sound waves of constant frequency. Detector **P** is placed inside the police car and detector **Q** is placed next to the road at a certain distance away from the car. The two detectors record the changes in the air pressure readings caused by the sound waves emitted by the siren as a function of time.

The graphs below were obtained from the recorded results.

GRAPH A: AIR PRESSURE VS TIME RECORDED BY DETECTOR P IN THE CAR



GRAPH B: AIR PRESSURE VS TIME RECORDED BY DETECTOR Q NEXT TO THE ROAD



- 6.1 Different patterns are shown above for the same sound wave emitted by the siren. What phenomenon is illustrated by the two detectors showing the different patterns? (1)

The police car is moving AWAY from detector **Q**.

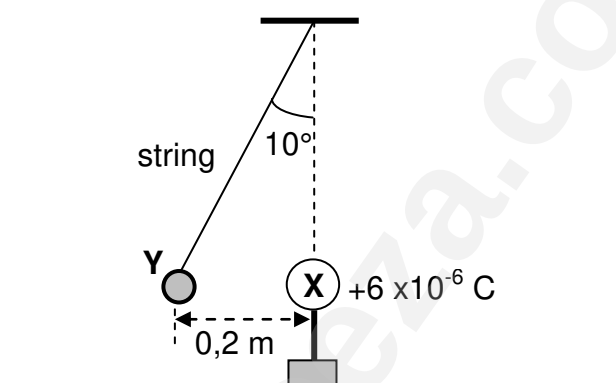
- 6.2 Use the graphs and give a reason why it can be confirmed that the police car is moving away from detector **Q**. (1)
- 6.3 Calculate the frequency of the sound waves recorded by detector **P**. (3)
- 6.4 Use the information in the graphs to calculate the speed of the police car. Take the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$. (6)

[11]

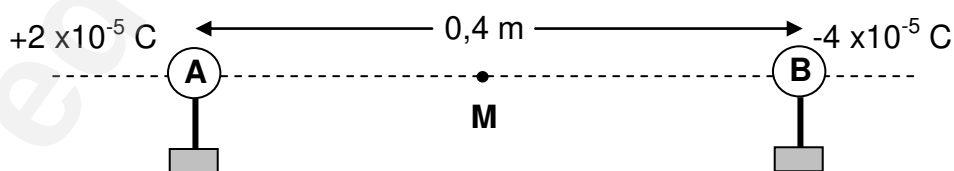
QUESTION 7 (Start on a new page.)

- 7.1 A small sphere, **Y**, carrying an unknown charge, is suspended at the end of a light inextensible string which is attached to a fixed point. Another sphere, **X**, carrying a charge of $+6 \times 10^{-6} \text{ C}$, on an insulated stand is brought close to sphere **Y**.

Sphere **Y** experiences an electrostatic force and comes to rest 0,2 m away from sphere **X**, with the string at an angle of 10° with the vertical, as shown in the diagram below.



- 7.1.1 What is the nature of the charge on sphere **Y**? Choose from POSITIVE or NEGATIVE. (1)
- 7.1.2 Calculate the magnitude of the charge on sphere **Y** if the magnitude of the electrostatic force acting on it is 3,05 N. (3)
- 7.1.3 Draw a labelled free-body diagram for sphere **Y**. (3)
- 7.1.4 Calculate the magnitude of the tension in the string. (3)
- 7.2 Two small charged spheres, **A** and **B**, on insulated stands, with charges $+2 \times 10^{-5} \text{ C}$ and $-4 \times 10^{-5} \text{ C}$ respectively, are placed 0,4 m apart, as shown in the diagram below. **M** is the midpoint between spheres **A** and **B**.



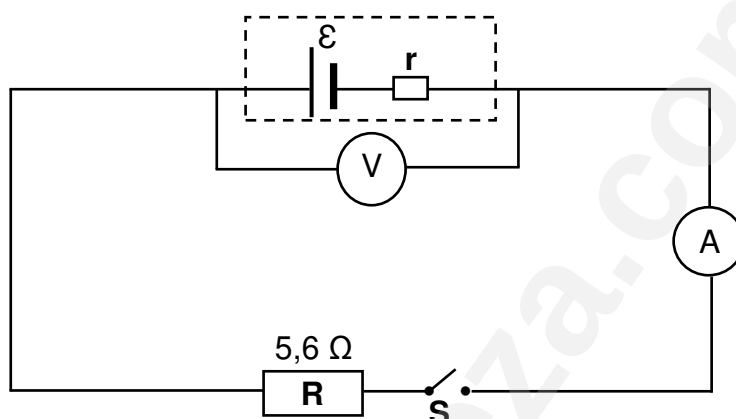
- 7.2.1 Define the term *electric field at a point*. (2)
- 7.2.2 Calculate the net electric field at point **M**. (6)

[18]

QUESTION 8 (Start on a new page.)

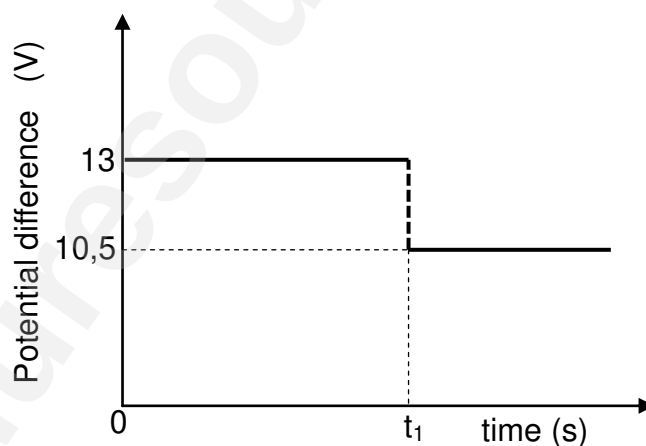
In the circuit diagram below, resistor **R**, with a resistance of $5,6 \, \Omega$, is connected, together with a switch, an ammeter and a high-resistance voltmeter, to a battery with an unknown internal resistance, **r**.

The resistance of the connecting wires and the ammeter may be ignored.



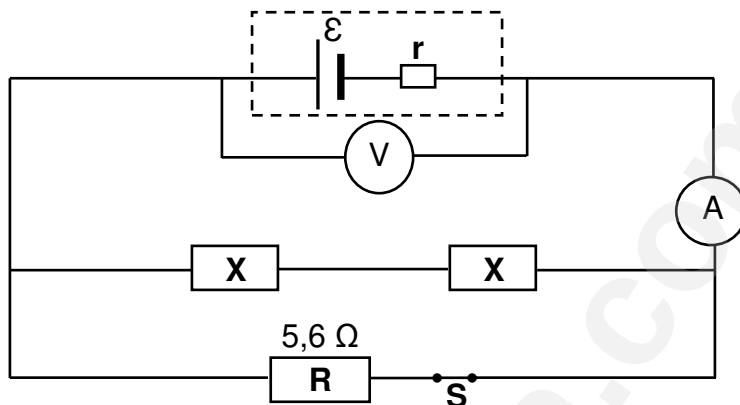
The graph below shows the potential difference across the terminals of the battery as a function of time.

At time t_1 , switch **S** is closed.



- 8.1 Define the term *emf* of a battery. (2)
- 8.2 Write down the value of the emf of the battery. (1)
- 8.3 When switch **S** is CLOSED, calculate the:
 - 8.3.1 Current through resistor **R** (3)
 - 8.3.2 Power dissipated in resistor **R** (3)
 - 8.3.3 Internal resistance, **r**, of the battery (3)

- 8.4 Two IDENTICAL resistors, each with resistance X , are now connected in the same circuit with switch S closed, as shown below.



The ammeter reading now increases to 4 A.

- 8.4.1 How would the voltmeter reading change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for the answer by referring to $V_{\text{internal resistance}}$.

(2)

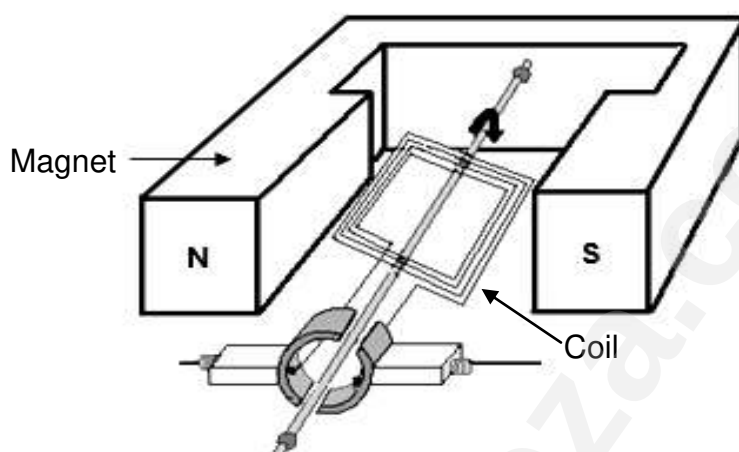
- 8.4.2 Calculate resistance X .

(5)

[19]

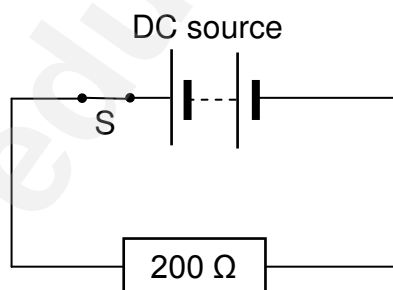
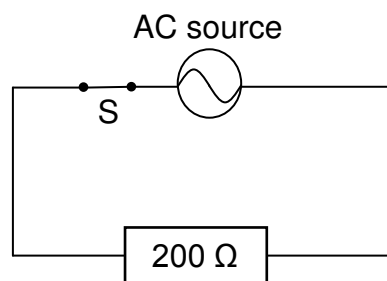
QUESTION 9 (Start on a new page.)

- 9.1 A simplified diagram of an electric generator is shown below. When the coil is rotated with a constant speed, an emf is induced in the coil.



- 9.1.1 Is this an AC generator or a DC generator? (1)
- 9.1.2 Briefly explain how an emf is generated in the coil when the coil is rotated by referring to the principle of electromagnetic induction. (2)
- 9.1.3 Draw a sketch graph of the output voltage versus time for this generator. Show ONE complete cycle. (2)
- 9.2 A $200\ \Omega$ resistor is connected to a DC voltage supply, as shown in diagram **A**. The energy dissipated in the resistor in 10 s is 500 J.

The same resistor is now connected to an AC source (diagram **B**) and 500 J of energy is also dissipated in the resistor in 10 s.

Diagram **A**Diagram **B**

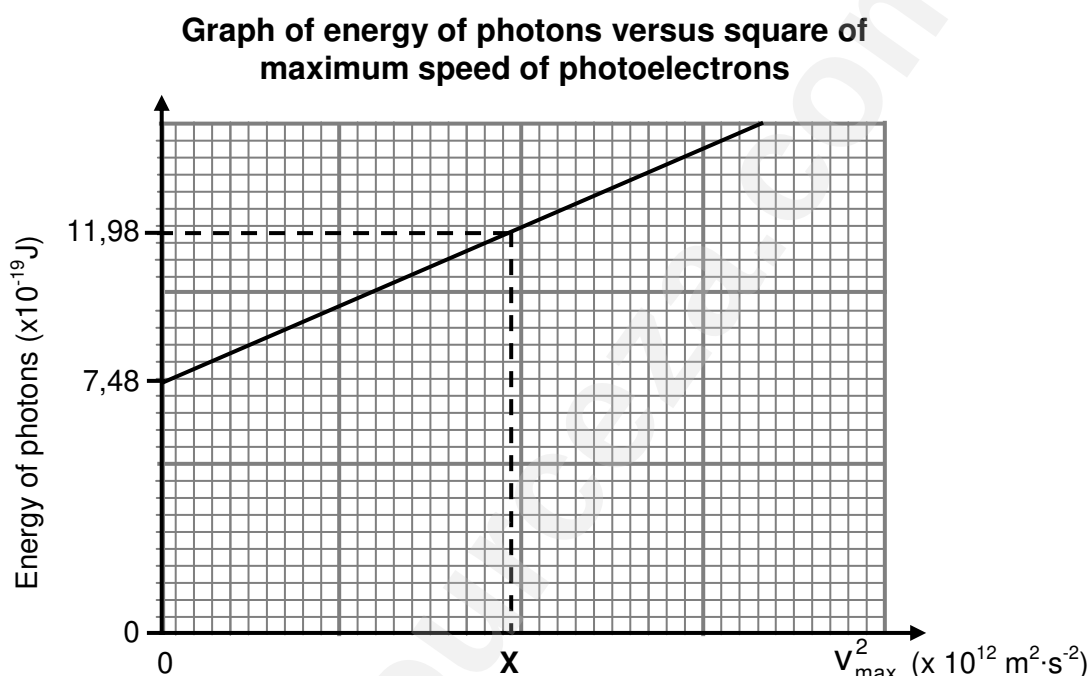
- 9.2.1 Define the term *rms voltage* of an AC source. (2)
- 9.2.2 Calculate the maximum (peak) voltage of the AC source. (5)

[12]

QUESTION 10 (Start on a new page.)

During an experiment, light of different frequencies is radiated onto a silver cathode of a photocell and the corresponding maximum speed of the ejected photoelectrons are measured.

A graph of the energy of the incident photons versus the square of the maximum speed of the ejected photoelectrons is shown below.



10.1 Define the term *photoelectric effect*. (2)

Use the graph to answer the following questions.

10.2 Write down the value of the work function of silver. (1)
Use a relevant equation to justify the answer. (3)

10.3 Which physical quantity can be determined from the gradient of the graph? (1)

10.4 Calculate the value of **X** as shown on the graph. (5)

The experiment above is now repeated using light of higher intensity.

10.5 How will EACH of the following be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

10.5.1 The gradient of the graph (1)

10.5.2 The number of photoelectrons emitted per unit time (1)

[13]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or/of $E = W_0 + K_{\text{max}}$ where/waar $E = hf$ and/en $W_0 = hf_0$ and/en $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ or/of $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or / of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ε) = $I(R + r)$ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

NOVEMBER 2019

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 24 pages. /
Hierdie nasienriglyne bestaan uit 24 bladsye.**

QUESTION 1/VRAAG 1

- 1.1 C ✓✓ (2)
- 1.2 A ✓✓ (2)
- 1.3 A ✓✓ (2)
- 1.4 D ✓✓ (2)
- 1.5 B ✓✓ (2)
- 1.6 D ✓✓ (2)
- 1.7 A ✓✓ (2)
- 1.8 B ✓✓ (2)
- 1.9 D ✓✓ (2)
- 1.10 C ✓✓ (2)
- [20]**

QUESTION 2/VRAAG 2

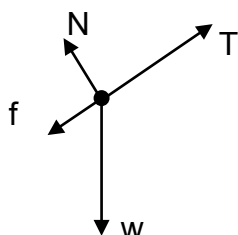
NOTE: -1 mark for each key word/phrase omitted in the correct context
LET WEL: -1 punt vir elke sleutel woord/frase in die korrekte konteks weggelaat

- 2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. ✓✓
 Wanneer 'n resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

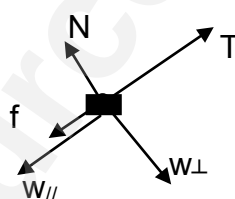
OR/OF

The resultant/net force acting on an object is equal to the rate of change of momentum of the object (in the direction of the resultant/net force.) ✓✓
 Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum van die voorwerp (in die rigting van die resulterende/netto krag.)

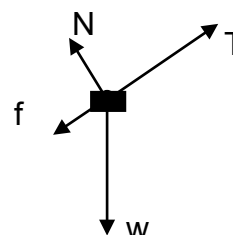
2.2



ACCEPT/AANVAAR



OR/OF



	Accept the following symbols/Aanvaar die volgende simbole.
N ✓	F_N /Normal/Normaál/Normal force/Normaalkrag /16,97 N
f ✓	F_f / f_k / f_r / frictional force/wrywingskrag/kinetic frictional force/kinetiese wrywingskrag
W ✓	F_g ,/mg/weight/ $F_{\text{Earth on block}}$ /19,6 N/gravitational force/gewig/ $F_{\text{aarde op blok}}$ /gravitasiekrag
T ✓	Tension/Spinning/ F_T / F_A / F / F_s

Notes/Aantekeninge

- Mark is awarded for label and arrow. /Punt word toegeken vir byskrif en pyltjie
- Do not penalise for length of arrows.
Moenie vir die lengte van die pyltjies penaliseer nie.
- Deduct 1 mark for any additional force. /Trek 1 punt af vir enige addisionele krag.
- If force(s) do not make contact with body/dot //Indien krag(te) nie met die voorwerp / kolletjie kontak maak nie: Max./Maks: $\frac{3}{4}$
- If arrows missing//Indien pyltjies uitgelaat is: Max./Maks: $\frac{3}{4}$

2.3

For the 2 kg (P) block/Vir die 2 kg (P) blok: $\left. \begin{aligned} F_{\text{net}} &= ma \\ T + (-w_{\parallel}) + (-f_k) &= ma \\ T - (w_{\parallel} + f_k) &= ma \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $T - (2)(9,8)\sin 30^\circ \checkmark - 2,5 \checkmark = 2a \checkmark$ $T - 9,8 - 2,5 = 2a$ $T - 12,3 = 2a \dots\dots\dots(1)$ For the 3 kg (Q) block/Vir die 3 kg (Q) blok: $\left. \begin{aligned} F_x + (-T) + (-w_{\parallel}) &= ma \\ F_x - (T + w_{\parallel}) &= ma \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $[40 \cos 25^\circ \checkmark - T - (3)(9,8)\sin 30^\circ \checkmark] \checkmark = 3a$ $36,25 - T - 14,7 = 3a$ $21,55 - T = 3a \dots\dots\dots(2)$ $9,25 = 5a$ $a = 1,85 \text{ m}\cdot\text{s}^{-2} \checkmark$	Marking criteria/Nasienriglyne • Formula/Formule $\checkmark$ • Substitution of /vervanging van $w_{\parallel}$ for/vir 2 kg: $(2)(9,8)\sin 30^\circ \checkmark$ • Substitution of -2,5 N /Vervanging van -2,5 N $\checkmark$ • 2a OR/OF 3a $\checkmark$ • Calculate/Bereken F_x: $40 \cos 25^\circ \checkmark$ ($40 \sin 65^\circ$) • Substitution of /vervanging van $w_{\parallel}$ for/vir for 3 kg: $(3)(9,8)\sin 30^\circ \checkmark$ • Left hand side substitution for 3 kg/Linkerkant vervanging vir 3 kg $\checkmark$ • Final answer/Finale antwoord: $1,85 \text{ m}\cdot\text{s}^{-2} \checkmark$
Systems Approach (Massless String Approximation / Sisteembenadering (Massalose Tou Benadering)) (Max 5/8 marks / Maks 5/8 punte) $\left. \begin{aligned} F_{\text{net}} &= ma \\ F_x + (-w_{\parallel}) + (-f_k) &= ma \\ F_x - (w_{\parallel} + f_k) &= ma \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $40\cos 25^\circ \checkmark - (5)(9,8)\sin 30^\circ \checkmark - 2,5 \checkmark = 5a$ $a = 1,85 \text{ m}\cdot\text{s}^{-2} \checkmark$	

(8)

2.4

Greater than/groter as $\checkmark$
 F_{net} increases. / F_{net} neem toe. $\checkmark$

ACCEPT/AANVAAR

There is no friction. /Daar is geen wrywing nie.

OR/OF

The surface is smooth / Die oppervlak is glad

(2)

[16]

QUESTION 3/VRAAG 3

- 3.1 (Motion during which) the only force acting is the force of gravity. ✓✓
 (Beweging waartydens) die enigste krag wat inwerk gravitasiekrag is.

(2 or/of 0)

(2)

3.2

Marking criteria/Nasienriglyne:

- Any appropriate formula for Δy /Enige toepaslike formule vir Δy ✓
- Whole substitution to calculate 5,1 m /Hele vervanging om 5,1 m te bereken ✓
- 40 + answer from calculation/antwoord van berekening ✓
- Final answer/Finale antwoord: 45,10 m ✓ (Accept/aanvaar 45,1 m)

OPTION 1/OPSIE 1

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$0 = (10)^2 + (2)(-9,8)\Delta y \quad \checkmark$$

$$\Delta y = 5,10 \text{ m } (5,102 \text{ m})$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \quad \checkmark \\ &= 45,10 \text{ m } \quad \checkmark \end{aligned}$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$0 = (-10)^2 + (2)(9,8)\Delta y \quad \checkmark$$

$$\Delta y = -5,10 \text{ m } (5,102)$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \quad \checkmark \\ &= 45,10 \text{ m } \quad \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

$$v_f = v_i + a\Delta t$$

$$0 = (10) + (-9,8)\Delta t$$

$$\Delta t = 1,02 \text{ s}$$

$$\begin{aligned} \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \checkmark \\ &= (10)(1,02) + \frac{1}{2}(-9,8)(1,02)^2 \quad \checkmark \\ &= 5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \quad \checkmark \\ &= 45,10 \text{ m } \quad \checkmark \end{aligned}$$

Accept swapping of v_i and v_f
 Aanvaar die omruiling van v_i en v_f

OR/OF

$$\begin{aligned} \Delta y &= \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark \\ &= \left(\frac{10 + 0}{2} \right) (1,02) \quad \checkmark \\ &= 5,10 \text{ m} \end{aligned}$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$v_f = v_i + a\Delta t$$

$$0 = (-10) + (9,8)\Delta t$$

$$\Delta t = 1,02 \text{ s}$$

$$\begin{aligned} \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \checkmark \\ &= (-10)(1,02) + \frac{1}{2}(9,8)(1,02)^2 \quad \checkmark \\ &= 5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \quad \checkmark \\ &= 45,10 \text{ m } \quad \checkmark \end{aligned}$$

Accept swapping of v_i and v_f
 Aanvaar die omruiling van v_i en v_f

OPTION 3/OPSIE 3

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$0 = (10) \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$\Delta t = 2,04 \text{ s}$$

$$\begin{aligned} \Delta y &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= (10)(1,02) + \frac{1}{2} (-9,8)(1,02)^2 \checkmark \\ &= 5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \\ &= 45,10 \text{ m} \checkmark \end{aligned}$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$0 = (-10) \Delta t + \frac{1}{2} (9,8) \Delta t^2$$

$$\Delta t = 2,04 \text{ s}$$

$$\begin{aligned} \Delta y &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= (-10)(1,02) + \frac{1}{2} (9,8)(1,02)^2 \checkmark \\ &= -5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \checkmark \\ &= 45,10 \text{ m} \checkmark \end{aligned}$$

OPTION 4/OPSIE 4

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$0 = (10) \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$\Delta t = 2,04 \text{ s}$$

$$\begin{aligned} \Delta y &= \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark \\ &= \left(\frac{10 + 0}{2} \right) (1,02) \checkmark \\ &= 5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \checkmark \\ &= 45,10 \text{ m} \checkmark \end{aligned}$$

Accept swapping of v_i and v_f
 Aanvaar die omruiling van v_i en v_f

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$0 = (-10) \Delta t + \frac{1}{2} (9,8) \Delta t^2$$

$$\Delta t = 2,04 \text{ s}$$

$$\begin{aligned} \Delta y &= \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark \\ &= \left(\frac{-10 + 0}{2} \right) (1,02) \checkmark \\ &= -5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \checkmark \\ &= 45,10 \text{ m} \checkmark \end{aligned}$$

Accept swapping of v_i and v_f
 Aanvaar die omruiling van v_i en v_f

OPTION 5/OPSIE 5

$$\begin{aligned} E_{(\text{mech/meg})\text{roof/dak}} &= E_{(\text{mech/meg})\text{top/bo}} \\ (E_p + E_k)_{\text{roof/dak}} &= (E_p + E_k)_{\text{top/bo}} \\ (mgh + \frac{1}{2}mv^2)_{\text{roof/dak}} &= (mgh + \frac{1}{2}mv^2)_{\text{top/bo}} \end{aligned} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{Any one/Enige een}$$

$$[m(9,8)(0) + \frac{1}{2}m(10)^2] = m(9,8)(h) + 0 \quad \checkmark$$

$$h = 5,10 \text{ m}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \quad \checkmark \\ &= 45,10 \text{ m} \quad \checkmark \end{aligned}$$

OPTION 6/OPSIE 6

$$\begin{aligned} W_{\text{net}} &= \Delta E_k \quad \checkmark \\ w\Delta x \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ (m)(9,8)\Delta x \cos 180^\circ &= 0 - \frac{1}{2}m(10)^2 \quad \checkmark \\ \Delta x &= 5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \quad \checkmark \\ &= 45,10 \text{ m} \quad \checkmark \end{aligned}$$

OPTION 7/OPSIE 7

$$\begin{aligned} W_{\text{nc}} &= \Delta E_p + \Delta E_k \quad \checkmark \\ 0 &= m(9,8)(h_f - 0) + \frac{1}{2}m(0 - 10^2) \quad \checkmark \\ h_f &= 5,10 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Height} &= 40 + 5,10 \quad \checkmark \\ &= 45,10 \text{ m} \quad \checkmark \end{aligned}$$

OPTION 8/OPSIE 8

Marking criteria/Nasienriglyne:

- Appropriate formula/Toegepaste formule $\checkmark$
- Substitution left/Vervanging links $\checkmark$
- Substitution right/Vervanging regs $\checkmark$
- Final answer/Finale antwoord: 45,10 m $\checkmark$

$$\begin{aligned} E_{(\text{mech/meg})\text{roof/dak}} &= E_{(\text{mech/meg})\text{top/bo}} \\ (E_p + E_k)_{\text{roof/dak}} &= (E_p + E_k)_{\text{top/bo}} \\ (mgh + \frac{1}{2}mv^2)_{\text{roof/dak}} &= (mgh + \frac{1}{2}mv^2)_{\text{top/bo}} \end{aligned} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{Any one/Enige een}$$

$$m(9,8)(40) + \frac{1}{2}m(10)^2 = m(9,8)(h) + 0 \quad \checkmark$$

$$h = 45,10 \text{ m} \quad \checkmark$$

(4)

3.3 $9,8 \text{ m} \cdot \text{s}^{-2} \quad \checkmark$ downwards/afwaarts $\checkmark$

(2)

3.4

Marking criteria/Nasienriglyne

- Calculation/use of 10,26 m./Berekening/gebruik van 10,26 m. ✓
- Appropriate formula to calculate Δt /Toepaslike formule om Δt te bereken ✓
- Substitution for stone A/Vervanging vir klip A ✓
- Substitution for stone B/Vervanging vir klip B ✓
- Calculating time difference between two stones. /Berekening van tydverskil tussen klippe. ✓
- Final answer/Finale antwoord: 1,34 (s) ✓

OPTION 1/OPSIE 1

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

Displacement from roof to meeting point /Verplasing vanaf dak tot ontmoetingspunt = $-40 + 29,74 = -10,26$ m

Stone/Klip A

$$\Delta y_A = v_i \Delta t + \frac{1}{2} a \Delta t^2 \quad \checkmark$$

$$-10,26 \checkmark = \frac{10 \Delta t}{2} + \frac{1}{2} (-9,8) \Delta t^2 \quad \checkmark$$

$$\Delta t = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$-10,26 = 0 + \frac{1}{2} (-9,8) \Delta t^2 \quad \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \quad \checkmark$$

OR/OF

$$[-10,26 = 0(2,79 - x) + \frac{1}{2} (-9,8)(2,79 - x)^2] \checkmark \checkmark$$

$$x = 1,34 \text{ (s)} \quad \checkmark$$

$$\begin{aligned} v_f^2 &= v_i^2 + 2a\Delta y \\ &= 0^2 + 2(-9,8)(-10,26) \\ v_f &= -14,18 \text{ m} \cdot \text{s}^{-1} \end{aligned}$$

$$\begin{aligned} v_f &= v_i + a\Delta t \\ -14,18 &= 0 + (-9,8)\Delta t \quad \checkmark \\ \Delta t &= 1,45 \text{ s} \end{aligned}$$

$$\begin{aligned} x &= 2,79 - 1,45 \quad \checkmark \\ &= 1,34 \text{ (s)} \quad \checkmark \end{aligned}$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

Displacement from roof to meeting point /Verplasing vanaf dak tot ontmoetingspunt = $40 - 29,74 = 10,26$ m

Stone/Klip A

$$\Delta y_A = v_i \Delta t + \frac{1}{2} a \Delta t^2 \quad \checkmark$$

$$10,26 \checkmark = \frac{-10 \Delta t}{2} + \frac{1}{2} (9,8) \Delta t^2 \quad \checkmark$$

$$\Delta t = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$10,26 = 0 + \frac{1}{2} (9,8) \Delta t^2 \quad \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \quad \checkmark$$

OR/OF

$$[-10,26 = 0(2,79 - x) + \frac{1}{2} (-9,8)(2,79 - x)^2] \checkmark \checkmark$$

$$x = 1,34 \text{ (s)} \quad \checkmark$$

$$\begin{aligned} v_f^2 &= v_i^2 + 2a\Delta y \\ &= 0^2 + 2(9,8)(10,26) \\ v_f &= 14,18 \text{ m} \cdot \text{s}^{-1} \end{aligned}$$

$$\begin{aligned} v_f &= v_i + a\Delta t \\ 14,18 &= 0 + (9,8)\Delta t \quad \checkmark \\ \Delta t &= 1,45 \text{ s} \end{aligned}$$

$$\begin{aligned} x &= 2,79 - 1,45 \quad \checkmark \\ &= 1,34 \text{ (s)} \quad \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

Displacement from roof to meeting point /Verplasing vanaf dak tot ontmoetingspunt = $-40 + 29,74 = -10,26$ m

Displacement of stone A from max height to meeting point/ Verplasing van klip A vanaf maksimum hoogte tot ontmoetingspunt = $-15,36$ m

Stone/Klip A

$$v_f = v_i + a\Delta t$$

$$0 = 10 + (-9,8)\Delta t$$

$$\Delta t = 1,02 \text{ s}$$

$$\Delta y_A = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$-15,36 = 0 + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,77 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,77 + 1,02 = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$-10,26 \checkmark = 0 + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(-9,8)(-10,26)$$

$$v_f = -14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$-14,18 = 0 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

Displacement from roof to meeting point /Verplasing vanaf dak tot ontmoetingspunt = $40 - 29,74 = 10,26$ m $\checkmark$

Displacement of ball A from max height to meeting point/ Verplasing van bal A vanaf maksimum hoogte tot ontmoetingspunt = $15,36$ m

Stone/Klip A

$$v_f = v_i + a\Delta t$$

$$0 = -10 + (9,8)\Delta t$$

$$\Delta t = 1,02 \text{ s}$$

$$\Delta y_A = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$15,36 = 0 + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,77 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,77 + 1,02 = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$10,26 = 0 + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(9,8)(10,26)$$

$$v_f = 14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$14,18 = 0 + (9,8)\Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

OPTION 3/OPSIE 3

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

Displacement of stones A and B from roof to meeting point/*Verplasing van klippe A en B vanaf dak tot by ontmoetingspunt* = - 40 + 29,74
 = - 10,26 m

Stone/Klip A

$$v_f = v_i + a\Delta t$$

$$0 = 10 + (-9,8)\Delta t$$

$$\Delta t = 1,02 \text{ s}$$

$$\Delta y_A = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$-10,26 \checkmark = \underline{-10 + \frac{1}{2}(-9,8)\Delta t^2} \checkmark$$

$$\Delta t = 0,75 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,02 + 1,02 + 0,75 = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$\underline{-10,26 = 0 + \frac{1}{2}(-9,8)\Delta t^2} \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(-9,8)(-10,26)$$

$$v_f = -14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$\underline{-14,18 = 0 + (-9,8)\Delta t} \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

Displacement of stones A and B from roof to meeting point/*Verplasing van klippe A en B vanaf dak tot by ontmoetingspunt* = 40 - 29,74 = 10,26 m

Stone/Klip A

$$v_f = v_i + a\Delta t$$

$$0 = -10 + (9,8)\Delta t$$

$$\Delta t = 1,02 \text{ s}$$

$$\Delta y_A = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$10,26 \checkmark = \underline{10 + \frac{1}{2}(9,8)\Delta t^2} \checkmark$$

$$\Delta t = 0,75 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,02 + 1,02 + 0,75 = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$\underline{10,26 = 0 + \frac{1}{2}(9,8)\Delta t^2} \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(9,8)(10,26)$$

$$v_f = 14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$\underline{14,18 = 0 + (9,8)\Delta t} \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

OPTION 4/OPSIE 4

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

Displacement from roof to meeting point /Verplasing vanaf dak tot ontmoetingspunt = $-40 + 29,74 = -10,26$ m

Stone/Klip A

$$\Delta y_A = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$-5,10 = 0 + \frac{1}{2} (-9,8) \Delta t^2$$

$$\Delta t = 1,02 \text{ s}$$

$$\Delta y_A = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$-10,26 \checkmark = -10 + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$$

$$\Delta t = 0,75 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,02 + 1,02 + 0,75 = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$-10,26 = 0 + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(-9,8)(-10,26)$$

$$v_f = -14,18 \text{ m} \cdot \text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$-14,18 = 0 + (-9,8) \Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

Displacement from roof to meeting point /verplasing vanaf dak tot by ontmoetingspunt = $40 - 29,74 = 10,26$ m

Stone/Klip A

$$\Delta y_A = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$5,10 = 0 + \frac{1}{2} (9,8) \Delta t^2$$

$$\Delta t = 1,02 \text{ s}$$

$$\Delta y_A = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$10,26 \checkmark = 10 + \frac{1}{2} (9,8) \Delta t^2 \checkmark$$

$$\Delta t = 0,75 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,02 + 1,02 + 0,75 = 2,79 \text{ s}$$

Stone/Klip B

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$10,26 = 0 + \frac{1}{2} (9,8) \Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(9,8)(10,26)$$

$$v_f = 14,18 \text{ m} \cdot \text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$14,18 = 0 + (9,8) \Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

OPTION 5/OPSIE 5

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

Displacement from roof to meeting point /Verplasing vanaf dak tot ontmoetingspunt = $-40 + 29,74 = -10,26$ m

Displacement of stone A from max height to meeting point/ Verplasing van klip A vanaf maksimum hoogte tot ontmoetingspunt = $-15,36$ m

Stone/Klip A

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = (0)^2 + (2)(-9,8)(-15,36)$$

$$v_f = -17,35 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$-17,35 = 0 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 1,77 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,02 + 1,77 = 2,79 \text{ (s)}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$-10,26 \checkmark = 0 + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(-9,8)(-10,26)$$

$$v_f = -14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$-14,18 = 0 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

Displacement from roof to meeting point /Verplasing vanaf dak tot ontmoetingspunt = $40 - 29,74 = 10,26$ m

Displacement of stone A from max height to meeting point/ Verplasing van klip A vanaf maksimum hoogte tot ontmoetingspunt = $15,36$ m

Stone/Klip A

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = (0)^2 + (2)(9,8)(15,36)$$

$$v_f = 17,35 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$17,35 = 0 + (9,8)\Delta t \checkmark$$

$$\Delta t = 1,77 \text{ s}$$

$$\Delta t_{\text{tot}} = 1,02 + 1,77 = 2,79 \text{ (s)}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$10,26 \checkmark = 0 + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(9,8)(10,26)$$

$$v_f = 14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$14,18 = 0 + (9,8)\Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

OPTION 6/OPSIE 6

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

Displacement from roof to meeting point/Verplasing vanaf dak tot by ontmoetingspunt = $-40 + 29,74 = -10,26$ m

Stone/Klip A

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = (-10)^2 + (2)(-9,8)(-10,26)$$

$$v_f = -17,35 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$-17,35 = -10 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 0,75 \text{ s}$$

$$\text{Ball A: } \Delta t = 1,02 + 1,02 + 0,75 = 2,79 \text{ (s)}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$-10,26 \checkmark = 0 + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(-9,8)(-10,26)$$

$$v_f = -14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$-14,18 = 0 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

Displacement from roof to meeting point/Verplasing vanaf dak tot by ontmoetingspunt = $40 - 29,74 = 10,26$ m

Stone/Klip A

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = [(10)^2 + (2)(9,8)(10,26)$$

$$v_f = 17,35 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$17,35 = 10 + (9,8)\Delta t \checkmark$$

$$\Delta t = 0,75 \text{ s}$$

$$\text{Ball A: } \Delta t = 1,02 + 1,02 + 0,75 = 2,79 \text{ (s)}$$

Stone/Klip B

$$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$10,26 \checkmark = 0 + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = 1,45 \text{ s (1,447 s)}$$

$$x = 2,79 - 1,45 \checkmark = 1,34 \text{ (s)} \checkmark$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$= 0^2 + 2(9,8)(10,26)$$

$$v_f = 14,18 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$14,18 = 0 + (9,8)\Delta t \checkmark$$

$$\Delta t = 1,45 \text{ s}$$

$$x = 2,79 - 1,45 \checkmark$$

$$= 1,34 \text{ (s)} \checkmark$$

(6)

3.5.1 d $\checkmark$ **Accept / Aanvaar** (0 – e; 0 – d; d – e)

(1)

3.5.2 a $\checkmark$

(1)

3.5.3 f $\checkmark$

(1)

3.5.4 c $\checkmark$

(1)

[18]

QUESTION 4/VRAAG 4

- 4.1 **NOTE:** -1 mark for each key word/phrase omitted in the correct context.
LET WEL: -1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.

Isolated system is a system on which the resultant/net external force is zero. ✓✓

Geïsoleerde sisteem is 'n sisteem waarop die resultante / netto eksterne krag nul is.

OR/OF

Isolated system is one that has no net / external force acting on it.

'n Geïsoleerde stelsel is een wat geen netto eksterne krag het wat daarop inwerk nie.

(2)

- 4.2.1 $p = mv$ ✓
 $24 = m (480)$ ✓
 $m = 0,05 \text{ kg}$ ✓

Note: p and v must have the same sign
 Let wel: p en v moet dieselfde tekens hê

(3)

- 4.2.2 **Marking criteria/Nasienriglyne**
- Appropriate formula including F_{net} or W_{net} . / Toepaslike formule wat F_{net} of W_{net} insluit. ✓
 - Substitutions/Vervangings ✓✓
 - Final answer/Finale antwoord: 2 000 N ✓
 - Correct direction/Korrekte rigting: west or left/Wes of links ✓
- POSITIVE MARKING FROM QUESTION 4.2.1**
POSITIEWE NASIEN VANAF VRAAG 4.2.1
- OPTION 1/OPSIE 1**
- $F_{\text{net}}\Delta t = \Delta p$
 $F_{\text{net}}\Delta t = (p_{\text{bullet}})_f - (p_{\text{bullet}})_i$ } ✓ Any one/Enige een
 $F_{\text{net}}\Delta t = (mv_{\text{bullet}})_f - (mv_{\text{bullet}})_i$ }
 $F_{\text{net}}(0,01) \checkmark = (0,05)(80) - 24 \checkmark$ or/of $(0,05)(80) - (0,05)(480)$
 $F_{\text{net}} = -2\,000 \text{ N}$
 $F_{\text{net}} = 2\,000 \text{ N} \checkmark$ west/wes ✓
- OPTION 2/OPSIE 2**
- $v_f = v_i + a\Delta t$
 $80 = 480 + a(0,01) \checkmark$
 $a = -40\,000 \text{ m}\cdot\text{s}^{-2}$
 $F_{\text{net}} = ma \checkmark$
 $= (0,05)(-40\,000) \checkmark$
 $= -2\,000 \text{ N}$
 $F_{\text{net}} = 2\,000 \text{ N} \checkmark$ west/wes ✓

OPTION 3/OPSIE 3

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$= \frac{480 + 80}{2} (0,01)$$

$$= 2,80 \text{ m}$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$(80)^2 = (480)^2 + 2a(2,80) \checkmark$$

$$a = -40\,000 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark$$

$$= (0,05)(-40\,000) \checkmark$$

$$= -2\,000 \text{ N}$$

$$F_{\text{net}} = 2\,000 \text{ N} \checkmark \text{ west/wes} \checkmark$$

$$W_{\text{net}} = \Delta K \checkmark$$

$$F_{\text{net}} \Delta x \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$F_{\text{net}}(2,80)\cos 0^\circ \checkmark = \frac{1}{2}(0,05)(80^2 - 480^2) \checkmark$$

$$F_{\text{net}} = -2\,000 \text{ N}$$

$$F_{\text{net}} = 2\,000 \text{ N} \checkmark \text{ west/wes} \checkmark$$

OR/OF

$$F_{\text{net}}(2,80)\cos 180^\circ \checkmark = \frac{1}{2}(0,05)(80^2 - 480^2) \checkmark$$

$$F_{\text{net}} = 2\,000 \text{ N} \checkmark \text{ west/wes} \checkmark$$

(5)
[10]

QUESTION 5

5.1

Note: -1 mark for each key word/phrase omitted in the correct context.

Let Wel: -1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.

IF: The word "work" is omitted - 0 marks.

INDIEN: Die woord "arbeid" uitgelaat is - 0 punte.

A conservative force is a force for which the work done (in moving an object between two points) is independent of the path taken. ✓✓

'n Konserwatiewe krag is 'n krag waarvoor die arbeid wat verrig is (om 'n voorwerp tussen twee punte te beweeg) onafhanklik is van die pad wat gevat word.

OR/OF

A conservative force is a force for which the work done in moving an object in a closed path is zero.

'n Konserwatiewe krag is 'n krag waarvoor die arbeid verrig om 'n voorwerp in 'n geslote pad te beweeg, nul is.

(2)

5.2

Gravitational (force)/Gravitasiekrag ✓

ACCEPT/AANVAAR: Gravitation /Gravity /Gravitasie /Weight /Gewig

(1)

5.3

No/Nee ✓

There is friction/non-conservative force (doing work)/It is not isolated system. ✓

Daar is wrywing/nie konserwatiewe krag (wat arbeid verrig)./Dit is nie 'n geïsoleerde sisteem nie.

OR/OF

The net work done by the non-conservative forces is not zero/Die netto arbeid deur die nie-konserwatiewe kragte is nie nul nie. ✓

(2)

5.4	OPTION 1/OPSIE 1 $E_p = mgh \checkmark$ $= (1,8)(9,8)(1,5) \checkmark$ $= 26,46 \text{ J} \checkmark$	OPTION 2/OPSIE 2 $W_w = -\Delta E_p \checkmark$ $(1,8)(9,8)(h - 0)\cos 180^\circ = -(E_{pA} - E_{p(\text{ground})})$ $(1,8)(9,8)(1,5)(-1) = -E_{pA} \checkmark$ $E_p = 26,46 \text{ J} \checkmark$ OR/OF $W = F\Delta x \cos \theta$ $= mg\Delta h \cos \theta$ $= (1,8)(9,8)(1,5)\cos 0^\circ \checkmark$ $= 26,46 \text{ J} \checkmark$	(3)
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5.5	POSITIVE MARKING FROM QUESTION 5.4 / POSITIEWE NASIEN VANAF VRAAG 5.4 OPTION 1/OPSIE 1 $W_{nc} = \Delta K + \Delta U$ $W_f = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \checkmark$ $= \frac{1}{2}(1,8)(4^2 - 0,95^2) \checkmark + (0 - 26,46) \checkmark$ $= -12,87 \text{ J} \checkmark$ OPTION 2/OPSIE 2 $W_{net} = \Delta K$ $W_f + W_g = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $W_f + mgh = \frac{1}{2}m(v_f^2 - v_i^2)$ $W_f + mgh = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $W_f + 26,46 \checkmark = \frac{1}{2}(1,8)[(4)^2 - (0,95)^2] \checkmark$ $W_f = -12,87 \text{ J} \text{ (- 12,872 J)} \checkmark$ OPTION 3/OPSIE 3 $E_{(\text{mech/meg})A} = E_{(\text{mech})B} - W_f$ $(E_p + E_k)_A = (E_p + E_k)_B - W_f$ $(mgh + \frac{1}{2}mv^2)_A = (mgh + \frac{1}{2}mv^2)_B - W_f$ $26,46 + \frac{1}{2}(1,8)(0,95^2) \checkmark = 0 + \frac{1}{2}(1,8)(4^2) - W_f \checkmark$ $W_f = -12,87 \text{ J} \checkmark$	(4)
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5.6	$W_{net} = 0 \text{ (J) / zero} \checkmark$	(1)
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[13]

QUESTION 6/VRAAG 6

6.1	Doppler effect/Doppler-effek $\checkmark$	(1)
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6.2	(Q): (records sounds with) longer period/ longer time per wave / lower frequency. (Q): (teken klank aan met) langer periode / langer tyd per golf / laer frekwensie.	
-----	--	--

OR/OF

P: (records sounds with) shorter period/ shorter time per wave / higher frequency. $\checkmark$

P: (teken klank aan met) korter periode/ korter tyd per golf / hoër frekwensie.

ACCEPT/AANVAAR

(Q): longer wavelength. /P: shorter wavelength.

(Q): langer golflengte./P: korter golflengte het.

(1)

6.3 **OPTION 1/OPSIE 1**

$$f = \frac{1}{T} \checkmark = \frac{1}{17 \times 10^{-4}} \checkmark = 5,88 \times 10^2 = 588,24 \text{ Hz} \checkmark$$

OPTION 2/OPSIE 2

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$340 = \frac{\text{distance}}{25,5 \times 10^{-4}}$$

$$\text{Distance} = 0,867 \text{ m}$$

$$\text{Distance} = 1 \frac{1}{2} \lambda$$

$$\therefore \lambda = 0,578 \text{ m}$$

$$v = f\lambda \checkmark$$

$$340 = f(0,578) \checkmark$$

$$f = 588,24 \text{ Hz} \checkmark$$

OPTION 3/OPSIE 3

$$v = \frac{\lambda}{T}$$

$$340 = \frac{\lambda}{17 \times 10^{-4}}$$

$$\therefore \lambda = 0,578 \text{ m}$$

$$v = f\lambda \checkmark$$

$$340 = f(0,578) \checkmark$$

$$f = 588,24 \text{ Hz} \checkmark$$

(3)

6.4 **POSITIVE MARKING FROM QUESTIONS 6.2 AND 6.3.**

POSITIEWE NASIEN VANAF VRAE 6.2 EN 6.3

Do not penalise if 10^{-4} is again omitted. /Moenie penaliseer indien 10^{-4} weer uitgelaat is nie.

OPTION 1/OPSIE 1

$$f = \frac{1}{18 \times 10^{-4}} \checkmark = 5,56 \times 10^2 = 555,56 \text{ Hz}$$

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark \quad \text{OR/OF} \quad f_L = \frac{v}{v + v_s} f_s$$

$$555,56 \checkmark = \left(\frac{340}{340 + v} \right) 588,24 \checkmark$$

$$v = 20 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$\text{Range/Gebied } 19,57 - 20,09 \text{ m} \cdot \text{s}^{-1}$$

OPTION 2/OPSIE 2

$$f_L = \frac{1}{18 \times 10^{-4}} \checkmark$$

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark \quad \text{OR/OF} \quad f_L = \frac{v}{v + v_s} f_s$$

$$\frac{1}{18 \times 10^{-4}} \checkmark = \left(\frac{340}{340 + v} \right) \frac{1}{17 \times 10^{-4}} \checkmark$$

$$v = 20 \text{ m} \cdot \text{s}^{-1} \checkmark$$

$$\text{Range/Gebied } 19,57 - 20,09 \text{ m} \cdot \text{s}^{-1}$$

(6)

[11]

QUESTION 7/VRAAG 7

7.1.1 Positive/Positief ✓

(1)

7.1.2

Marking criteria/Nasienriglyne:

- Appropriate formula /Toepaslike formule✓
- Whole substitution Hele vervanging✓/
- Final answer/finale antwoord: $2,26 \times 10^{-6} \text{ C}$ ✓

OPTION 1/OPSIE 1

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$3,05 = \frac{(9 \times 10^9)(6 \times 10^{-6})Q}{0,2^2} \checkmark$$

$$Q = 2,26 \times 10^{-6} \text{ C} \checkmark$$

$$(2,259 \times 10^{-6} \text{ C})$$

OPTION 2/OPSIE 2

$$E = \frac{kQ}{r^2}$$

$$= \frac{(9 \times 10^9)(6 \times 10^{-6})}{0,2^2}$$

$$= 1,35 \times 10^6 \text{ N} \cdot \text{C}^{-1}$$

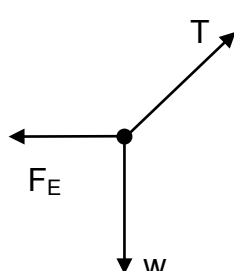
$$F = Eq \checkmark$$

$$3,05 = (1,35 \times 10^6)q \checkmark$$

$$q = 2,26 \times 10^{-6} \text{ N} \checkmark$$

(3)

7.1.3



Accepted labels/Aanvaarde benoemings

$w \checkmark$	$F_g / F_w / \text{weight} / mg / \text{gravitational force}$ $F_g / F_w / \text{gewig} / mg / \text{gravitasiekrag}$
$T \checkmark$	$F_T / \text{tension} / \text{spanning}$
$F_E / F \checkmark$	Electrostatic force/ Coulomb force/ $F_{E \text{ Field}} / F_{x \text{ on } Y}$ / 3,05 N Elektrostatiese krag/ Coulombkrag

Notes/Aantekeninge

- Mark is awarded for label and arrow. /Punt word toegeken vir byskrif en pyltjie.
- Do not penalise for length of arrows.
Moenie vir die lengte van die pyltjies penaliseer nie.
- Deduct 1 mark for any additional force /Trek 1 punt af vir enige addisionele krag
- If force(s) do not make contact with dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{2}{3}$
- If arrows missing/Indien pyltjies uitgelaat word: Max/Maks $\frac{2}{3}$

(3)

7.1.4

$$F_{\text{net}} = 0$$

$$F_E = T \sin 10^\circ$$

$$F_E = T \cos 80^\circ$$

$$[3,05 = T \sin 10^\circ \checkmark] \checkmark$$

$$[\text{IF /INDIEN } T \cos 10^\circ = 3,05 \left(\frac{1}{3} \right)]$$

OR/OF

$$[3,05 = T \cos 80^\circ \checkmark] \checkmark$$

$$[\text{IF /INDIEN } T \sin 80^\circ = 3,05 \left(\frac{1}{3} \right)]$$

$$T = 17,56 \text{ N} \checkmark (17,564 \text{ N})$$

(3)

7.2.1

Marking criteria/Nasienriglyne

-1 mark for each key word/phrase omitted in the correct context.
 -1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.

The electric field at a point is the (electrostatic) force experienced per unit positive charge placed at that point. ✓✓

Die elektriese veld by 'n punt is die (elektrostatiese) krag wat per positiewe eenheidslading wat by die punt geplaas is, ondervind word.

[IF the word “unit” or phrase “positive charge” is omitted in this definition: -1 for each
INDIEN die woord “eenheid” of frase “positiewe lading” uitgelaat is in hierdie definisie: -1 vir elk]

OR/OF

The electric field at a point is the (electrostatic) force experienced by a UNIT positive charge placed at that point. ✓✓

Die elektriese veld by 'n punt is die (elektrostatiese) krag wat deur 'n positiewe EENHEIDSlading wat by die punt geplaas is, ondervind word.

[If “UNIT” is omitted in this definition, then 0 marks.

Indien “EENHEIDS” uitgelaat word in hierdie definisie, dan 0 punte.]

(2)

7.2.2

OPTION 1/OPSIE 1

Electric field at **M** due to **A** ($+2 \times 10^{-5}$ C):

$$E_A = \frac{kQ}{r^2} \checkmark$$

$$= 9 \times 10^9 \frac{(2 \times 10^{-5})}{(0,2)^2} \checkmark$$

$$= 4,5 \times 10^6 \text{ N} \cdot \text{C}^{-1}$$

Electric field at **M** due to **B** (-4×10^{-5} C):

$$E_B = \frac{kQ}{r^2} \quad \text{OR/OF} \quad q_B = 2q_A$$

$$= 9 \times 10^9 \frac{(4 \times 10^{-5})}{(0,2)^2} \checkmark \quad E_B = 2E_A \checkmark$$

$$= 9 \times 10^6 \text{ N} \cdot \text{C}^{-1} \quad = 9 \times 10^6 \text{ N} \cdot \text{C}^{-1}$$

$$E_{\text{net}} \text{ at } \mathbf{M} = E_A + E_B$$

$$= (4,5 \times 10^6 + 9 \times 10^6) \checkmark$$

$$= 1,35 \times 10^7 \text{ N} \cdot \text{C}^{-1} \checkmark \text{ to the right/na regs/towards B/na B}$$

/away from A / weg vanaf A✓

OPTION 2/OPSIE 2

Net electrostatic force at **M** / Netto elektrostatische krag by **M**

$$F_{\text{net}} = \frac{kQ_1Q_2}{r^2} + \frac{kQ_1Q_2}{r^2}$$

$$= \frac{(9 \times 10^9)(2 \times 10^{-5})q}{(0,2)^2} + \frac{(9 \times 10^9)(4 \times 10^{-5})q}{(0,2)^2} \checkmark \text{ (any one/ enige een)}$$

$$= 4,5 \times 10^6 q + 9 \times 10^6 q$$

$$= 1,35 \times 10^7 q \text{ N}$$

$$F_{\text{net}} = E_{\text{net}}q \checkmark$$

$$1,35 \times 10^7 q \checkmark = E_{\text{net}}q$$

$$E_{\text{net}} = 1,35 \times 10^7 \text{ N} \cdot \text{C}^{-1} \checkmark \text{ to the right/na regs } \checkmark \text{ /towards B / na B}$$

(6)

[18]

QUESTION 8/VRAAG 8

- 8.1 (Maximum) energy provided (work done) ✓ by a battery per coulomb / unit charge passing through it. ✓
(Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheidlading wat daardeur beweeg.

ACCEPT/AANVAAR:

The reading on a voltmeter connected across a battery when there is no current/ in an open circuit. ✓✓

Lesing op 'n voltmeter oor 'n battery as daar geen stroom is nie

(2)

- 8.2 13 V ✓

(1)

8.3.1	$R = \frac{V}{I} \checkmark$ $5,6 = \frac{10,5}{I} \checkmark$ $I = 1,88 \text{ A} \checkmark (1,875 \text{ A})$	Marking criteria/Nasienriglyne: - Appropriate formula/<i>Toepaslike formule</i> ✓ - Whole substitution/<i>Hele vervanging</i> ✓ - Final answer/<i>Finale antwoord</i>: 1,88 A ✓
-------	--	--

(3)

8.3.2	POSITIVE MARKING FROM QUESTION 8.3.1. POSITIEWE NASIEN VANAF VRAAG 8.3.1	
	OPTION 1 $P = VI \checkmark$ $= (10,5)(1,88) \checkmark$ $= 19,74 \text{ W} \checkmark (19,688 \text{ W})$	OPTION 2 $P = I^2 R \checkmark$ $= (1,88)^2 (5,6) \checkmark$ $= 19,79 \text{ W} \checkmark (19,688 \text{ W})$
	OPTION 3 $P = \frac{V^2}{R} \checkmark$ $= \frac{10,5^2}{5,6} \checkmark$ $= 19,69 \text{ W} \checkmark (19,688 \text{ W})$	

(3)

8.3.3	POSITIVE MARKING FROM QUESTIONS 8.2 AND 8.3.1. POSITIEWE NASIEN VANAF VRAAG 8.2 EN 8.3.1	
	OPTION 1/OPSIE 1 $\mathcal{E} = I(R + r) \checkmark$ $13 = 1,88 (5,6 + r) \checkmark$ $r = 1,31 \Omega \checkmark (1,31 - 1,33 \Omega)$	OPTION 2/OPSIE 2 $r = \frac{V_{\text{internal}}}{I} \checkmark$ $= \frac{2,5}{1,88} \checkmark$ $= 1,33 \Omega \checkmark (1,31 - 1,33 \Omega)$
	OPTION 3/OPSIE 3 $\mathcal{E} = V_{\text{ext}} + V_{\text{int}}$ $13 = 10,5 + V_{\text{int}}$ $V_{\text{int}} = 2,5 \text{ V}$ $V_{\text{int}} = Ir \checkmark$ $2,5 = (1,88)r \checkmark$ $r = 1,31 \Omega \checkmark (1,31 - 1,33 \Omega)$	

(3)

8.4.1 Decreases/Neem af ✓

$V_{\text{internal resistance}}$ /Internal volts increase ✓
 $V_{\text{interne weerstand}}$ /Interne volts neem toe

(2)

8.4.2

Marking criteria/Nasienriglyne

- Formula/Formule $\mathcal{E} = I(R + r)$ ✓
- Correct substitution into/ Korrekte vervanging in $\mathcal{E} = I(R + r)$ ✓
- Substitution of values into R_p formula/Vervanging van waarde van R_p in formule ✓
- Halving value of R_{2X} /Halvering van waarde van R_{2X} ✓
- Final answer/Finale antwoord: $1,49 \Omega$ ✓ Range/Gebied: $1,46 \Omega - 1,49 \Omega$

POSITIVE MARKING FROM QUESTIONS 8.2 AND 8.3.3

POSITIEWE NASIEN VANAF VRAE 8.2 EN 8.3.3

OPTION 1/OPSIE 1

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ 13 &= 4(R_{\text{ext}} + 1,31) \checkmark \\ R_{\text{ext}} &= 1,94 \Omega \quad (1,92 \Omega) \\ \frac{1}{R_p} &= \frac{1}{R_1} + \frac{1}{R_2} \\ \frac{1}{1,94} &= \frac{1}{5,6} + \frac{1}{R_2} \checkmark \\ R_2 &= 2,97 \Omega \quad (2,92 \Omega) \\ X &= \frac{1}{2}(2,97) \checkmark \\ &= 1,49 \Omega \checkmark \quad (1,46 - 1,49 \Omega)\end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ 13 &= 4(R_{\text{ext}} + 1,31) \checkmark \\ R_{\text{ext}} &= 1,94 \Omega \quad (1,92 \Omega) \\ R_p &= \frac{R_1 R_2}{R_1 + R_2} \\ 1,94 &= \frac{5,6 R_2}{5,6 + R_2} \checkmark \\ R_2 &= 2,97 \Omega \quad (2,92 \Omega) \\ X &= \frac{1}{2}(2,97) \checkmark \\ &= 1,49 \Omega \checkmark \quad (1,46 - 1,49 \Omega)\end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ 13 &= 4(R_{\text{ext}} + 1,31) \checkmark \\ R_{\text{ext}} &= 1,94 \Omega \quad (1,92 \Omega) \\ \frac{1}{R_p} &= \frac{1}{R_1} + \frac{1}{R_2} \\ \left[\frac{1}{1,94} = \frac{1}{5,6} + \frac{1}{2X} \right] \checkmark \\ X &= 1,49 \Omega \checkmark \quad (1,46 - 1,49 \Omega)\end{aligned}$$

OPTION 4/OPSIE 4

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ 13 &= 4(R_{\text{ext}} + 1,31) \checkmark \\ R_{\text{ext}} &= 1,94 \Omega \quad (1,92 \Omega) \\ R_p &= \frac{R_1 R_2}{R_1 + R_2} \\ \left[1,94 = \frac{(5,6)(2X)}{5,6 + 2X} \right] \checkmark \\ X &= 1,49 \Omega \checkmark\end{aligned}$$

OPTION 5/OPSIE 5

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ V_{\text{ext}} &= 13 - (4)(1,31) \checkmark \\ &= 7,76 \text{ V} \\ V_p &= IR_{5,6} \\ 7,76 &= I(5,6) \\ I_{5,6} &= 1,37 \text{ A} \\ I_T &= I_{2X} + I_{5,6} \\ 4 &= I_{2X} + 1,37 \\ I_{2X} &= 2,63 \text{ A} \\ V &= IR_{2X} \\ [7,76 &= (2,63)2X] \checkmark \\ X &= 1,46 \Omega \checkmark\end{aligned}$$

OPTION 6/OPSIE 6

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ V_{\text{ext}} &= 13 - (4)(1,31) \checkmark \\ V_{\text{ext}} &= 7,76 \text{ V} \\ I_{5,6} &= \frac{7,76}{5,6} = 1,39 \text{ A} \\ I_{2X} &= 4 - 1,39 = 2,61 \text{ A} \\ V_{2X} &= I_{2X} R_{2X} \\ [7,76 &= (2,61)2X] \checkmark \\ 2X &= 2,97 \Omega \\ X &= 1,49 \Omega \checkmark \\ V_X &= I_X R_X \\ 3,88 &= (2,61)R_X \checkmark \\ R_X &= 1,49 \Omega \checkmark\end{aligned}$$

OPTION 7/OPSIE 7

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ V_{\text{ext}} &= 13 - (4)(1,31) \checkmark \\ &= 7,76 \text{ V} \\ V_{\text{ext}} &= IR_{\text{ext}} \\ 7,76 &= (4) \left(\frac{1}{2X} + \frac{1}{5,6} \right)^{-1} \checkmark \\ X &= 1,48 \, \Omega \checkmark\end{aligned}$$

(5)
[19]

QUESTION 9/VRAAG 9

9.1

9.1.1 DC/GS ✓

(1)

9.1.2

NOTE: -1 mark for each key word/phrase omitted in correct context.
LET WEL: -1 punt vir elke sleutel woord/frase weggelaat in die korrekte konteks.

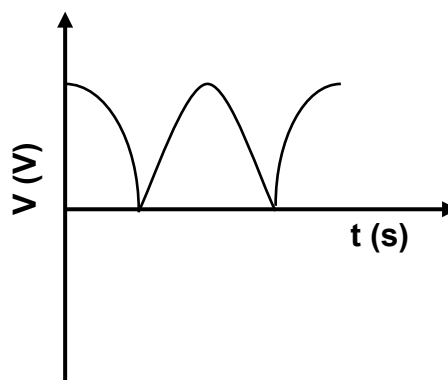
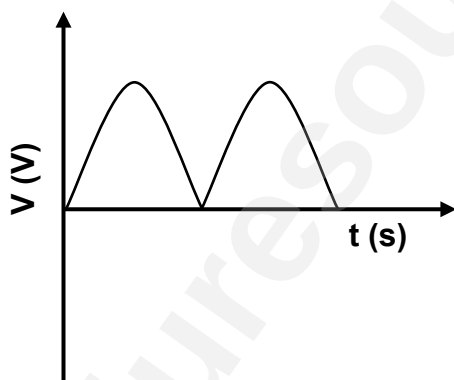
Emf is induced as a result of change of magnetic flux (linked) with the coil. ✓✓

Emk word geïnduseer as gevolg van verandering van die magnetiese vloedkoppeling.

(2)

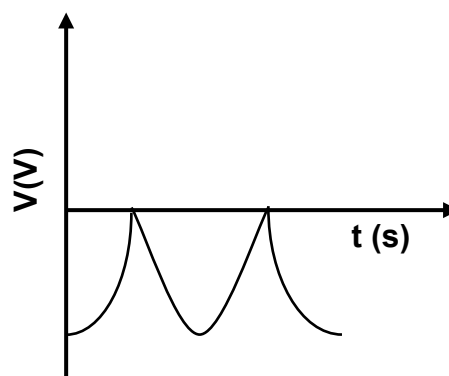
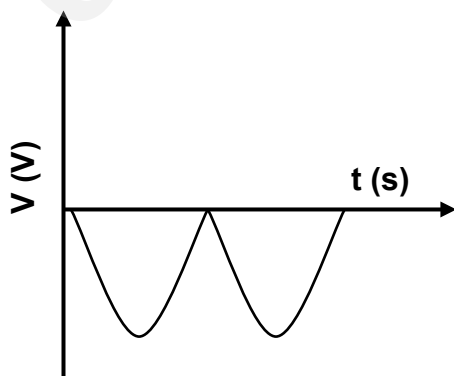
9.1.3

POSITIVE MARKING FROM QUESTION 9.1.1
POSITIEWE NASIEN VANAF VRAAG 9.1.1



OR/OF

Marking criteria for graph:	
Correct shape <i>Korrekte vorm</i>	✓
One complete cycle/ <i>Een volledige siklus</i>	✓



(2)

- 9.2.1 The AC potential difference/voltage which dissipates the same amount of energy ✓ as DC potential difference. ✓
 Die WS potensiaalverskil/spanning wat dieselfde hoeveelheid energie verbruik as GS potensiaalverskil/spanning

OR/OF

(The rms value of AC is) the DC potential difference/voltage which dissipates the same amount of energy ✓ as AC potential difference/voltage. ✓
 Dit is die GS potensiaalverskil/spanning wat dieselfde hoeveelheid energie verbruik as WS potensiaalverskil/spanning.

(2)

9.2.2	OPTION 1 / OPSIE 1 $W = \frac{V^2}{R} \Delta t \checkmark$ $500 = \frac{V^2}{200} (10) \checkmark$ $V = V_{\text{rms}} = 100 \text{ V}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $100 = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $V_{\text{max}} = 141,42 \text{ V} \checkmark$	OPTION 2 / OPSIE 2 $W = I^2 R \Delta t$ $500 = I^2 (200) (10)$ $I = I_{\text{rms}} = 0,5 \text{ A}$ $P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \checkmark$ $\frac{500}{10} = \frac{V_{\text{rms}} (0,5)}{10} \checkmark$ $V_{\text{rms}} = 100 \text{ V}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $100 = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $V_{\text{max}} = 141,42 \text{ V} \checkmark$	OPTION 3 / OPSIE 3 $P_{\text{ave}} = I_{\text{rms}}^2 R$ $\frac{500}{10} = I_{\text{rms}}^2 (200)$ $I_{\text{rms}} = 0,5 \text{ A}$ $P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \checkmark$ $\frac{500}{10} = \frac{V_{\text{rms}} (0,5)}{10} \checkmark$ $V_{\text{rms}} = 100 \text{ V}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $100 = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $V_{\text{max}} = 141,42 \text{ V} \checkmark$	OPTION 4 / OPSIE 4 $R = \frac{V_{\text{rms}}}{I_{\text{rms}}} \checkmark$ $200 = \frac{V_{\text{rms}}}{0,5} \checkmark$ $V_{\text{rms}} = 100 \text{ V}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $100 = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $V_{\text{max}} = 141,42 \text{ V} \checkmark$
	OPTION 5 / OPSIE 5 $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark$ $\frac{500}{10} = \frac{V_{\text{rms}}^2}{200} \checkmark$ $V_{\text{rms}} = 100 \text{ V}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $100 = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $V_{\text{max}} = 141,42 \text{ V} \checkmark$	OPTION 6 / OPSIE 6 $P_{\text{ave}} = \frac{P_{\text{max}}}{2} \checkmark$ $\frac{500}{10} = \frac{P_{\text{max}}}{2} \checkmark$ $P_{\text{max}} = 100 \text{ W}$ $P_{\text{max}} = \frac{V_{\text{max}}^2}{R} \checkmark$ $100 = \frac{V_{\text{max}}^2}{200} \checkmark$ $V_{\text{max}} = 141,42 \text{ V} \checkmark$	OPTION 7 / OPSIE 7 $P = \frac{W}{\Delta t} = \frac{500}{10}$ $= 50 \text{ W}$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark$ $50 = \frac{V_{\text{rms}}^2}{200} \checkmark$ $V_{\text{rms}} = 100 \text{ V}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $100 = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$ $V_{\text{max}} = 141,42 \text{ V} \checkmark$	OPTION 8 / OPSIE 8 $P_{\text{ave}} = I_{\text{rms}}^2 R \checkmark$ $\frac{500}{10} = I_{\text{rms}}^2 (200) \checkmark$ $I_{\text{rms}} = 0,5 \text{ A}$ $I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \checkmark$ $0,5 = \frac{I_{\text{max}}}{\sqrt{2}} \checkmark$ $I_{\text{max}} = 0,71 \text{ A}$ $V_{\text{max}} = I_{\text{max}} R \checkmark$ $= (0,71)(200) \checkmark$ $= 142 \text{ V} \checkmark$

(5)

[12]

QUESTION 10/VRAAG 10

- 10.1 **Note:** -1 mark for each key word/phrase omitted in correct context.
Let Wel: -1 punt vir elke sleutel woord/frase weggelaat in die korrekte konteks.

The process whereby electrons are ejected from a metal / surface when light (of suitable frequency) is incident on that surface. ✓✓
 Die proses waarby elektrone vanaf 'n (metaal)oppervlak vrygestel word wanneer lig (van geskikte frekwensie) daarop skyn/inval. (2)

- 10.2  $7,48 \times 10^{-19} \text{ (J) } \checkmark$
 $E = W_o + E_{k(\text{max})} (= W_o + \frac{1}{2}mv_{\text{max}}^2) \checkmark$
 When/Wanneer $E_{k(\text{max})} = 0 / v = 0 / v^2 = 0 / E = W_o / W_o$ is the y-intercept / is die y-afsnit ✓ (3)

- 10.3 Mass (of photo-electron)/Massa (van foto-elektron)/m ✓

ACCEPT/AANVAAR:

$\frac{1}{2}m$

(1)

- 10.4

OPTION 1/OPSIE 1

Gradient = $\frac{1}{2}m$

$$\frac{11,98 \times 10^{-19} \checkmark - 7,48 \times 10^{-19} \checkmark}{X - 0 \checkmark} = \frac{1}{2}(9,11 \times 10^{-31}) \checkmark$$

$$X = 0,9879 \checkmark \quad (0,99 \text{ or } 0,988)$$

ACCEPT/AANVAAR

$$X = 0,9879 \times 10^{12} \text{ (m}^2 \cdot \text{s}^{-2})$$

POSITIVE MARKING FROM 10.2/POSITIEWE NASIEN VANAF 10.2

OPTION 2/ OPSIE 2

$$E = W_o + E_{k(\text{max})} \quad \left. \begin{array}{l} E = W_o + \frac{1}{2}mv_{(\text{max})}^2 \end{array} \right\} \checkmark \text{ Any one / Enige een}$$

$$11,98 \times 10^{-19} \checkmark = 7,48 \times 10^{-19} \checkmark + \frac{1}{2}(9,11 \times 10^{-31}) v^2 \checkmark \quad [\text{or/of } \frac{1}{2}(9,11 \times 10^{-31})X]$$

$$4,5 \times 10^{-19} = 4,56 \times 10^{-31} v^2$$

$$v^2 = 0,9868 \times 10^{12}$$

$$X/v^2 = 0,9868 \checkmark \quad (0,99)$$

$$\text{Range/gebied } (0,9868 - 0,9879 / 9,87 \times 10^{11} - 9,88 \times 10^{11})$$

ACCEPT/AANVAAR:

$$X = 0,9868 \times 10^{12} \text{ (m}^2 \cdot \text{s}^{-2}) / 9,868 \times 10^{11} \text{ (m}^2 \cdot \text{s}^{-2})$$

(5)

- 10.5.1 Remains the same / Bly dieselfde ✓ (1)

- 10.5.2 Increases / Neem toe ✓ (1)

[13]

TOTAL/TOTAAL: 150



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following combinations consists of only SCALAR quantities?

- A Velocity, speed and time
- B Time, distance and speed
- C Acceleration, speed and distance
- D Displacement, velocity and acceleration

(2)

1.2 The acceleration due to gravity on Earth is g .

Which ONE of the following represents the acceleration due to gravity on a planet that has TWICE the mass and HALF the radius of the Earth?

- A $\frac{1}{2}g$
- B $2g$
- C $4g$
- D $8g$

(2)

1.3 A ball is projected vertically upwards from the ground and reaches its maximum height after a while.

Ignore the effects of air friction.

How will the ACCELERATION and TOTAL MECHANICAL ENERGY of the ball at its maximum height compare to that immediately after it was projected?

	ACCELERATION	TOTAL MECHANICAL ENERGY
A	Equal to	Equal to
B	Greater than	Smaller than
C	Equal to	Greater than
D	Smaller than	Equal to

(2)

- 1.4 A car travels at **CONSTANT VELOCITY** along a horizontal road. A constant frictional force acts on the car during its motion.

Which **ONE** of the following statements about the power dissipated by the engine of the car during the motion is **CORRECT**?

The power ...

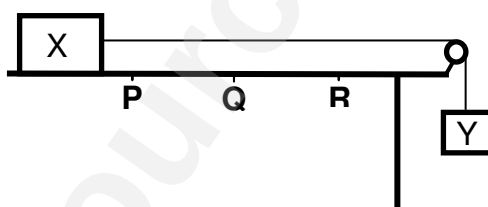
- A is zero.
- B increases.
- C decreases.
- D remains constant.

(2)

- 1.5 Block X is placed on a horizontal table and is connected to block Y by a light inextensible string passing over a frictionless pulley, as shown below.

A constant frictional force acts on block X while it moves to the right.

P, **Q** and **R** are points on the table such that the distance from **P** to **Q** is equal to that from **Q** to **R**.



When block X reaches point **Q**, the string is cut and block X continues to move towards point **R**. Ignore the effect of air friction.

Consider the following statements:

- (i) The work done by the frictional force acting on block X is greater when the block moves from point **P** to point **Q** than when the block moves from point **Q** to point **R**.
- (ii) Both the momentum and kinetic energy of block X decrease when the block moves from point **Q** to point **R**.
- (iii) The total mechanical energy of block X remains constant when the block moves from point **Q** to point **R**.

Which of the statements above is/are **CORRECT** as block X moves from point **Q** to point **R**?

- A (i) only
- B (ii) only
- C (i) and (ii) only
- D (ii) and (iii) only

(2)

- 1.6 Light emitted from a distant star contains a spectral line X of frequency f . The spectral lines of this star when observed on Earth are red shifted.

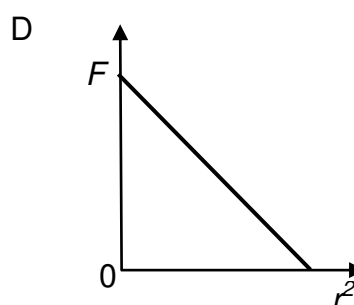
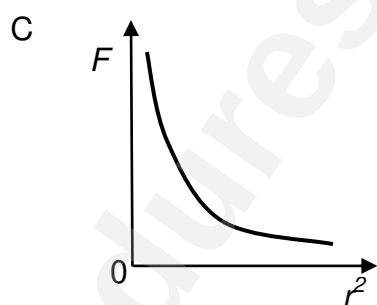
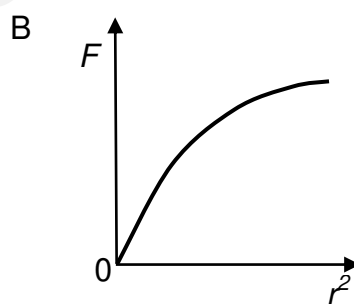
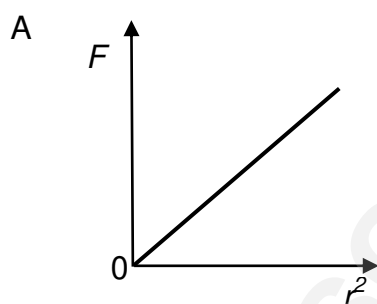
Which ONE of the following combinations of the OBSERVED FREQUENCY of spectral line X and the MOTION OF THE STAR is CORRECT?

	OBSERVED FREQUENCY	MOTION OF THE STAR
A	Greater than f	Away from Earth
B	Greater than f	Towards Earth
C	Smaller than f	Away from Earth
D	Smaller than f	Towards Earth

(2)

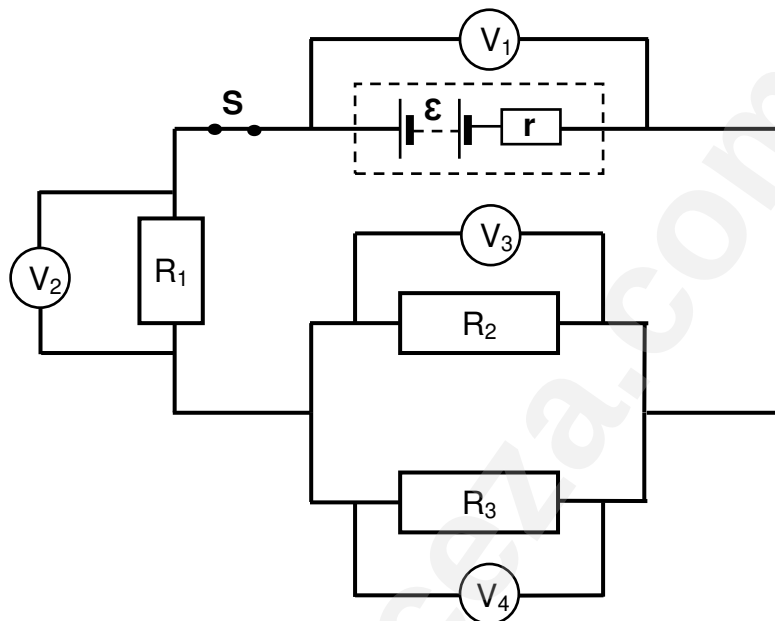
- 1.7 A proton and an electron are a distance r apart. The magnitude of the electrostatic force that they exert on each other is F .

Which ONE of the following graphs shows the relationship between F and r^2 as the proton and the electron approach each other?



(2)

- 1.8 The emf of a battery is $\mathcal{E}$ and its internal resistance is r . The battery is connected to three resistors and four voltmeters, as shown below. The resistance of the conducting wires is negligible, while the voltmeters have very high resistances.

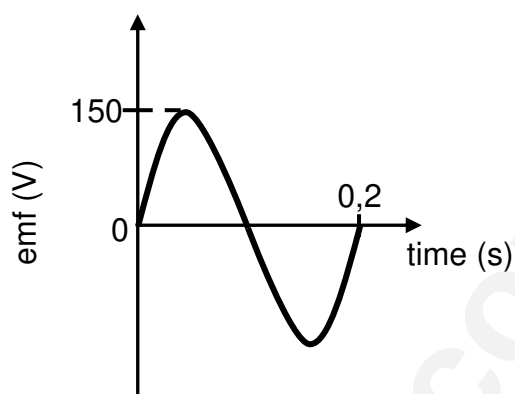


Which ONE of the following equations represents the reading on voltmeter V_1 in terms of the readings on the other voltmeters?

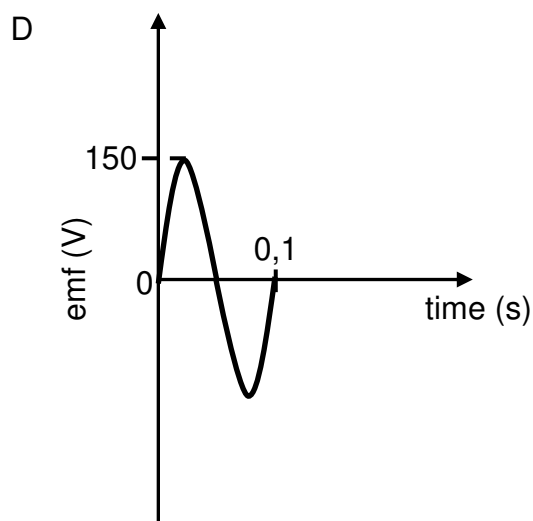
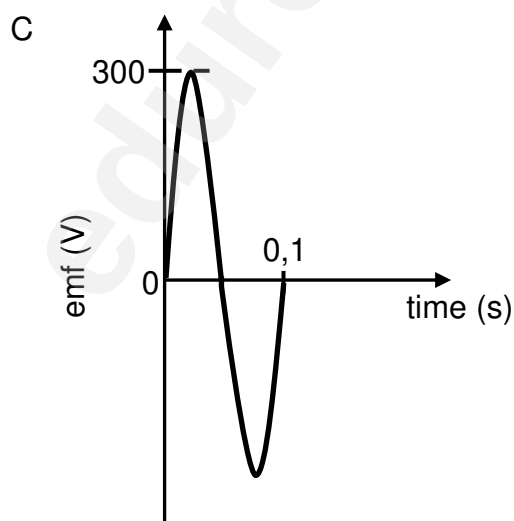
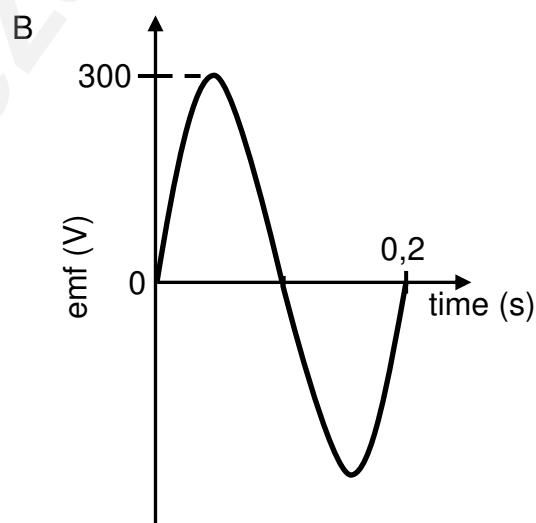
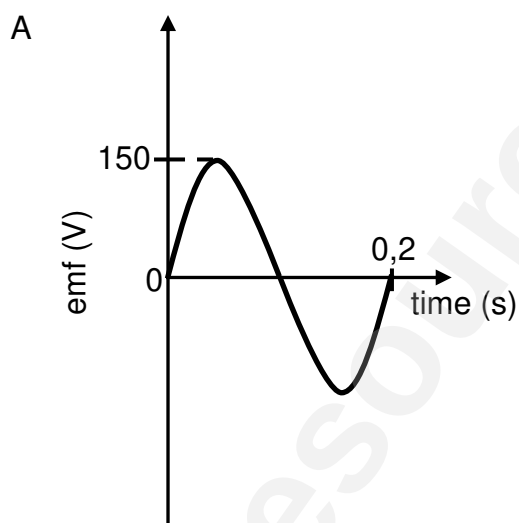
- A $V_1 = V_2 + V_3$
- B $V_1 = V_2 + \frac{1}{2}V_3$
- C $V_1 = V_2 + V_3 + V_4$
- D $V_1 = V_2 + 2V_3$

(2)

- 1.9 An AC generator consists of a coil which is rotated in a magnetic field. The emf time graph for one complete rotation of the coil is shown below.

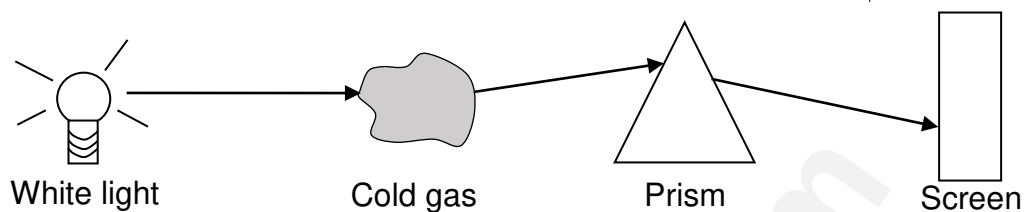


If the speed of rotation of the coil is now DOUBLED, which ONE of the following graphs is CORRECT for one complete rotation of the coil?



(2)

- 1.10 White light is passed through a cold gas and then through a prism, as shown below. A line spectrum is observed on the screen.



Which ONE of the following correctly describes the ENERGY TRANSITION of the atoms of the gas and the TYPE OF LINE SPECTRUM observed on the screen?

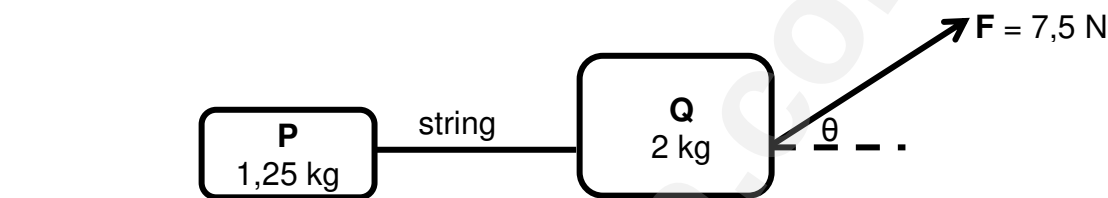
	ENERGY TRANSITION	TYPE OF LINE SPECTRUM
A	Higher to lower energy level	Emission
B	Lower to higher energy level	Emission
C	Higher to lower energy level	Absorption
D	Lower to higher energy level	Absorption

(2)
[20]

QUESTION 2 (Start on a new page.)

Crate **P** of mass 1,25 kg is connected to another crate, **Q**, of mass 2 kg by a light inextensible string. The two crates are placed on a rough horizontal surface. A constant force **F** of magnitude 7,5 N, acting at angle θ to the horizontal, is applied on crate **Q**, as shown in the diagram below.

The crates accelerate at $0,1 \text{ m} \cdot \text{s}^{-2}$ to the right.



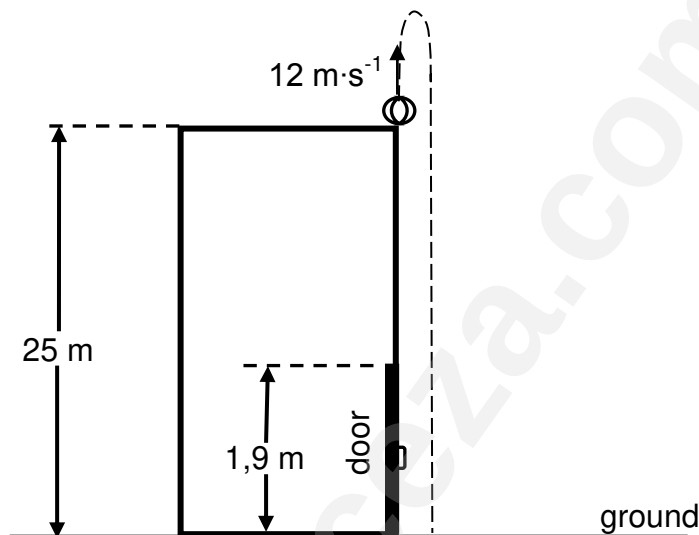
Crate **P** experiences a constant frictional force of 1,8 N and crate **Q** experiences a constant frictional force of 2,2 N.

- 2.1 State Newton's Second Law of Motion in words. (2)
- 2.2 Draw a labelled free-body diagram for crate **P**. (4)
- 2.3 Calculate the magnitude of:
 - 2.3.1 The tension in the string (4)
 - 2.3.2 Angle θ (3)

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards from the top of a building of height 25 m with a velocity of $12 \text{ m}\cdot\text{s}^{-1}$. On its way down, the ball passes a door which has a height of 1,9 m and then strikes the ground, as shown in the diagram below.

Ignore the effects of air friction.



3.1 Define the term *free fall*. (2)

3.2 Calculate the:

3.2.1 Time taken for the ball to reach its maximum height (3)

3.2.2 Velocity with which the ball strikes the ground (4)

3.2.3 Time it took the ball to move from the top of the door to the ground (4)

3.3 Draw a velocity versus time graph for the motion of the ball from the moment that the ball is thrown upwards until it strikes the ground. Use the ground as zero reference.

Clearly indicate the following on your graph:

- The velocity with which the ball was thrown upwards
- Time taken by the ball to reach its maximum height
- The velocity with which the ball strikes the ground

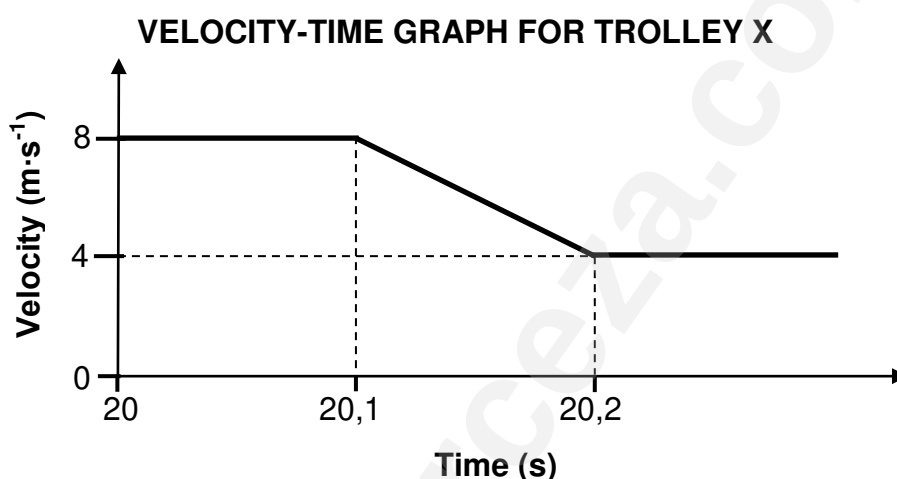
(3)
[16]

QUESTION 4 (Start on a new page.)

Trolley X of mass 1,2 kg travels at $8 \text{ m}\cdot\text{s}^{-1}$ east and collides with trolley Y of mass 0,5 kg which is initially at rest.

Ignore all frictional effects.

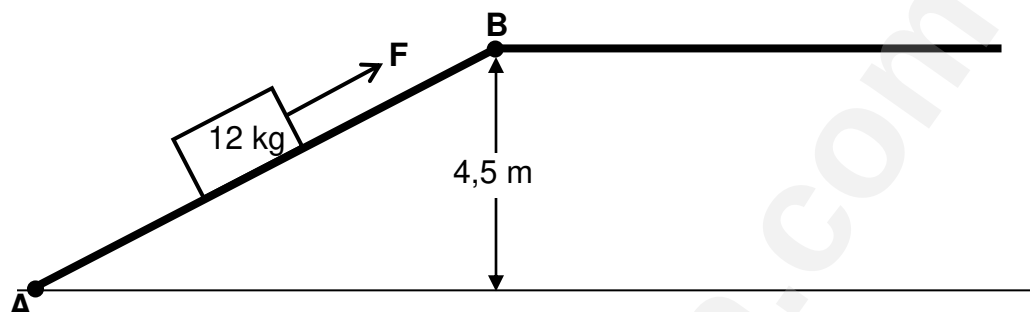
The velocity-time graph below shows the velocity of trolley X before, during and after the collision with trolley Y.



- 4.1 State the *principle of conservation of linear momentum*. (2)
- 4.2 Calculate the magnitude of the:
- 4.2.1 Velocity of trolley Y immediately after the collision (4)
- 4.2.2 Average net force that trolley X exerts on trolley Y during the collision (3)
- 4.3 Is the collision ELASTIC or INELASTIC?
Explain the answer by means of suitable calculations. (5)
- [14]**

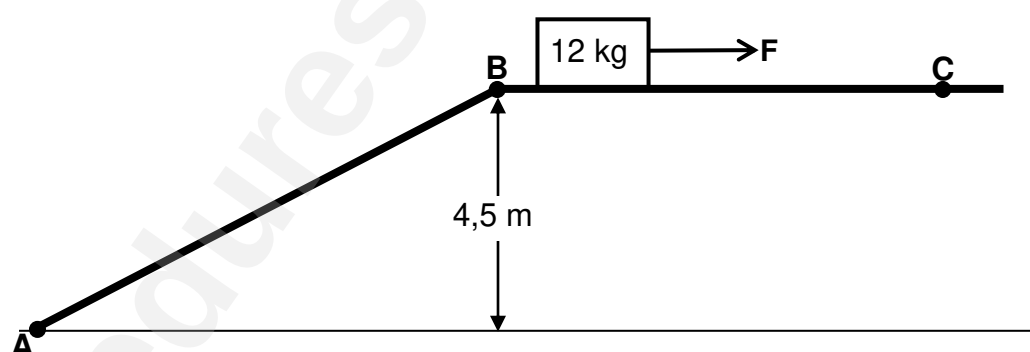
QUESTION 5 (Start on a new page.)

A 12 kg block is initially at rest at point **A** at the bottom of a ROUGH inclined plane. The block is pulled up the incline by a constant force **F** acting parallel to the incline. The block reaches point **B**, which is at a vertical height of 4,5 m above the horizontal, with a speed of $2,25 \text{ m}\cdot\text{s}^{-1}$. See the diagram below.



- 5.1 Define the term *non-conservative force*. (2)
- 5.2 Draw a labelled free-body diagram for the block when it is pulled up the inclined plane. (4)
- 5.3 Calculate the total work done on the block by the NON-CONSERVATIVE forces when the block moved from point **A** to point **B**. (4)

The same constant force **F** now moves the block at a CONSTANT VELOCITY across a rough horizontal surface from point **B** to point **C**, as shown below. Force **F** acts parallel to the horizontal surface.



The magnitude of the constant frictional force acting on the block while moving from point **B** to point **C** is 42 N LARGER than the magnitude of the constant frictional force acting on the block when it moves from point **A** to point **B**.

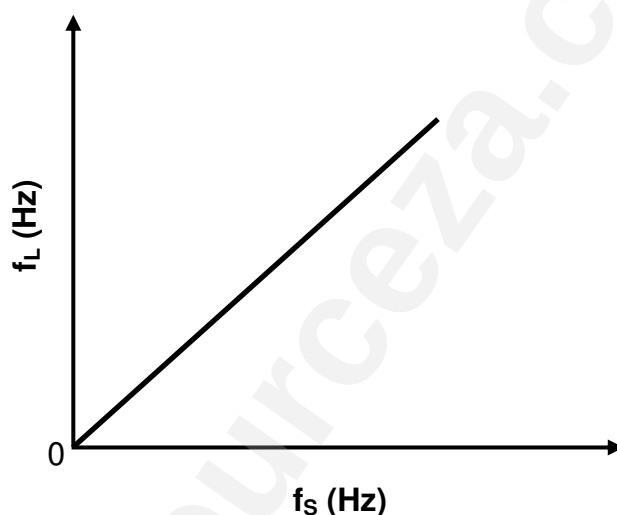
- 5.4 Calculate the distance from point **A** to point **B**. (5)
- [15]

QUESTION 6 (Start on a new page.)

A learner investigates the relationship between the observed frequency and the frequency of sound waves emitted by a stationary source.

The learner moves towards the source at a constant velocity and records the observed frequency (f_L) for a given source frequency (f_s). This process is repeated for different frequencies of the source, with the learner moving at the same constant velocity each time.

The graph below shows how the observed frequency changes as the frequency of sound waves emitted by the source changes.



6.1 Name the phenomenon illustrated by the graph. (1)

6.2 Name ONE application in the medical field of the phenomenon in QUESTION 6.1. (1)

6.3 Write down the type of proportionality that exists between f_L and f_s , as illustrated by the graph. (1)

6.4 The gradient of the graph obtained is found to be 1,06.

If the speed of sound in air is $340 \text{ m} \cdot \text{s}^{-1}$, calculate the magnitude of the velocity at which the learner approaches the source. (5)

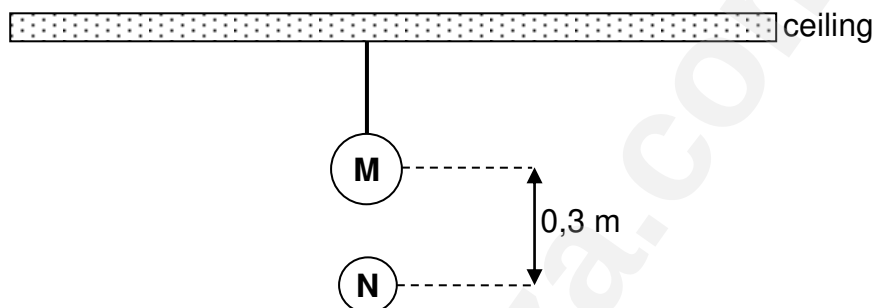
The investigation is now repeated with the learner moving at a HIGHER constant velocity towards the sound source.

6.5 Copy the graph above in your ANSWER BOOK and label it as **A**. On the same set of axes, sketch the graph that will be obtained when the learner is moving at the HIGHER velocity. Label this graph as **B**. (2)
[10]

QUESTION 7 (Start on a new page.)

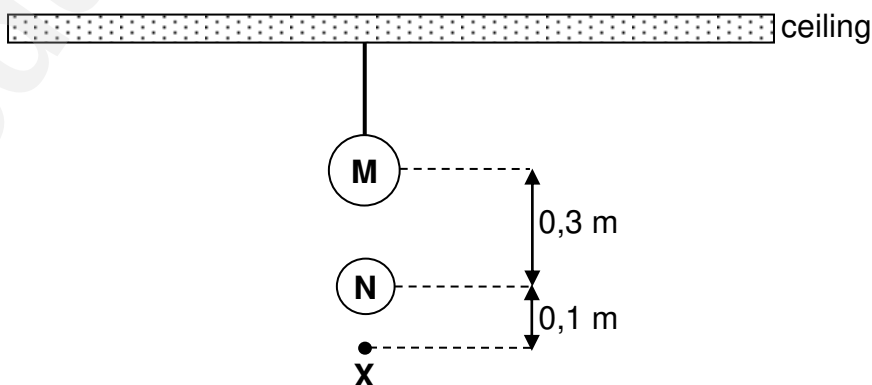
A charged sphere **M** is suspended from a ceiling by a light inextensible, insulated string.

Another charged sphere **N**, of mass $2,04 \times 10^{-3}$ kg and carrying a charge of $+ 8,6 \times 10^{-8}$ C, hangs STATIONARY vertically below sphere **M**. The centres of the spheres are 0,3 m apart, as shown in the diagram below.



- 7.1 State Coulomb's law in words. (2)
- 7.2 State whether the charge on sphere **M** is POSITIVE or NEGATIVE. (1)
- 7.3 Draw a labelled free-body diagram for sphere **N**. (2)
- 7.4 Calculate the magnitude of the charge on sphere **M**. (5)
- 7.5 How does the electrostatic force that sphere **M** exerts on sphere **N** compare to that exerted by sphere **N** on sphere **M** with respect to:
- 7.5.1 Magnitude (1)
- 7.5.2 Direction (1)

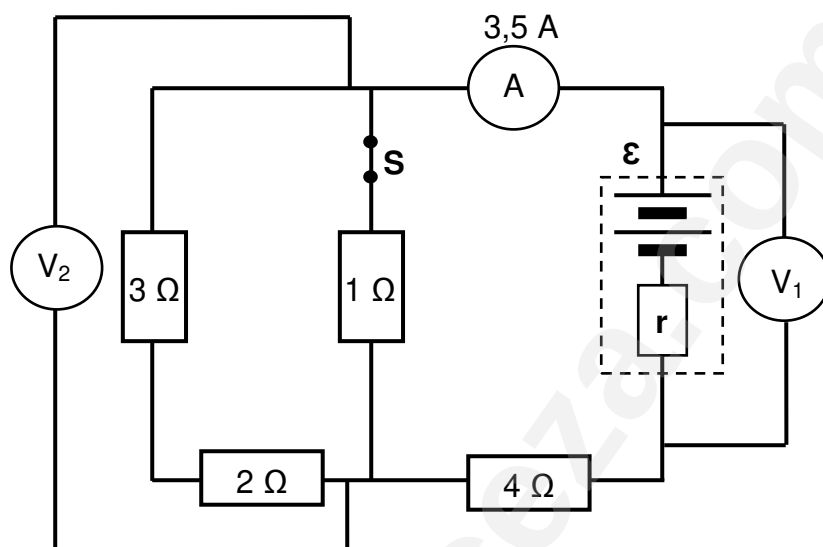
Point **X** is 0,1 m vertically below the centre of sphere **N**, as shown below.



- 7.6 Calculate the net electric field at point **X**. (5)
- [17]**

QUESTION 8 (Start on a new page.)

The circuit diagram below shows four resistors connected to a battery of emf $\mathcal{E}$ and internal resistance r . The resistances of the ammeter and the connecting wires are negligible, while the voltmeters have very high resistances.



8.1 State Ohm's law in words. (2)

Switch **S** is CLOSED.

8.2 The reading on the ammeter is 3,5 A. (4)

8.2.1 Calculate the total external resistance of the circuit. (2)

8.2.2 Calculate the reading on voltmeter V_1 . (3)

8.2.3 How does the reading on voltmeter V_2 compare to the reading on voltmeter V_1 ? Choose from SMALLER THAN, EQUAL TO or GREATER THAN. (1)

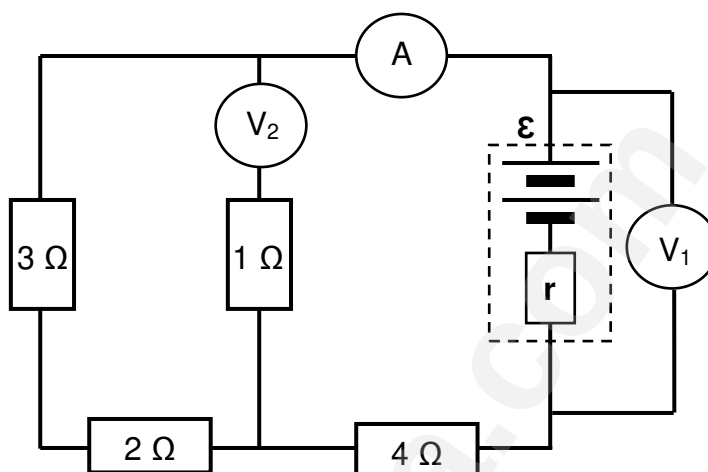
8.3 A learner concludes that the emf of the battery is equal to the reading on voltmeter V_1 . (2)

8.3.1 Define the term *emf*. (2)

8.3.2 Is the learner's conclusion CORRECT? Choose from YES or NO. (1)

8.3.3 Give a reason for the answer to QUESTION 8.3.2. (1)

Switch **S** is now removed and replaced by voltmeter V_2 , as shown in the circuit diagram below.



8.4 How will EACH of the following change?

(Choose from INCREASES, DECREASES or REMAINS THE SAME.)

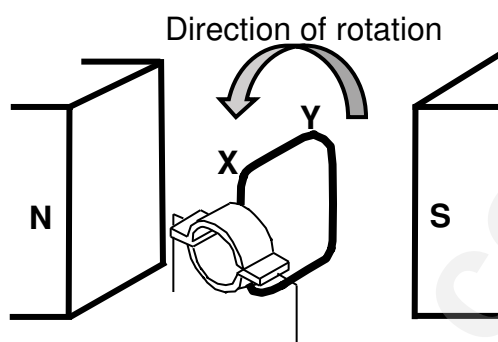
8.4.1 The power dissipated by the $4\ \Omega$ resistor (1)

8.4.2 The reading on voltmeter V_1 (1)

8.5 Explain the answer to QUESTION 8.4.2. (4)
[20]

QUESTION 9 (Start on a new page.)

- 9.1 The diagram below shows the initial position of the coil in a simple DC generator. The coil is rotated in an anticlockwise direction, as shown.



- 9.1.1 Name the component in this generator that ensures that the induced current in the external circuit is in one direction only. (1)

- 9.1.2 Is the direction of the induced current from **X to Y** or from **Y to X**? (1)

A maximum voltage of 90 V is generated when the coil is rotating at a frequency of 20 Hz.

- 9.1.3 Write down the time taken for the coil to complete ONE rotation. (1)

- 9.1.4 The coil starts rotating from the initial position, as shown in the diagram above.

Sketch a graph of output voltage versus time for one complete rotation of the coil. Indicate the maximum voltage and the relevant time values on the graph. (4)

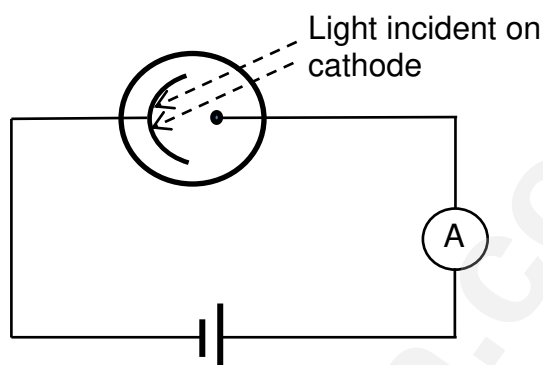
- 9.2 Wall sockets supply rms voltage and current.

A 220 V AC voltage is supplied from a wall socket to an electric kettle having a resistance of 32 Ω .

- Calculate the average energy dissipated by the kettle in TWO minutes. (4)
[11]

QUESTION 10 (Start on a new page.)

Light is incident on the cathode of a photoelectric cell connected to a battery and a sensitive ammeter, as shown below.



- 10.1 What conclusive evidence about the nature of light is provided by the photoelectric effect? (1)

The cathode has a work function of $3,42 \times 10^{-19}$ J.

- 10.2 Define the term *work function*. (2)

Light of frequency $5,96 \times 10^{14}$ Hz is shone onto the cathode.

- 10.3 Calculate the maximum kinetic energy of an electron ejected from the cathode. (4)

- 10.4 The ammeter registers a constant current of 0,012 A.

Calculate the minimum number of photons of light that strike the cathode in a 10 s period. (4)

- 10.5 The intensity of the incident light is now INCREASED. How will this change affect the reading on the ammeter?

Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

[14]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ / $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(\text{max})}$ or/of $E = W_o + K_{\text{max}}$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ or/of $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ϵ) = $I(R + r)$ emk (ϵ) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemid}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemid}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemid}} = \frac{V_{\text{wgk}}^2}{R}$
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

NOVEMBER 2022

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 32 pages.
Hierdie nasienriglyne bestaan uit 32 bladsye.**

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | B ✓✓ | (2) |
| 1.2 | D ✓✓ | (2) |
| 1.3 | A ✓✓ | (2) |
| 1.4 | D ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | C ✓✓ | (2) |
| 1.7 | C ✓✓ | (2) |
| 1.8 | A ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | D ✓✓ | (2) |
| | | [20] |

QUESTION 2/VRAAG 2

2.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant/net force and inversely proportional to the mass of the object. ✓✓
 Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Die versnelling is direk eweredig aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.

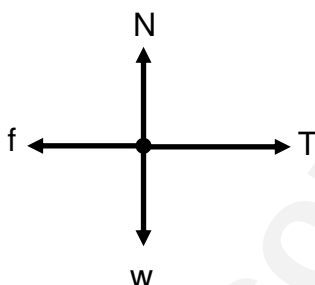
OR/OF

The resultant/net force acting on an object is equal to the rate of change of momentum of the object. **(2 or 0)**

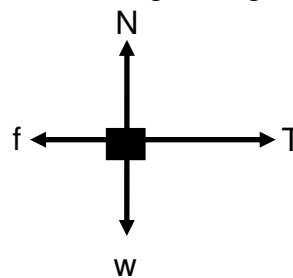
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum. **(2 of 0)**

(2)

2.2



Accept force diagram/
 Aanvaar kragte-diagram:



Accepted labels/Aanvaarde benoemings	
w	F_g / F_w / $F_{\text{earth on P}}$ / weight / mg / 12,25 N / gravitational force F_g / F_w / $F_{\text{aarde op P}}$ / gewig / mg / 12,25 N / gravitasiekrag
T	F_T / F_{string} / F_{tou} / F_t / tension / spanning / F_s
f	F_f / f_k / (kinetic) friction / (kinetiese) wrywing / 1,8 N / F_w
N	F_N / Normal / F_{normal} / F_{normaal} / Normaal
Notes/Aantekeninge	
- Mark awarded for label <u>and</u> arrow./Punt toegeken vir benoeming <u>en</u> pyltjie. - Do not penalise for length of arrows since drawing is not to scale./Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie. - Any other additional force(s)/Enige ander addisionele krag(te): Max/Maks $\frac{3}{4}$ - If everything correct, but no arrows/Indien alles korrek, maar geen pyltjies: Max/Maks $\frac{3}{4}$ - If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{3}{4}$	

(4)

2.3.1

For P/Vir P RIGHT AS POSITIVE/ REGS AS POSITIEF $\left. \begin{array}{l} F_{\text{net}} = ma \\ T + f = ma \\ T - f = ma \end{array} \right\} \begin{array}{l} \text{Any one/} \\ \text{Enige een} \end{array}$ $\frac{T - 1,8}{T} = \frac{(1,25)(0,1)}{1,93 \text{ N}} \checkmark$	For P/Vir P LEFT AS POSITIVE/ LINKS AS POSITIEF $\left. \begin{array}{l} F_{\text{net}} = ma \\ T + f = ma \\ -T + f = ma \end{array} \right\} \begin{array}{l} \text{Any one/} \\ \text{Enige een} \end{array}$ $\frac{-T + 1,8}{T} = \frac{(1,25)(-0,1)}{1,93 \text{ N}} \checkmark$
---	--

(4)

2.3.2

POSITIVE MARKING FROM QUESTION 2.3.1/ POSITIEWE NASIEN VANAF VRAAG 2.3.1. RIGHT AS POSITIVE/REGS AS POSITIEF: For Q/Vir Q $\begin{array}{l} F_{\text{net}} = ma \\ F \cos \theta - T - f = ma \\ F \cos \theta + T + f = ma \\ \frac{7,5 \cos \theta - 1,93 - 2,2}{\theta} = \frac{(2)(0,1)}{54,74^\circ} \checkmark \end{array}$	Accept/Aanvaar $\sin(90^\circ - \theta)$
LEFT AS POSITIVE/LINKS AS POSITIEF: For Q/Vir Q $\begin{array}{l} F_{\text{net}} = ma \\ -F \cos \theta + T + f = ma \\ F \cos \theta + T + f = ma \\ \frac{-7,5 \cos \theta + 1,93 + 2,2}{\theta} = \frac{(2)(-0,1)}{54,74^\circ} \checkmark \end{array}$	Accept/Aanvaar $\sin(90^\circ - \theta)$

(3)
 [13]

QUESTION 3/VRAAG 3

3.1

Motion under the influence of gravity/weight/gravitational force only. $\checkmark \checkmark$
 Beweging slegs onder die invloed van gravitasie/gewig/swaartekrag.
 (2 or/of 0)

OR/OF

Motion in which the only force acting is gravity/weight/gravitational force.
 Beweging waar die enigste krag wat inwerk, gravitasie/gewig/swaartekrag is.
 (2 or/of 0)

(2)

3.2.1

Marking criteria/Nasienkriteria

- Formula with Δt /Formule met Δt ✓
- Correct substitution into formula/Korrekte vervanging in formule ✓
- Final answer/Finale antwoord: 1,22 s ✓ (1,22 s to/tot 1,23 s)

OPTION 1/OPSIE 1

A-B:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$0 = 12 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$0 = -12 + (9,8)\Delta t \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

OPTION 2/OPSIE 2

B-C:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$-12 = 0 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$12 = 0 + (9,8)\Delta t \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

OPTION 3/OPSIE 3

A-C:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$-12 = 12 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$12 = -12 + (9,8)\Delta t \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \checkmark$$

OPTION 4/OPSIE 4

A-C:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$0 = (12)\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \checkmark$$

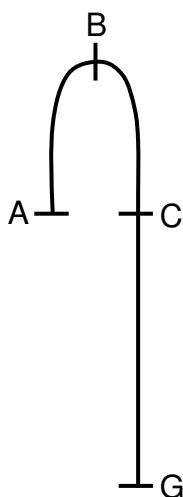
**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

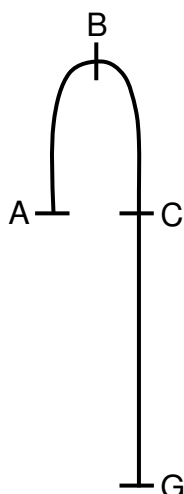
$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$0 = (-12)\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \checkmark$$





OPTION 5/OPSIE 5

A-B OR/OF B-C:

$$\begin{aligned}(E_{\text{mech}})_{\text{Top/Bo}} &= (E_{\text{mech}})_{25\text{ m}} \\(E_P + E_K)_{\text{Top/Bo}} &= (E_P + E_K)_{25\text{ m}} \\(mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} &= (mgh + \frac{1}{2}mv^2)_{25\text{ m}} \\(9,8)h + 0 &= 0 + (\frac{1}{2})(12)^2 \\ \Delta h &= 7,35\text{ m}\end{aligned}$$

OPTION 6/OPSIE 6

A-B OR/OF B-C

$$\begin{aligned}W_{\text{nc}} &= \Delta K + \Delta U \\W_{\text{nc}} &= \Delta K + mg(h_f - h_i) \\0 &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \\0 &= \frac{1}{2}(0^2 - 12^2) + (9,8)\Delta h \\ \Delta h &= 7,35\text{ m}\end{aligned}$$

OPTION 7/OPSIE 7

A-B OR/OF B-C

$$\begin{aligned}W_{\text{net}} &= \Delta E_K \\w\Delta y \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\(9,8)\Delta y \cos 180^\circ &= 0 - \frac{1}{2}(12)^2 \\ \Delta y &= 7,35\text{ m}\end{aligned}$$

OPTION 8/OPSIE 8

A-B:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \\0^2 &= 12^2 + 2(-9,8)\Delta y \\ \Delta y &= 7,35\text{ m}\end{aligned}$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \\0^2 &= (-12)^2 + 2(9,8)\Delta y \\ \Delta y &= -7,35\text{ m}\end{aligned}$$

OPTION 9/OPSIE 9

B-C:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \\(-12)^2 &= 0^2 + 2(-9,8)\Delta y \\ \Delta y &= -7,35\text{ m}\end{aligned}$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

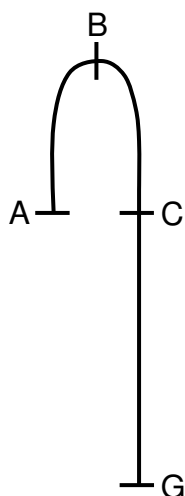
$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \\(12)^2 &= 0^2 + 2(9,8)\Delta y \\ \Delta y &= 7,35\text{ m}\end{aligned}$$

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$\begin{aligned}\Delta y &= \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark \\7,35 &= \left(\frac{12 + 0}{2}\right)\Delta t \checkmark \\ \Delta t &= 1,23\text{ s} \checkmark\end{aligned}$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$\begin{aligned}\Delta y &= \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark \\-7,35 &= \left(\frac{-12 + 0}{2}\right)\Delta t \checkmark \\ \Delta t &= 1,23\text{ s} \checkmark\end{aligned}$$



OPTION 10/OPSIE 10

A-B:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$\Delta y = \left(\frac{12 + 0}{2} \right) \Delta t$$

$$\Delta y = 6\Delta t$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = (12)^2 + 2(-9,8)(6\Delta t) \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$\Delta y = \left(\frac{-12 + 0}{2} \right) \Delta t$$

$$\Delta y = -6\Delta t$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = (-12)^2 + 2(9,8)(-6\Delta t) \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

OPTION 12/OPSIE 12

A-B:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

$$F_{\text{net}}\Delta t = m\Delta v$$

$$F_{\text{net}}\Delta t = m(v_f - v_i)$$

$$-(9,8)\Delta t = 0 - 12 \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

$$F_{\text{net}}\Delta t = m\Delta v$$

$$F_{\text{net}}\Delta t = m(v_f - v_i)$$

$$(9,8)\Delta t = 12 - 0 \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

OPTION 11/OPSIE 11

B-C:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$\Delta y = \left(\frac{0 - 12}{2} \right) \Delta t$$

$$\Delta y = -6\Delta t$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$-12 = (0)^2 + 2(-9,8)(-6\Delta t) \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$\Delta y = \left(\frac{12 + 0}{2} \right) \Delta t$$

$$\Delta y = 6\Delta t$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$12^2 = 0^2 + 2(9,8)(6\Delta t) \checkmark$$

$$\Delta t = 1,22 \text{ s} \checkmark$$

3.2.2

Marking criteria/Nasienkriteria

- Formula with v_f . / *Formule met v_f .* ✓
- Correct substitution into formula. / *Korrekte vervanging in formule.* ✓
- Correct final answer / *Korrekte finale antwoord:*
 $25,18 \text{ m} \cdot \text{s}^{-1}$ ✓ ($25,03 \text{ m} \cdot \text{s}^{-1}$ to/tot $25,59 \text{ m} \cdot \text{s}^{-1}$)
- Correct direction (only if numerical value is given). / *Korrekte rigting (slegs indien numeriese waarde gegee is).* ✓

OPTION 1/OPSIE 1

A-G:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (12)^2 + 2(-9,8)(-25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

A-G:

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (-12)^2 + 2(9,8)(25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

OPTION 2/OPSIE 2

C-G:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (-12)^2 + 2(-9,8)(-25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G:

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (12)^2 + 2(9,8)(25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

OPTION 3/OPSIE 3

B-G

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (0)^2 + 2(-9,8)(-32,35) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

B-G

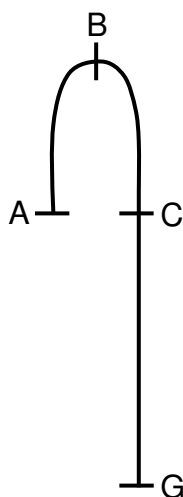
**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

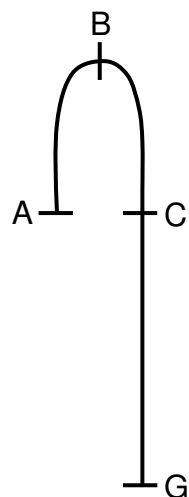
$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (0)^2 + 2(9,8)(32,35) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts





OPTION 4/OPSIE 4

A-G:

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$-25 = 12 \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$\Delta t = 3,79 \text{ s}$$

A-G

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$-25 = \left(\frac{12 + v_f}{2} \right) 3,79$$

$$v_f = -25,18 \text{ m} \cdot \text{s}^{-1}$$

$$\therefore v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

B-G

$$v_f = v_i + a \Delta t \checkmark$$

$$v_f = 0 + (-9,8)(3,79 - 1,22) \checkmark$$

$$v_f = -25,19 \text{ m} \cdot \text{s}^{-1}$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G

$$v_f = v_i + a \Delta t \checkmark$$

$$v_f = -12 + (-9,8)(1,35) \checkmark$$

$$v_f = -25,19 \text{ m} \cdot \text{s}^{-1}$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

A-G:

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$25 = -12 \Delta t + \frac{1}{2} (9,8) \Delta t^2$$

$$\Delta t = 3,79 \text{ s}$$

A-G

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$25 = \left(\frac{-12 + v_f}{2} \right) 3,79 \checkmark$$

$$\therefore v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

B-G

$$v_f = v_i + a \Delta t \checkmark$$

$$= 0 + (9,8)(3,79 - 1,22) \checkmark$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G

$$v_f = v_i + a \Delta t \checkmark$$

$$v_f = 12 + (9,8)(3,79 - 2(1,22)) \checkmark$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

OPTION 5/OPSIE 5

C-G:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$-25 = -12 \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$\Delta t = 1,34 \text{ s}$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$-25 = \left(\frac{-12 + v_f}{2} \right) 1,34 \checkmark$$

$$v_f = -25,18 \text{ m} \cdot \text{s}^{-1}$$

$$\therefore v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G:

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$25 = 12 \Delta t + \frac{1}{2} (9,8) \Delta t^2$$

$$\Delta t = 1,34 \text{ s}$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$25 = \left(\frac{12 + v_f}{2} \right) 1,34 \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

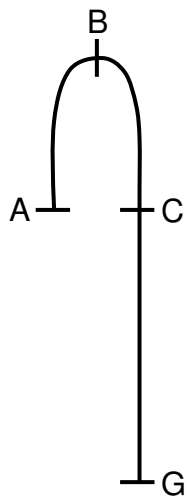
afwaarts

OPTION 6/OPSIE 6

$$\left. \begin{aligned} (E_{\text{mech/meg}})_i &= (E_{\text{mech/meg}})_f \\ (E_P + E_K)_i &= (E_P + E_K)_f \\ (mgh + \frac{1}{2}mv^2)_i &= (mgh + \frac{1}{2}mv^2)_f \end{aligned} \right\} \begin{aligned} &\checkmark \text{ Any one/} \\ &\text{Enige een} \end{aligned}$$

$$\underline{m(9,8)(25) + \frac{1}{2}m(12^2) = 0 + \frac{1}{2}mv_f^2} \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards/afwaarts } \checkmark$$



OPTION 7/OPSIE 7

$$W_{nc} = \Delta E_k + \Delta E_p$$

$$= (E_{kf} - E_{ki}) + (E_{pf} - E_{pi})$$

$$= (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) + (mgh_f - mgh_i)$$

$$0 = [\frac{1}{2}mv_f^2 - \frac{1}{2}m(12)^2] + [0 - m(9,8)(25)] \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards/afwaarts} \checkmark$$

✓ Any one/
Enige een

OPTION 8/OPSIE 8

$$W_{net} = \Delta E_k$$

$$= (E_{kf} - E_{ki})$$

$$= (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$$

$$m(9,8)(25) = \frac{1}{2}mv_f^2 - \frac{1}{2}m(12)^2 \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards/afwaarts} \checkmark$$

✓ Any one/
Enige een

3.2.3

POSITIVE MARKING FROM QUESTION 3.2.2.

POSITIEWE NASIEN VANAF VRAAG 3.2.2.

Marking criteria/Nasienkriteria

- Substitution into formula to calculate v at the top of the door ✓
Vervanging in formule om v bokant die deur te bereken.
- Formula to calculate Δt from top to bottom of door. ✓
Formule om Δt te bereken van bokant tot onderkant van deur.
- Substitution to calculate Δt . ✓
Vervanging om Δt te bereken.
- Final answer/Finale antwoord: 0,07 to/tot 0,08 s ✓

OPTION 1/OPSIE 1

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

A-D:

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$\frac{v_f^2}{v_f} = \frac{(12)^2 + 2(-9,8)(-23,1)}{v_f} \checkmark$$

$$v_f = 24,43 \text{ m} \cdot \text{s}^{-1}$$

C-D:

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$\frac{v_f^2}{v_f} = \frac{(-12)^2 + 2(-9,8)(-23,1)}{v_f} \checkmark$$

$$v_f = 24,43 \text{ m} \cdot \text{s}^{-1}$$

D-G:

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$\frac{(-25,18)^2}{v_i} = \frac{(v_i)^2 + 2(-9,8)(-1,9)}{v_i} \checkmark$$

$$v_i = 24,43 \text{ m} \cdot \text{s}^{-1}$$

B-D

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$\frac{v_f^2}{v_f} = \frac{0 + 2(-9,8)(-30,447)}{v_f} \checkmark$$

$$= 24,43 \text{ m} \cdot \text{s}^{-1}$$

D-G:

$$E_{(\text{mech top/meg bo})} = E_{(\text{mech bot/meg ond})}$$

$$(E_p + E_k)_{\text{top/bo}} = (E_p + E_k)_{\text{bot/ond}}$$

$$(mgh + \frac{1}{2}mv^2)_{\text{top/bo}} = (mgh + \frac{1}{2}mv^2)_{\text{bot/ond}}$$

$$m(9,8)(1,9) + \frac{1}{2}m(v_i)^2 = 0 + \frac{1}{2}m(25,18)^2 \checkmark$$

$$v_i = 24,43 \text{ m} \cdot \text{s}^{-1}$$

D-G:

$$v_f = v_i + a\Delta t \checkmark$$

$$\frac{-25,18}{\Delta t} = \frac{-24,43 + (-9,8)\Delta t}{\Delta t} \checkmark$$

$$\Delta t = 0,08 \text{ s} \checkmark$$

D-G:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$\frac{-1,9}{\Delta t} = \frac{-24,43\Delta t + \frac{1}{2}(-9,8)\Delta t^2}{\Delta t} \checkmark$$

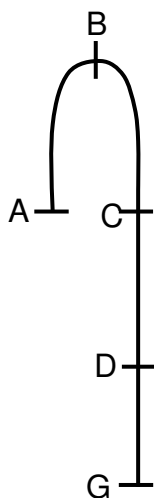
$$\Delta t = 0,08 \text{ s} \checkmark$$

D-G:

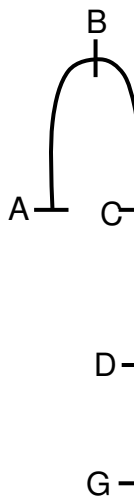
$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$-1,9 = \left(\frac{-24,43 - 25,18}{2} \right) \Delta t \checkmark$$

$$\Delta t = 0,08 \text{ s} \checkmark$$



DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:



A-D:
 $v_f^2 = v_i^2 + 2a\Delta y$
 $v_f^2 = (-12)^2 + 2(9,8)(23,1) \checkmark$
 $v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$

C-D:
 $v_f^2 = v_i^2 + 2a\Delta y$
 $v_f^2 = (12)^2 + 2(9,8)(23,1) \checkmark$
 $v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$

D-G:
 $v_f^2 = v_i^2 + 2a\Delta y$
 $(25,18)^2 = (v_i)^2 + 2(9,8)(1,9) \checkmark$
 $v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$

B-D
 $v_f^2 = v_i^2 + 2a\Delta y$
 $v_f^2 = 0 + 2(9,8)(30,447) \checkmark$
 $= 24,43 \text{ m}\cdot\text{s}^{-1}$

D-G:
 $E_{(\text{mech top/meg bo})} = E_{(\text{mech bot/meg ond})}$
 $(E_p + E_k)_{\text{top/bo}} = (E_p + E_k)_{\text{bot/ond}}$
 $(mgh + \frac{1}{2}mv^2)_{\text{top/bo}} = (mgh + \frac{1}{2}mv^2)_{\text{bot/ond}}$
 $m(9,8)(1,9) + \frac{1}{2}m(v_i)^2 = 0 + \frac{1}{2}m(25,18)^2 \checkmark$
 $v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$

D-G:
 $v_f = v_i + a\Delta t \checkmark$
 $25,18 = 24,43 + (9,8)\Delta t \checkmark$
 $\Delta t = 0,08 \text{ s} \checkmark$

D-G:
 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$
 $1,9 = 24,43\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$
 $\Delta t = 0,08 \text{ s} \checkmark$

D-G:
 $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$
 $1,9 = \left(\frac{24,43 + 25,18}{2} \right) \Delta t \checkmark$
 $\Delta t = 0,08 \text{ s} \checkmark$

Marking criteria OPTION 2 and 3/Nasienkriteria OPSIE 2 en 3

- Either one of the formula to calculate Δt . / Enige een van die formules om Δt te bereken. ✓
- Substitute into formula to calculate time from A to G or C to G / Vervanging in formule om tyd te bereken tussen A tot G of C tot G ✓
- Substitute into formula to calculate time from A to D or C to D / Vervanging in formule om tyd te bereken tussen A tot D of C tot D ✓
- Final answer / Finale antwoord: 0,07 s ✓ (0,07s to/tot 0,08s)

OPTION 2/OPSIE 2

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

A-G:

$$v_f = v_i + a\Delta t$$

$$\underline{-25,18 = 12 + (-9,8) \Delta t \checkmark}$$

$$\Delta t = 3,79 \text{ s}$$

✓ Any one/
Enige een

A-D:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$\underline{-23,1 = (12) \Delta t + \frac{1}{2} (-9,8) \Delta t^2 \checkmark}$$

$$\Delta t = 3,72 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

D-G:

$$3,79 - 3,72 = 0,07 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

A-G:

$$v_f = v_i + a\Delta t$$

$$\underline{25,18 = -12 + (9,8) \Delta t \checkmark}$$

$$\Delta t = 3,79 \text{ s}$$

✓ Any one/
Enige een

A-D:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$\underline{23,1 = (-12) \Delta t + \frac{1}{2} (9,8) \Delta t^2 \checkmark}$$

$$\Delta t = 3,72 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

D-G:

$$3,79 - 3,72 = 0,07 \text{ s} \checkmark$$

OPTION 3/OPSIE 3

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

C-G:

$$v_f = v_i + a\Delta t$$

$$\underline{-25,18 = -12 + (-9,8) \Delta t \checkmark}$$

$$\Delta t = 1,34 \text{ s}$$

✓ Any one/
Enige een

C-D:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$\underline{-23,1 = (-12) \Delta t + \frac{1}{2} (-9,8) \Delta t^2 \checkmark}$$

$$\Delta t = 1,27 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

D-G:

$$1,34 - 1,27 = 0,07 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

C-G:

$$v_f = v_i + a\Delta t$$

$$\underline{25,18 = 12 + (9,8) \Delta t \checkmark}$$

$$\Delta t = 1,34 \text{ s}$$

✓ Any one/
Enige een

C-D:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$\underline{23,1 = (12) \Delta t + \frac{1}{2} (9,8) \Delta t^2 \checkmark}$$

$$\Delta t = 1,27 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

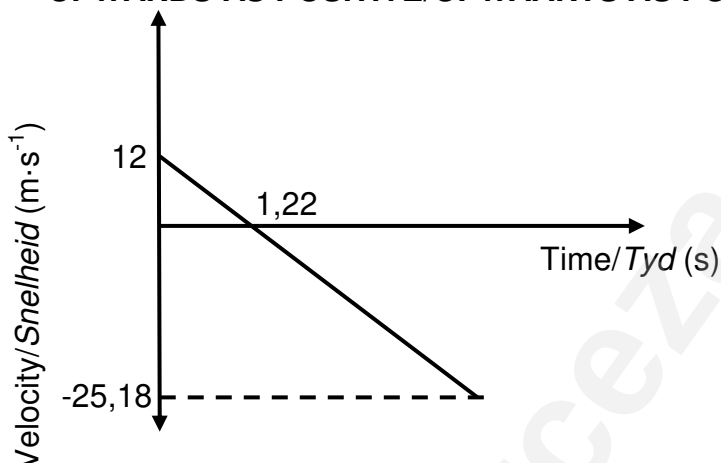
D-G:

$$1,34 - 1,27 = 0,07 \text{ s} \checkmark$$

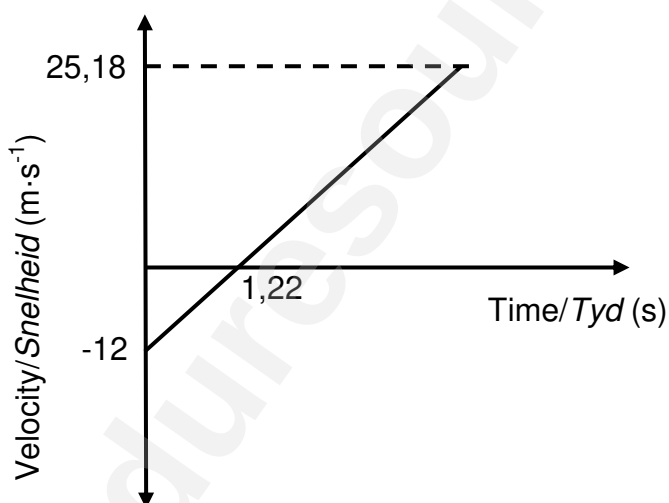
OPTION 4/OPSIE 4 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF: G-D: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $1,9 \checkmark = \frac{25,18 \Delta t}{1} + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$ $\Delta t = 0,08 \text{ s} \checkmark \quad (0,077 \text{ s})$	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF: G-D: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $-1,9 \checkmark = \frac{-25,18 \Delta t}{1} + \frac{1}{2} (9,8) \Delta t^2 \checkmark$ $\Delta t = 0,08 \text{ s} \checkmark \quad (0,077 \text{ s})$
--	--

(4)

3.3 **POSITIVE MARKING FROM QUESTION 3.2.1 AND QUESTION 3.2.2.**
POSITIEWE NASIEN VANAF VRAAG 3.2.1 EN VRAAG 3.2.2.
UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:



DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:



Criteria for graph/Kriteria vir grafiek	
Straight line starting at $v = 12 \text{ m} \cdot \text{s}^{-1}$ with negative final velocity or straight line starting at $v = -12 \text{ m} \cdot \text{s}^{-1}$ with positive final velocity. /Reguitlyn wat begin by $v = 12 \text{ m} \cdot \text{s}^{-1}$ met negatiewe finale snelheid of reguitlyn wat begin by $v = -12 \text{ m} \cdot \text{s}^{-1}$ met positiewe finale snelheid.	✓
Straight line cuts time axis at time calculated in Question 3.2.1/ Reguitlyn sny tydas by die tyd bereken in Vraag 3.2.1.	✓
Correct final velocity as calculated in Question 3.2.2 is indicated./Korrekte finale snelheid soos uitgewerk in Vraag 3.2.2 is aangedui.	✓

(3)

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QUESTION 4/VRAAG 4

4.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

In an isolated/closed system the total (linear) momentum is conserved/remains constant. ✓✓

In 'n geïsoleerde/geslote sisteem bly die totale (lineêre) momentum behoue/konstant. (2)

4.2.1

OPTION 1/OPSIE 1

EAST AS POSITIVE/OOS AS POSITIEF

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ m_x v_{ix} + m_y v_{iy} &= m_x v_{fx} + m_y v_{fy} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(1,2)(8) \checkmark + (0,5)(0) = (1,2)(4) + (0,5)(v_{fy}) \checkmark$$

$$\therefore v_{fy} = 9,6 \text{ m} \cdot \text{s}^{-1} \checkmark$$

WEST AS POSITIVE/WES AS POSITIEF

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ m_x v_{ix} + m_y v_{iy} &= m_x v_{fx} + m_y v_{fy} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(1,2)(-8) \checkmark + (0,5)(0) = (1,2)(-4) + (0,5)(v_{fy}) \checkmark$$

$$v_{fy} = -9,6 \text{ m} \cdot \text{s}^{-1}$$

$$\therefore v_{fy} = 9,6 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 2 / OPSIE 2

EAST AS POSITIVE/OOS AS POSITIEF

$$\left. \begin{aligned} \Delta p_x &= -\Delta p_y \\ m(v_{xf} - v_{xi}) &= -m(v_{yf} - v_{yi}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$1,2(4 - 8) \checkmark = -0,5(v_f - 0) \checkmark$$

$$\therefore v_{fy} = 9,6 \text{ m} \cdot \text{s}^{-1} \checkmark$$

WEST AS POSITIVE/WES AS POSITIEF

$$\left. \begin{aligned} \Delta p_x &= -\Delta p_y \\ m(v_{xf} - v_{xi}) &= -m(v_{yf} - v_{yi}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$1,2(-4 + 8) \checkmark = -0,5(v_f - 0) \checkmark$$

$$v_{fy} = -9,6 \text{ m} \cdot \text{s}^{-1}$$

$$\therefore v_{fy} = 9,6 \text{ m} \cdot \text{s}^{-1} \checkmark$$

4.2.2

OPTION 1/OPSIE 1

EAST POSITIVE/OOS POSITIEF:

For X/Vir X:

$$\left. \begin{aligned} F_{\text{net}} \Delta t &= \Delta p \\ F_{\text{net}} \Delta t &= m(v_f - v_i) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$F_{\text{net}}(0,1) = 1,2(4 - 8) \checkmark$$

$$F_{\text{net}} = -48 \text{ N} \checkmark$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST POSITIVE/WES POSITIEF:

For X /Vir X:

$$\left. \begin{aligned} F_{\text{net}} \Delta t &= \Delta p \\ F_{\text{net}} \Delta t &= m(v_f - v_i) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$F_{\text{net}}(0,1) = 1,2(-4 + 8) \checkmark$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 2/OPSIE 2

POSITIVE MARKING FROM QUESTION 4.2.1.

POSITIEWE NASIEN VANAF VRAAG 4.2.1.

EAST AS POSITIVE

OOS AS POSITIEF

For Y/Vir Y:

$$\left. \begin{aligned} F_{\text{net}}\Delta t &= \Delta p \\ F_{\text{net}}\Delta t &= m(v_f - v_i) \end{aligned} \right\} \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array}$$

$$F_{\text{net}}(0,1) = 0,5(-9,6 - 0) \checkmark$$

$$F_{\text{net}} = -48 \text{ N}$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST AS POSITIVE

WES AS POSITIEF

For Y/Vir Y:

$$\left. \begin{aligned} F_{\text{net}}\Delta t &= \Delta p \\ F_{\text{net}}\Delta t &= m(v_f - v_i) \end{aligned} \right\} \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array}$$

$$F_{\text{net}}(0,1) = 0,5(9,6 - 0) \checkmark$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 3/OPSIE 3

EAST AS POSITIVE for X

OOS AS POSITIEF vir X

$$v_f = v_i + a\Delta t$$

$$-4 = -8 + a(0,1)$$

$$a = -40 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark$$

$$F_{\text{net}} = (1,2)(-40) \checkmark$$

$$F_{\text{net}} = -48 \text{ N}$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST AS POSITIVE for X

WES AS POSITIEF vir X

$$v_f = v_i + a\Delta t$$

$$4 = 8 + a(0,1)$$

$$a = 40 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark$$

$$F_{\text{net}} = (1,2)(40) \checkmark$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 4/OPSIE 4

EAST AS POSITIVE for X

OOS AS POSITIEF vir X

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$\Delta x = \left(\frac{8 + 4}{2} \right) (0,1)$$

$$\Delta x = 0,6 \text{ m}$$

$$F_{\text{net}}\Delta x \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark$$

$$F_{\text{net}}(0,6)\cos 180^\circ = \frac{1}{2}(1,2)(4)^2 - \frac{1}{2}(1,2)(8)^2 \checkmark$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST AS POSITIVE for X

WES AS POSITIEF vir X

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$\Delta x = \left(\frac{-8 - 4}{2} \right) (0,1)$$

$$\Delta x = -0,6 \text{ m}$$

$$F_{\text{net}}\Delta x \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark$$

$$F_{\text{net}}(0,6)\cos 0^\circ = \frac{1}{2}(1,2)(-4)^2 - \frac{1}{2}(1,2)(-8)^2 \checkmark$$

$$F_{\text{net}} = -48 \text{ N} \checkmark$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 5/OPSIE 5

$$\begin{aligned} \text{Gradient} &= \frac{\Delta y}{\Delta x} \\ &= \frac{\Delta v}{\Delta t} \\ &= \frac{4 - 8}{0,1} \\ &= -40 \text{ m}\cdot\text{s}^{-2} \end{aligned}$$

$$F_{\text{net}} = ma \checkmark$$

$$F_{\text{net}} = (1,2)(-40) \checkmark$$

$$F_{\text{net}} = -48 \text{ N}$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

(3)

4.3 **POSITIVE MARKING FROM QUESTION 4.2.1/
 POSITIEWE NASIEN VANAF VRAAG 4.2.1.**

OPTION 1/OPSIE 1

Inelastic/oneelasties ✓

$$E_k = \frac{1}{2}mv^2 \quad \checkmark$$

$$\begin{aligned} \sum E_{ki} &= \frac{1}{2}m_X v_{Xi}^2 + \frac{1}{2}m_Y v_{Yi}^2 \\ &= \frac{1}{2}(1,2)(8)^2 + 0 \quad \checkmark \\ &= 38,4 \text{ J} \end{aligned}$$

$$\begin{aligned} \sum E_{kf} &= \frac{1}{2}m_X v_{Xf}^2 + \frac{1}{2}m_Y v_{Yf}^2 \\ &= \frac{1}{2}(1,2)(4)^2 + \frac{1}{2}(0,5)(9,6)^2 \quad \checkmark \\ &= 32,64 \text{ J} \end{aligned}$$

$$\sum E_{ki} \neq \sum E_{kf} \quad \checkmark$$

OPTION 2/OPSIE 2 (Change in $E_{k\text{total}}$ total /verandering in $E_{k\text{totaal}}$)

Inelastic/oneelasties ✓

$$E_k = \frac{1}{2}mv^2 \quad \checkmark$$

$$\begin{aligned} \Delta E_k(X) &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ &= \frac{1}{2}(1,2)(4)^2 - \frac{1}{2}(1,2)(8)^2 \quad \checkmark \\ &= -28,8 \text{ J} \end{aligned}$$

$$\begin{aligned} \Delta E_k(Y) &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ &= \frac{1}{2}(0,5)(9,6)^2 - \frac{1}{2}(0,5)(0)^2 \quad \checkmark \\ &= 23,04 \text{ J} \end{aligned}$$

$$\Delta E_k(X) \neq \Delta E_k(Y) \quad \checkmark$$

Note/Aantekening:

If candidate starts with conservation of kinetic energy//Indien kandidaat begin met behoud van kinetiese energie: max/maks $\frac{4}{5}$

(5)
 [14]

QUESTION 5/VRAAG 5

5.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

A force is non-conservative if the work done by the force on an object (which is moving between two points) depends on the path taken. ✓✓

'n Krag waarvoor die arbeid wat verrig word deur die krag op 'n voorwerp (wat tussen twee punte beweeg,) afhanklik is van die pad wat gevolg word.

OR/OF

A force is non-conservative if the work it does in moving an object around a closed path is non-zero.

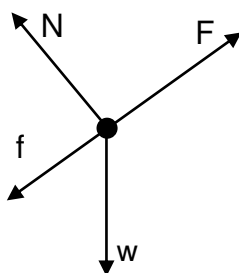
'n Krag is nie-konserwatief wanneer die arbeid wat dit verrig om 'n voorwerp in 'n geslote pad te beweeg, nie nul is nie.

Note/Aantekening:

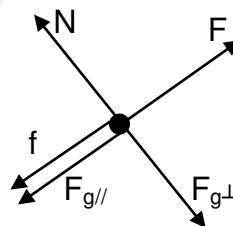
-If work done is omitted/ Indien arbeid verrig uitgelaat word: $\frac{0}{2}$

(2)

5.2



OR/OF



Accepted labels/Aanvaarde benoemings

w	F_w / F_g / mg / 117,6 N / gravitational force / <i>gravitasiekrag</i> / weight / <i>gewig</i>
F	F_A / Applied force / T / <i>Toegepaste krag</i> / F_T
f	F_f / f_k / (kinetic) Friction / (<i>kinetiese</i>) <i>wrywing</i> / F_w
N	F_N / Normal / <i>Normaal</i>

Notes/Aantekeninge:

- Mark awarded for label and arrow./Punt toegeken vir benoeming en pyltjie.
- Do not penalise for length of arrows since drawing is not to scale./Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.
- If w is not shown but $F_{//}$ and $F_{g\perp}$ are shown, give 1 mark for both./Indien w nie aangetoon is nie maar $F_{//}$ en $F_{g\perp}$ is getoon, ken 1 punt toe vir beide.
- Any other additional force(s)/Enige ander addisionele krag(te):
Max/Maks $\frac{3}{4}$
- If everything is correct, but no arrows/Indien alles korrek is, maar geen pyltjies: Max/Maks $\frac{3}{4}$ •
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{3}{4}$

(4)

5.3

OPTION 1/OPSIE 1

$$\left. \begin{aligned} W_{nc} &= \Delta E_k + \Delta E_p \\ W_{nc} &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$= \frac{1}{2}(12)(2,25^2 - 0) \checkmark + (12)(9,8)(4,5 - 0) \checkmark$$

$$= 559,58 \text{ J} \checkmark$$

OPTION 2/OPSIE 2

$$\begin{aligned} W_{Fg//} &= F_{g//}\Delta x \cos\theta \\ &= (mg\sin\theta)\Delta x \cos\theta \\ &= (12)(9,8)\left(\frac{4,5}{\Delta x}\right)\Delta x \cos 180^\circ \\ &= -529,2 \text{ J} \end{aligned}$$

$$\begin{aligned} W_{Fg} &= F_g\Delta x \cos(90^\circ + \theta) \\ &= mg\Delta x(-\sin\theta) \\ &= (12)(9,8)\left(-\frac{4,5}{\Delta x}\right)\Delta x \\ &= -529,2 \text{ J} \end{aligned}$$

$$W_{net} = \Delta E_k$$

$$\begin{aligned} &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ &= \frac{1}{2}(12)(2,25)^2 - 0^2 \checkmark \\ &= 30,375 \text{ J} \end{aligned}$$

$$W_{net} = W_{nc} + W_c \checkmark$$

$$\begin{aligned} 30,375 &= W_{nc} + (-529,2) \checkmark \\ W_{nc} &= 559,575 \text{ J} \checkmark \quad (559,58 \text{ J}) \end{aligned}$$

OPTION 3/OPSIE 3

$$\sin\theta = \frac{4,5}{\Delta x}$$

$$\Delta x = \frac{4,5}{\sin\theta}$$

$$W_{net} = \Delta E_k$$

$$W_F + W_f + W_w = \Delta E_k$$

$$W_{nc} + (mg\sin\theta)\Delta x(\cos\beta) = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$\checkmark$ Any one/
Enige een

$$W_{nc} + (12)(9,8)\left(\frac{4,5}{\sin\theta}\right)\sin\theta\cos 180^\circ \checkmark = \frac{1}{2}(12)(2,25)^2 - 0^2 \checkmark$$

$$W_{nc} = 559,58 \text{ J} \checkmark$$

(4)

5.4 **POSITIVE MARKING FROM QUESTION 5.3.**
POSITIEWE NASIEN VANAF VRAAG 5.3.

Marking criteria for OPTION 1 /Nasienkriteria vir OPSIE 1

- Formula for W_{nc} /Formule vir W_{nc} ✓
- Correct substitution of 559,58 J in W_{nc} along inclined plane ✓
 Korrekte vervanging van 559,58 J in W_{nc} langs die skuinsvlak
- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane ✓
 Korrekte kragvergelyking en vervanging van 0 vir F_{net} **OF** $F = f_2$ op die horisontale vlak.
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2). ✓
 Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).
- Correct answer/Korrekte antwoord: 13,32 m. ✓

OPTION 1/OPSIE 1

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

$$\left. \begin{aligned} W_{nc} &= W_F + W_f \\ W_{nc} &= F\Delta x \cos 0^\circ + f_1 \Delta x \cos 180^\circ \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$559,58 = F\Delta x \cos 0^\circ + f_1 \Delta x \cos 180^\circ$$

$$559,58 \checkmark = (F - f_1)\Delta x \dots\dots\dots(1)$$

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTAAL

$$\begin{aligned} F - f_2 &= ma \\ F - f_2 &= 0 \checkmark \end{aligned} \quad \boxed{\text{OR/OF } F = f_2}$$

$$F - (f_1 + 42) \checkmark = 0$$

$$F - f_1 = 42 \dots\dots\dots(2)$$

Substitute/Vervang (2) into/in (1):

$$559,58 = 42\Delta x$$

$$\Delta x = 13,32 \text{ m } \checkmark$$

Marking criteria for OPTION 2 and 3 /Nasienkriteria vir OPSIE 2 en 3

- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane ✓
 Korrekte kragvergelyking en vervanging van 0 vir F_{net} **OF** $F = f_2$ op die horisontale vlak.
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2). ✓
 Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).
- Formula for W_{nc} **OR** W_{net} /Formule vir W_{nc} **OF** W_{net} ✓
- Correct substitution into equation for W_{nc} **OR** W_{net} on the horizontal plane ✓
 Korrekte vervanging in W_{nc} **OF** W_{net} vergelyking langs die skuinsvlak
- Correct answer/Korrekte antwoord: 13,32 m. ✓

OPTION 2/OPSIE 2

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTAAL

$$\begin{aligned} F - f_2 &= ma \\ F - f_2 &= 0 \checkmark \end{aligned} \quad \boxed{\text{OR/OF } F = f_2}$$

$$F - (f_1 + 42) \checkmark = 0$$

$$F = f_1 + 42$$

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

$$\left. \begin{aligned} W_{nc} &= \Delta E_K + \Delta E_P \\ (F - f_1)\Delta x \cos \theta &= \left[\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \right] + [mgh_f - mgh_i] \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(f_1 + 42 - f_1)\Delta x \cos 0^\circ = \left[\frac{1}{2}(12)(2,25)^2 - 0^2 \right] + [(12)(9,8)(4,5) - 0] \checkmark$$

$$\Delta x = 13,32 \text{ m } \checkmark (13,32 \text{ m})$$

OPTION 3/OPSIE 3

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTALAAL

$$F - f_2 = ma$$

$$F - f_2 = 0 \checkmark$$

$$F - (f_1 + 42) \checkmark = 0$$

$$F = f_1 + 42$$

OR/OF $F = f_2$

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

$$W_{\text{net}} = \Delta E_K$$

$$(F - f_1 - F_{g//})\Delta x \cos \theta = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] \quad \left. \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array} \right\}$$

$$[(42) - (12)(9,8)\left(\frac{4,5}{\Delta x}\right)] \Delta x \cos 0^\circ = \frac{1}{2}(12)(2,25)^2 \checkmark - 0^2$$

$$\Delta x = 13,323214 \text{ m} \checkmark (13,32 \text{ m})$$

OPTION 4/OPSIE 4

$$W_{\text{nc}} = \Delta E_K + \Delta E_P$$

$$W_{\text{nc}} = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i] \quad \left. \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array} \right\}$$

$$(f_1 + 42 - f_1) \checkmark \Delta x \cos 0^\circ \checkmark = 559,575 \checkmark$$

$$(42) \Delta x \cos 0^\circ = 559,575$$

$$\Delta x = 13,323214 \text{ m} \checkmark (13,32 \text{ m})$$

Marking criteria for OPTION 5/Nasienkriteria vir OPSIE 5

- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane $\checkmark$ / *Korrekte kragvergeliking en vervanging van 0 vir F_{net} **OF** $F = f_2$ op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2). $\checkmark$
Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).
- Correct substitution to calculate a. / *Korrekte vervanging om a te bereken.* $\checkmark$.
- Substitution to calculate F_{net} . / *Vervanging om F_{net} te bereken.* $\checkmark$
- Correct answer / *Korrekte antwoord:* 13,32 m. $\checkmark$

OPTION 5/OPSIE 5

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTALAAL

$$F - f_2 = ma$$

$$F - f_2 = 0 \checkmark$$

$$F - (f_1 + 42) \checkmark = 0$$

$$F = f_1 + 42 \dots\dots(1)$$

OR/OF $F = f_2$

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$2,25^2 = 0 + 2a\Delta x \checkmark$$

$$a = \frac{2,53}{\Delta x}$$

$$F_{\text{net}} = ma$$

$$F - F_{g//} - f_1 = ma$$

$$F - mgsin\theta - f_1 = 12a \dots\dots$$

$$F - (12)(9,8)\sin\theta - f_1 = 12\left(\frac{2,53}{\Delta x}\right) \checkmark \dots\dots(2)$$

Substitute / *Vervang* (2) into / *in* (1):

$$42 - (12)(9,8)\left(\frac{4,5}{\Delta x}\right) = 30,38$$

$$\Delta x = 13,32 \text{ m} \checkmark$$

(5)
[15]

QUESTION/VRAAG 6

6.1 Doppler Effect/*Doppler-effek* ✓ (1)

6.2 Measurement of foetal heartbeat./*Meting van die hartklop van 'n fetus.*✓

OR/OF

Measurement of blood flow./*Meting van bloedvloe.* ✓

OR/OF

Doppler flow meter/*Doppler vloeimeter* ✓

(1)

6.3 $f_L \propto f_s$ ✓

OR/OF

Directly (proportional)/Direk (eweredig)

(1)

6.4

Marking criteria/Nasienkriteria

- Doppler formula/Doppler formule ✓
- Correct substitution for v and v_s ./Korrekte vervanging van v en v_s . ✓
- Substitution for $\frac{f_L}{f_s} = 1,06$ **OR** $f_L = 1,06 f_s$ **OR** any set of values for f_L and f_s so that
 $f_L = 1,06 f_s$ / Vervanging van $\frac{f_L}{f_s} = 1,06$ **OF** $f_L = 1,06 f_s$ **OF** enige stel waardes vir
 f_L en f_s sodat $f_L = 1,06 f_s$ ✓✓
- Final answer/Finale antwoord: $20,4 \text{ m} \cdot \text{s}^{-1}$ ✓

OPTION 1/OPSIE 1

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark \quad \text{OR/OF} \quad f_L = \frac{v + v_L}{v} f_s$$

$$\frac{f_L}{f_s} = \frac{v \pm v_L}{v \pm v_s}$$

$$1,06 = \frac{340 + v_L}{340} \checkmark$$

$$v_L = 20,4 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 2/OPSIE 2

$$\text{Gradient} = \frac{0 - f_L}{0 - f_s}$$

$$1,06 = \frac{0 - f_L}{0 - f_s}$$

$$f_L = 1,06 f_s$$

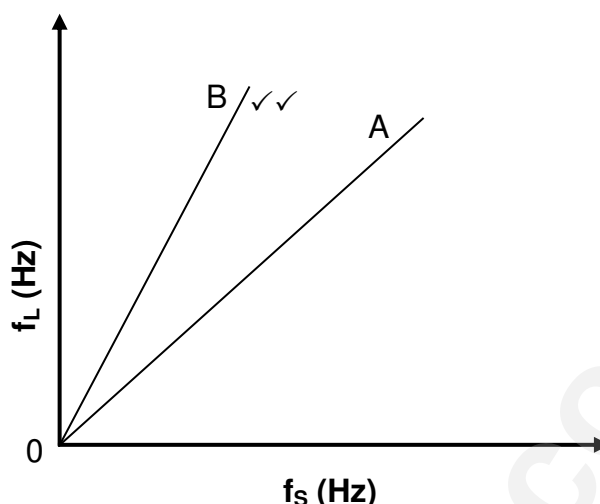
$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark \quad \text{OR/OF} \quad f_L = \frac{v + v_L}{v} f_s$$

$$1,06 f_s = \left(\frac{340 + v_L}{340} \right) f_s \checkmark$$

$$v_L = 20,4 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(5)

6.5



Marking criteria/Nasienkriteria	
Graph is a straight line starting at the origin./ Grafiek is 'n reguitlyn wat by die oorsprong begin.	✓
Gradient of B is greater than gradient of A./ Gradiënt van B is groter as gradiënt van A.	✓

(2)
[10]

QUESTION 7/VRAAG 7

7.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

The magnitude of the electrostatic force exerted by one point charge on another is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓

Die grootte van die elektrostatiese krag wat een puntlading op 'n ander uitoefen, is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

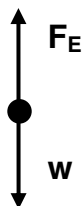
(2)

7.2

Negative/negatief ✓

(1)

7.3



Accepted labels/Aanvaarde byskrifte	
F_E	$F_{\text{electrostatic}}/ F/ F_{\text{M ON N}}/ \text{electrostatic force}/ F_M$ $F_{\text{elektrostaties}}/ F/ F_{\text{M OP N}}/ \text{elektrostatiese krag}/ F_M$
w	$F_g / w/ mg/ \text{gravitational force} / F_w/ \text{weight}/ \text{gravity}$ $F_g / w/ mg/ \text{gravitasiekrag}/ F_w/ \text{gewig}/ \text{swaartekrag}$
Notes/Aantekeninge: - Do not penalise for length of arrows./Moenie vir lengte van die pyltjie penaliseer nie. - Any other additional force(s)/Enige addisionele krag(te): Max/Maks $1/2$ - If arrows are omitted but correctly labelled/Indien pyltjies weggelaat is, maar korrek benoem: Max/Maks $1/2$ - If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $1/2$	

(2)

7.4

Marking criteria/Nasienkriteria	
- Correct substitution to calculate weight of M./Korrekte vervanging om gewig van M te bereken. ✓ - Coulomb's formula/Coulomb se formule ✓ - Substitute/Vervang $F_{\text{net}} = 0/ mg = \frac{kQ_M Q_N}{r^2}$ (equating forces)/ $0,02 = \frac{kQ_M Q_N}{r^2}$ (equating forces) ✓ - Correct substitution into $\frac{kQ_M Q_N}{r^2}$/Korrekte vervanging in $\frac{kQ_M Q_N}{r^2}$ ✓ - Correct final answer (accept negative value)/Korrekte finale antwoord (aanvaar negatiewe waarde): $2,33 \times 10^{-6} \text{ C}$ to/tot $2,32 \times 10^{-6} \text{ C}$ ✓	
$F_g = mg$ $= (2,04 \times 10^{-3})(9,8) \checkmark$ $= 0,02 \text{ N}$ $F = \frac{kQ_M Q_N}{r^2} \checkmark$ $F_{\text{net}} = mg - \frac{kQ_M Q_N}{r^2}$ $0 = 0,02 - \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2} \checkmark$ $Q_M = 2,33 \times 10^{-6} \text{ C} \checkmark$	IF/INDIEN: $F = \frac{kQ_M Q_N}{r^2} \checkmark$ $2,04 \times 10^{-3})(9,8) \checkmark \checkmark = \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2} \checkmark$ $Q_M = 2,33 \times 10^{-6} \text{ C} \checkmark$

(5)

7.5.1 Equal/Gelyk ✓

OR/OF

Same/Dieselfde

(1)

7.5.2 Opposite **OR** upwards/Teenoorgesteld **OF** opwaarts ✓

(1)

7.6 **POSITIVE MARKING FROM QUESTION 7.4.**

POSITIEWE NASIEN VANAF VRAAG 7.4.

Marking criteria/Nasienkriteria

- Formula for E./Formule vir E. ✓
- Correct substitution for M **OR** N./Korrekte vervanging vir M **OF** N. ✓
- Subtraction of $E_M - E_N$ **OR** $E_N - E_M$ /Aftrekking van $E_M - E_N$ **OF** $E_N - E_M$. ✓
- Correct final answer/Korrekte finale antwoord:
 $5,31 \times 10^4 \text{ N.C}^{-1}$ to/tot $5,37 \times 10^4 \text{ N.C}^{-1}$ ✓
- Correct direction/Korrekte rigting: upwards/opwaarts ✓

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

$$E = \frac{kQ}{r^2} \checkmark$$

$$E_{\text{net}} = \left(\frac{(9 \times 10^9)(2,33 \times 10^{-6})}{(0,4)^2} \right) - \left(\frac{(9 \times 10^9)(8,6 \times 10^{-8})}{(0,1)^2} \right) \checkmark$$

$$E_{\text{net}} = 131\,062,5 - 77\,400$$

$$= 53\,662,5 \text{ N.C}^{-1} \checkmark (5,36 \times 10^4 \text{ N.C}^{-1}) \text{ upwards/towards M}$$

opwaarts/na M ✓

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$E_{\text{net}} = \frac{kQ}{r^2} \checkmark$$

$$E_{\text{net}} = \left(\frac{(9 \times 10^9)(8,6 \times 10^{-8})}{(0,1)^2} \right) - \left(\frac{(9 \times 10^9)(2,33 \times 10^{-6})}{(0,4)^2} \right) \checkmark$$

$$E_{\text{net}} = 77\,400 - 131\,062,5$$

$$= -5,37 \times 10^4 \text{ N.C}^{-1}$$

$$\therefore E_{\text{net}} = 53\,662,5 \text{ N.C}^{-1} \checkmark (5,36 \times 10^4 \text{ N.C}^{-1}) \text{ upwards/towards M}$$

opwaarts/na M ✓

(5)
[17]

QUESTION 8/VRAAG 8

8.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided temperature and all other physical conditions are constant). ✓✓

Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly).

OR/OF

The ratio of potential difference to current is constant at constant temperature.

Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/OF

The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided temperature and all other physical conditions are constant).

Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly).

(2)

NOTE/LET WEL

Do not award the mark for addition of 4 if any other value is added to R_p / Moenie die punt vir bytel van 4 toeken indien enige ander waarde by R_p bygetel word nie.

8.2.1

OPTION 1/OPSIE 1

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$$

$$\left(\frac{1}{R_p} = \frac{1}{1} + \frac{1}{5} \right) \checkmark$$

$$R_p = 0,83 \, \Omega$$

$$R_T = 0,83 + 4 \checkmark$$

$$= 4,83 \, \Omega \checkmark$$

OPTION2/OPSIE2

$$R_p = \frac{R_1 R_2}{R_1 + R_2} \checkmark$$

$$R_p = \frac{(1)(5)}{1 + 5} \checkmark$$

$$R_p = 0,83 \, \Omega$$

$$R_T = 0,83 + 4 \checkmark$$

$$= 4,83 \, \Omega \checkmark$$

(4)

8.2.2 **POSITIVE MARKING FROM QUESTION 8.2.1.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1.

OPTION 1/OPSIE 1

$$R = \frac{V}{I} \checkmark$$

$$4,83 = \frac{V}{3,5} \checkmark$$

$$V = 16,91 \text{ V} \checkmark \quad (16,92 \text{ V})$$

OPTION 2/OPSIE 2

$$R_p = \frac{V_2}{I} \checkmark$$

$$0,83 = \frac{V}{3,5} \checkmark$$

$$V_2 = 2,91 \text{ V}$$

$$R_{4\Omega} = \frac{V_{4\Omega}}{I} \checkmark$$

$$4 = \frac{V_{4\Omega}}{3,5} \checkmark$$

$$V_{4\Omega} = 14 \text{ V}$$

$$V_1 = V_2 + V_{4\Omega}$$

$$V_1 = 2,91 + 14$$

$$= 16,91 \text{ V} \checkmark \quad (16,92 \text{ V})$$

✓ Any one/Enige een

(3)

8.2.3 Smaller than/Kleiner as ✓

(1)

8.3.1 **Marking criteria/Nasienkriteria**

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

Maximum work done by the battery per unit charge. ✓✓

Maksimum arbeid verrig deur die battery per eenheidslading.

OR/OF

Maximum energy supplied by the battery per unit charge.

Maksimum energie verskaf deur die battery per eenheidslading.

OR/OF

The total amount of electric energy supplied by the battery per coulomb/per unit charge.

Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheidslading.

(2)

8.3.2 No/Nee ✓

(1)

- 8.3.3 The battery has internal resistance. ✓
Die battery het interne weerstand.

OR/OF

Some energy per coulomb of charge/volts is used to overcome internal resistance.

'n Gedeelte van die energie per coulomb lading/volts word gebruik om interne weerstand te oorkom.

OR/OF

There is a potential drop/lost volts inside the battery.

Daar is 'n potensiaalval/verlore volts binne-in die battery.

OR/OF

$$\mathcal{E} = V_{\text{ext}} + V_{\text{int}}$$

OR/OF

$$\mathcal{E} > V_{\text{ext}}$$

(1)

- 8.4.1 Decreases/ *Verlaag* ✓

(1)

- 8.4.2 Increases/ *Verhoog* ✓

(1)

- 8.5 When the voltmeter is connected:

- No/very little current through the 1 Ω branch **OR** Branch with 1 Ω resistor is disabled/bypassed **OR** A voltmeter has a very high resistance **OR** The resistance of the parallel branch increases. ✓
- (Total) resistance of the circuit increases. ✓
- Current in circuit decreases. ✓
- V_{internal} / Internal volts/ V_{lost} decreases. ✓

Therefore, external volts increase for a constant emf.

Wanneer die voltmeter geskakel word:

- *Geen/baie min stroom deur die 1 Ω -tak* **OF** *Tak met 1 Ω -weerstand is uitgeskakel* **OF** *Voltmeter het baie hoë weerstand* **OF** *Die weerstand van die parallelle tak neem toe.*
- *(Totale) weerstand van die stroombaan neem toe.*
- *Stroom in stroombaan neem af.*
- *V_{intern} / Interne volts/ V_{verlore} neem af.*

Dus neem die eksterne volts toe vir konstante emf.

(4)

[20]

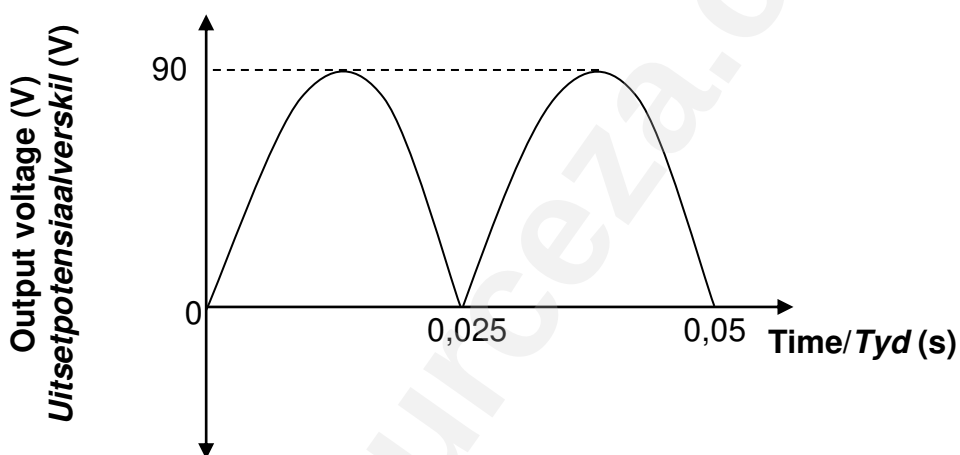
QUESTION 9/VRAAG 9

9.1.1 Split ring/commutator/*Splitring/kommutator* ✓ (1)

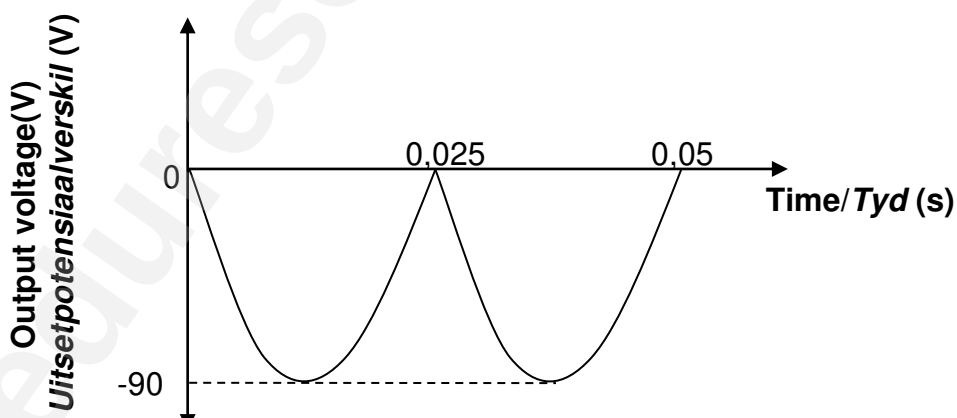
9.1.2 **Y to/na X OR/OF** 0 /no current/*geen stroom nie* ✓ (1)

9.1.3 $T = \frac{1}{f}$
 $T = \frac{1}{20}$
 $T = 0,05 \text{ s}$ ✓ (1)

9.1.4 **POSITIVE MARKING FROM QUESTION 9.1.3.**
POSITIEWE NASIEN VANAF VRAAG 9.1.3.



OR/OF



Criteria for graph/Kriteria vir grafiek	
Correct shape with one full cycle./Korrekte vorm met 1 volledige siklus.	✓
Curve starts at zero to first peak./Kurwe begin by nulpunt tot eerste piek.	✓
Any one of the correct time values at the correct position./Enige een van die korrekte tyd waardes op die korrekte posisie.	✓
Maximum voltage of 90 V OR -90 V/ Maksimum potensiaalverskil van 90 V OF -90 V	✓
NOTE/LET WEL:	
- 1 mark for half cycle/incomplete cycle or more than one cycle - 1 punt vir halwe siklus/onvoltooide siklus of meer as een siklus	

(4)

9.2

Marking criteria/Nasienkriteria

- Formula to calculate W_{ave} (do not penalise if subscripts are omitted)./
Formule om W_{gem} te bereken (moenie penaliseer indien onderskrifte uitgelaat is nie). ✓
- Substitution of 220 and 32 in correct equation. ✓
Vervanging van 220 en 32 in die korrekte vergelyking.
- Substitution of 120 for Δt /Vervanging van 120 in Δt . ✓
- Correct answer in range: 181 500 J to 181 764 J ✓
Korrekte antwoord in gebied: 181 500 J tot 181 764 J ✓

OPTION 1/OPSIE 1

$$W_{ave} = \frac{V_{rms}^2 \Delta t}{R} \checkmark$$

$$= \frac{220^2 (120)}{32} \checkmark$$

$$= 181\,500 \text{ J} \checkmark$$

OPTION 2/OPSIE 2

$$R = \frac{V_{rms}}{I_{rms}} \checkmark$$

$$32 = \frac{220}{I_{rms}}$$

$$I_{rms} = 6,88 \text{ A} \quad (6,875 \text{ A})$$

$$W_{ave} = V_{rms} I_{rms} \Delta t \checkmark$$

$$= (220)(6,88)(120) \checkmark$$

$$= 181\,632 \text{ J} \checkmark$$

OR/OF

$$W_{ave} = I_{rms}^2 R \Delta t \checkmark$$

$$= (6,88)^2 (32)(120) \checkmark$$

$$= 181\,764,10 \text{ J} \checkmark$$

OPTION 3/OPSIE 3

$$R = \frac{V_{rms}}{I_{rms}} \checkmark$$

$$32 = \frac{220}{I_{rms}} \checkmark$$

$$I_{rms} = 6,88 \text{ A} \quad (6,875 \text{ A})$$

$$P_{ave} = V_{rms} I_{rms}$$

$$= (220)(6,88)$$

$$= 1\,513,6 \text{ W}$$

$$(1,51 \times 10^3 \text{ W})$$

$$P_{ave} = I_{rms}^2 R$$

$$= (6,88)^2 (32)$$

$$= 1\,514,7 \text{ W} \quad (1\,512,5 \text{ W})$$

$$(1,51 \times 10^3 \text{ W})$$

OPTION 4/OPSIE 4

$$P_{ave} = \frac{V_{rms}^2}{R}$$

$$P_{ave} = \frac{220^2}{32} \checkmark$$

$$P_{ave} = 1\,512,5 \text{ W}$$

$$(1,51 \times 10^3 \text{ W})$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$1\,513,6 = \frac{W}{120} \checkmark$$

$$W = 181\,632 \text{ J} \checkmark \quad (1,82 \times 10^5 \text{ J})$$

(4)
 [11]

QUESTION 10/VRAAG 10

- 10.1 Light has a particle nature/is quantized ✓
Lig het 'n deeltjie geaardheid/is gekwantiseerd (1)

- 10.2 **Marking criteria/Nasienkriteria**
 If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓

Die minimum energie (van invallende fotone) wat elektrone kan vrystel vanuit 'n metaal/oppervlak. (2)

- 10.3
- $$\left. \begin{aligned} E &= W_0 + E_{k(\max)} \\ hf &= hf_0 + E_{k(\max)} \\ hf &= hf_0 + \frac{1}{2}mv_{\max}^2 \\ E &= W_0 + \frac{1}{2}mv_{\max}^2 \end{aligned} \right\} \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array}$$

$$\frac{(6,63 \times 10^{-34})(5,96 \times 10^{14})}{5,30 \times 10^{-20} \text{ J}} \checkmark = \frac{3,42 \times 10^{-19} + E_{k(\max)}}{(5,32 \times 10^{-20} \text{ J})} \checkmark$$
- (4)

- 10.4
- $q = I\Delta t$
 $= (0,012)(10) \checkmark$
 $= 0,12 \text{ C}$
- $n = \frac{Q}{e}$
- $n = \frac{0,12 \checkmark}{1,6 \times 10^{-19} \checkmark}$
 $n = 7,5 \times 10^{17} \text{ (electrons/elektrone)}$
- number of photons/aantal fotone = $n = 7,5 \times 10^{17} \checkmark$ (4)

- 10.5 Increases/Verhoog ✓
- More photons strike the surface of the metal per unit time/ at a higher rate ✓ hence more (photo) electrons ejected per unit time ✓ (resulting in increased current).
- Meer fotone tref die oppervlak van die metaal per eenheidstyd/ teen 'n hoër tempo, gevolglik word meer (foto) elektrone per eenheidstyd vrystel (wat tot 'n verhoogde stroom lei).* (3)

[14]

TOTAL/TOTAAL: 150



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Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE/
NATIONAL SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2020

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

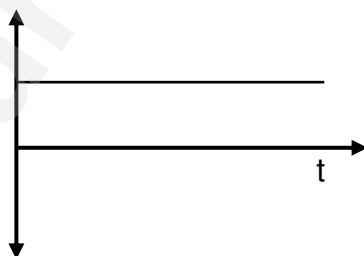
- 1.1 The rate of change of momentum of an object is equal to the ...
- A impulse on the object.
 - B net force acting on the object.
 - C product of the object's mass and its change in velocity.
 - D product of the net force acting on the object and its acceleration. (2)

- 1.2 The gravitational acceleration on the surface of planet **X** with mass M and radius r is g .

The gravitational acceleration on the surface of planet **Y** with mass $2M$ and radius $\frac{1}{2}r$ is ...

- A $\frac{1}{2}g$
- B g
- C $4g$
- D $8g$ (2)

- 1.3 The graph below shows how one of the physical quantities associated with an object in free fall changes with time t . The label on the y-axis is omitted. Ignore air friction.



Which ONE of the following physical quantities can be the label on the y-axis?

- A Velocity
- B Position
- C Weight
- D Momentum (2)

- 1.4 A ball of mass m , falling vertically downwards, hits the floor at a speed v and bounces vertically upwards at a speed $0,75v$.

Which ONE of the following combinations regarding the change in momentum of the ball during the collision is CORRECT?

	MAGNITUDE	DIRECTION
A	$0,25mv$	Upwards
B	$0,25mv$	Downwards
C	$1,75mv$	Upwards
D	$1,75mv$	Downwards

(2)

- 1.5 The base SI unit of the physical quantity 'work' is ...

A $\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$

B $\text{kg} \cdot \text{m}^2 \cdot \text{s}^2$

C $\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-2}$

D $\text{kg} \cdot \text{m} \cdot \text{s}^{-2}$

(2)

- 1.6 The siren of a police car, moving in front of a truck, emits sound waves of frequency f . Both vehicles are travelling at the same constant velocity.

The frequency of the sound heard by the driver of the truck is ...

A f .

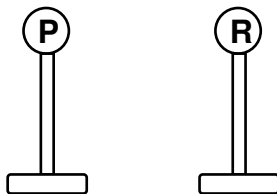
B zero.

C greater than f .

D smaller than f .

(2)

- 1.7 Two identical metal spheres, **P** and **R**, on insulated stands, carry different charges. The spheres are brought into contact and then separated again.



If the charge on sphere **R** AFTER the separation is q , the charge on sphere **P** after the separation is ...

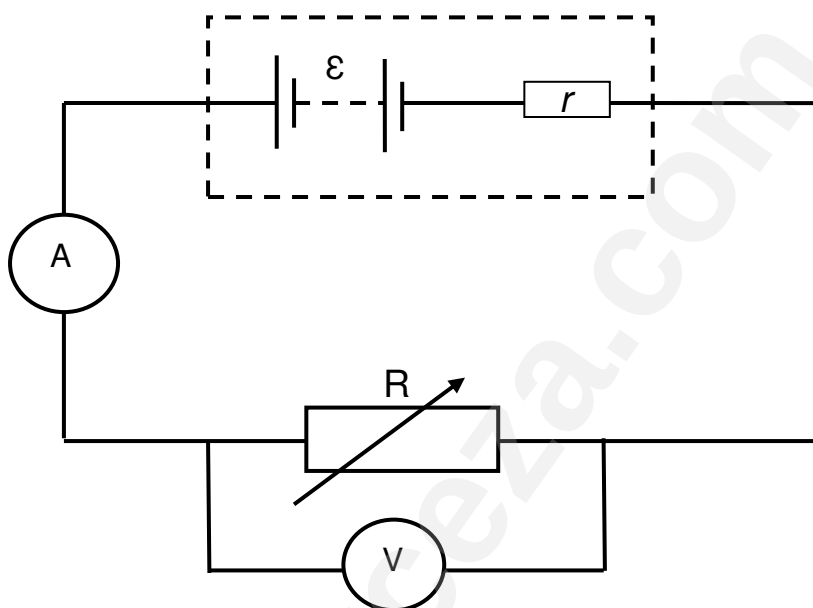
- A q .
- B zero.
- C less than q .
- D greater than q . (2)

- 1.8 An AC generator generates a current with a frequency of 50 Hz.

The number of times that the maximum (peak) current is produced in one second is ...

- A 25.
- B 50.
- C 75.
- D 100. (2)

- 1.9 In the circuit below, the battery has an internal resistance r and an emf $\mathcal{E}$. A variable resistor R is connected in the circuit and the ammeter and voltmeter register readings.



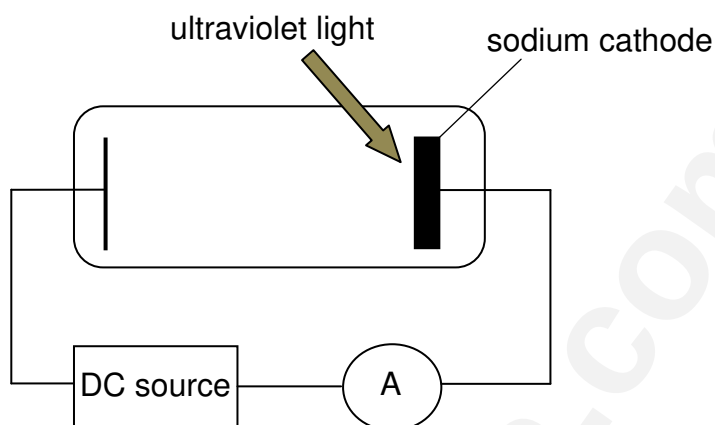
The resistance of the variable resistor R is INCREASED now.

Which ONE of the following combinations is the CORRECT representation of the change in the readings on the ammeter and voltmeter as the resistance of R is increased?

	AMMETER READING	VOLTMETER READING
A	Decreases	Increases
B	Increases	Increases
C	Increases	Decreases
D	Decreases	Decreases

(2)

- 1.10 The sodium cathode of a photocell is irradiated with ultraviolet light as shown in the diagram below. The ammeter registers a current.



Which ONE of the following changes will INCREASE the ammeter reading?

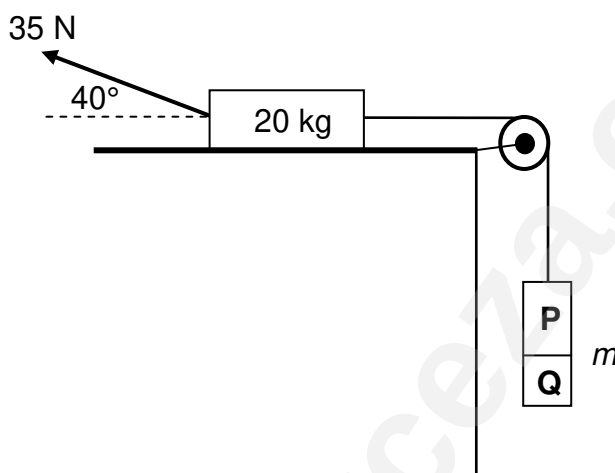
- A Use a thinner sodium cathode.
- B Increase the intensity of the ultraviolet light.
- C Increase the frequency of the ultraviolet light.
- D Replace the sodium cathode with a cathode of lower work function.

(2)
[20]

QUESTION 2 (Start on a new page.)

A 20 kg block, resting on a rough horizontal surface, is connected to blocks **P** and **Q** by a light inextensible string moving over a frictionless pulley. Blocks **P** and **Q** are glued together and have a combined mass of m .

A force of 35 N is now applied to the 20 kg block at an angle of 40° with the horizontal, as shown below.



The 20 kg block experiences a frictional force of magnitude 5 N as it moves to the RIGHT at a CONSTANT SPEED.

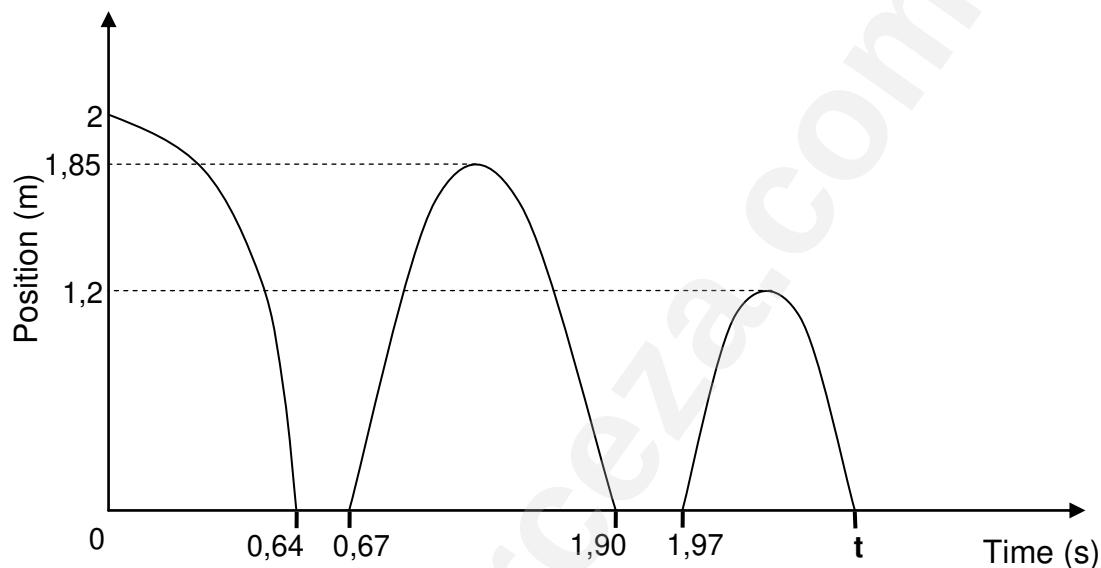
- 2.1 Define the term *normal force*. (2)
- 2.2 Draw a labelled free-body diagram of the 20 kg block. (5)
- 2.3 Calculate the combined mass m of the two blocks. (5)
- 2.4 At a certain stage of the motion, block **Q** breaks off and falls down.
How will EACH of the following be affected when this happens?
 - 2.4.1 The tension in the string
Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
 - 2.4.2 The velocity of the 20 kg block
Explain the answer. (3)

[16]

QUESTION 3 (Start on a new page.)

A small ball is dropped from a height of 2 m and bounces a few times after landing on a cement floor. Ignore air friction.

The position-time graph below, not drawn to scale, represents the motion of the ball.

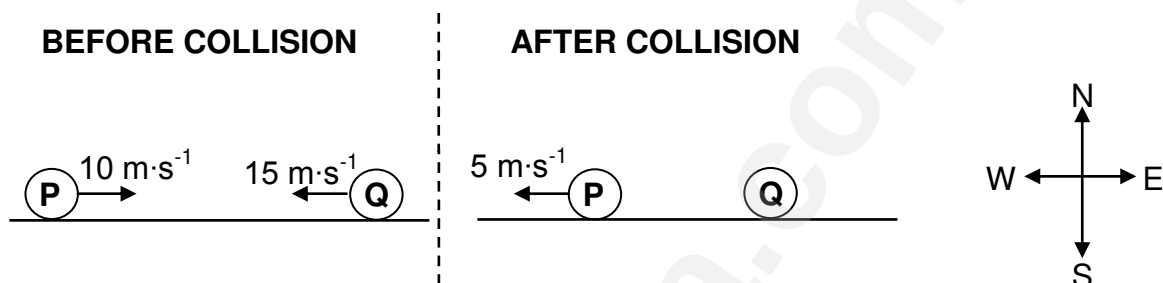


- 3.1 Define the term *free fall*. (2)
- 3.2 Use the graph and determine:
- 3.2.1 The time that the ball is in contact with the floor before the first bounce (2)
- 3.2.2 The time it takes the ball to reach its maximum height after the first bounce (2)
- 3.2.3 The speed at which the ball leaves the floor at the first bounce (3)
- 3.2.4 Time t indicated on the graph (6)
- [15]**

QUESTION 4 (Start on a new page.)

Ball **P** of mass 0,16 kg, moving east at a speed of $10 \text{ m}\cdot\text{s}^{-1}$, collides head-on with another ball **Q** of mass 0,2 kg, moving west at a speed of $15 \text{ m}\cdot\text{s}^{-1}$. After the collision, ball **P** moves west at a speed of $5 \text{ m}\cdot\text{s}^{-1}$, as shown in the diagram below.

Ignore the effects of friction and the rotational effects of the balls.



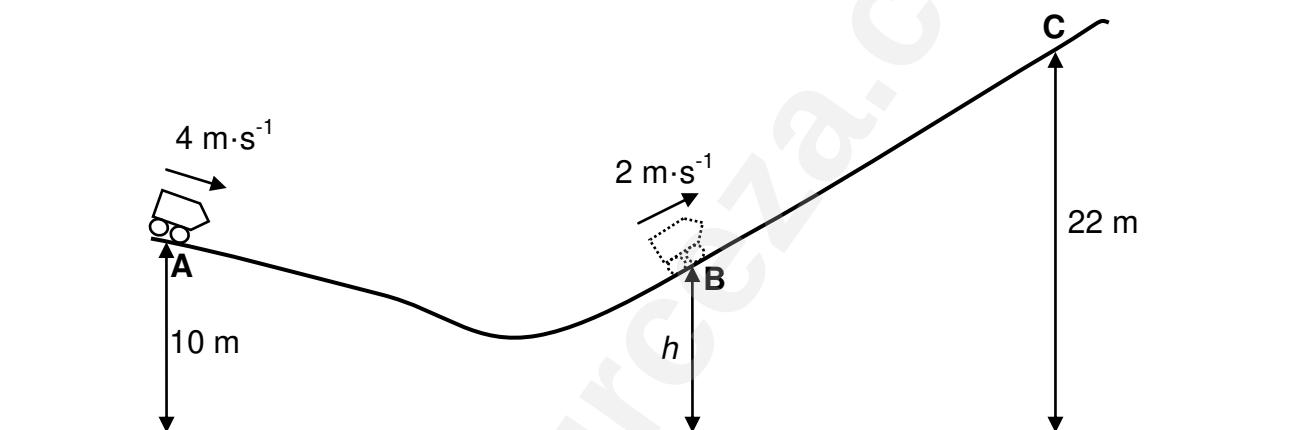
- 4.1 Define the term *momentum* in words. (2)
- 4.2 Calculate the:
- 4.2.1 Velocity of ball **Q** after the collision (5)
- 4.2.2 Magnitude of the impulse on ball **P** during the collision (3)
- [10]**

QUESTION 5 (Start on a new page.)

A roller-coaster car of mass 200 kg, with the engine switched off, travels along track **ABC** which has a rough surface, as shown in the diagram below. At point **A**, which is 10 m above the ground, the speed of the car is $4 \text{ m}\cdot\text{s}^{-1}$.

At point **B**, which is at a height h above the ground, the speed of the car is $2 \text{ m}\cdot\text{s}^{-1}$. During the motion from point **A** to point **B**, $3,40 \times 10^3 \text{ J}$ of energy is used to overcome friction.

Ignore rotational effects due to the wheels of the car.



5.1 Define the term *non-conservative force*. (2)

5.2 Calculate the change in the kinetic energy of the car after it has travelled from point **A** to point **B**. (3)

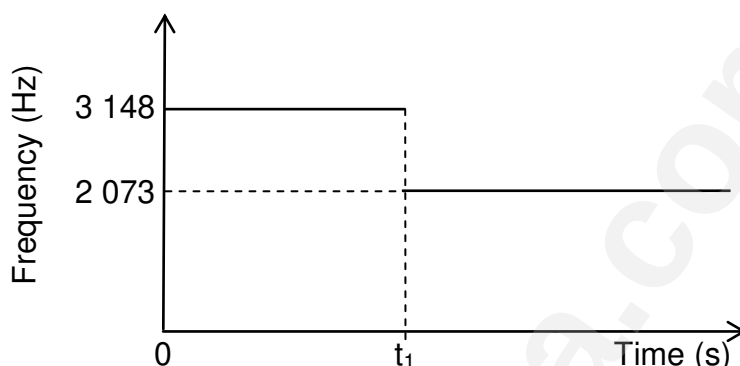
5.3 Use energy principles to calculate the height h . (4)

On reaching point **B**, the car's engine is switched on in order to move up the incline to point **C**, which is 22 m above the ground. While moving from point **B** to point **C**, the car travels for 15 s at a constant speed of $2 \text{ m}\cdot\text{s}^{-1}$, while an average frictional force of 50 N acts on it.

5.4 Calculate the power delivered by the engine to move the car from point **B** to point **C**. (5)
[14]

QUESTION 6 (Start on a new page.)

The siren of a train, moving at a constant speed along a straight horizontal track, emits sound with a constant frequency. A detector, placed next to the track, records the frequency of the sound waves. The results obtained are as shown in the graph below.

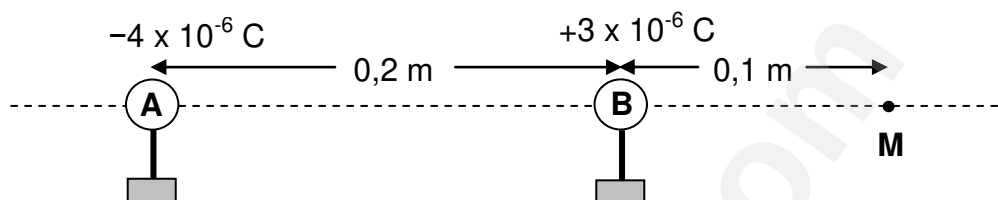


- 6.1 State the Doppler effect in words. (2)
- 6.2 Does the detector record the frequency of 3 148 Hz when the train moves TOWARDS the detector or AWAY from the detector? (1)
- 6.3 Calculate the speed of the train. Take the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$. (6)
- 6.4 The detector started recording the frequency of the moving train's siren when the train was 350 m away.
- Calculate time t_1 indicated on the graph above. (2)

[11]

QUESTION 7 (Start on a new page.)

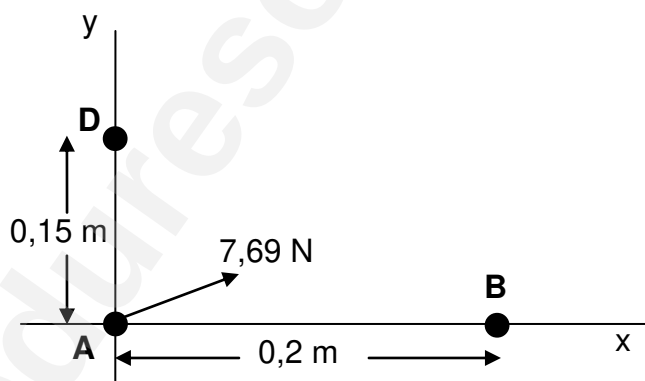
Two small charged spheres, **A** and **B**, are placed on insulated stands, 0,2 m apart, as shown in the diagram below. They carry charges of $-4 \times 10^{-6} \text{ C}$ and $+3 \times 10^{-6} \text{ C}$ respectively.



M is a point that is a distance of 0,1 m to the right of sphere **B**.

- 7.1 Calculate the number of electrons in excess on sphere **A**. (3)
- 7.2 Calculate the magnitude of the electrostatic force exerted by sphere **A** on sphere **B**. (3)
- 7.3 Describe the term *electric field*. (2)
- 7.4 Calculate the magnitude of the net electric field at point **M**. (5)

Charged spheres **A** and **B** and another charged sphere **D** are now arranged along a rectangular system of axes, as shown in the diagram below.



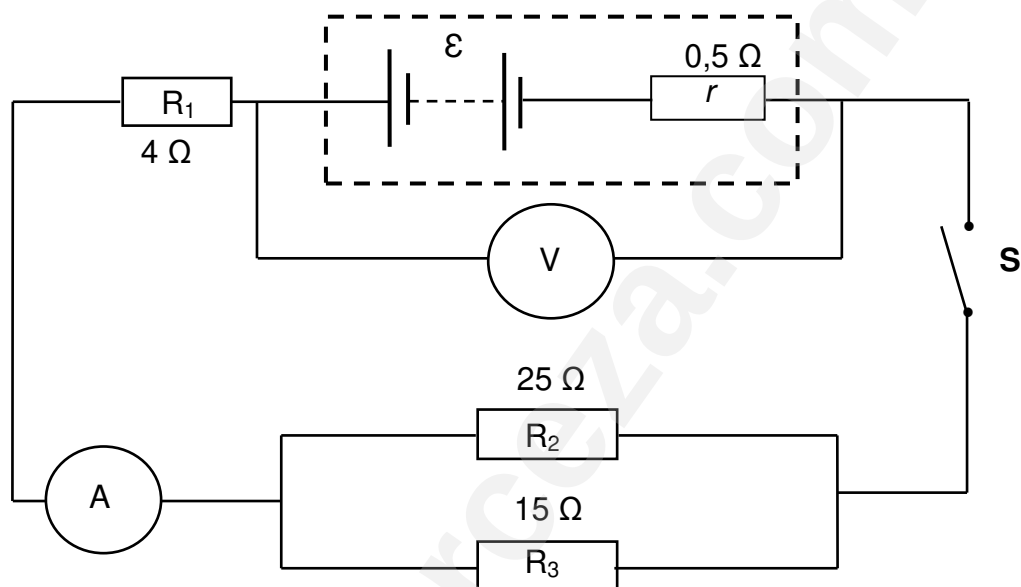
The net electrostatic force experienced by sphere **A** is 7,69 N in the direction as shown in the diagram above.

- 7.5 Is the charge on sphere **D** POSITIVE or NEGATIVE? (1)
 - 7.6 Calculate the magnitude of the charge on sphere **D**. (3)
- [17]**

QUESTION 8 (Start on a new page.)

A battery with an internal resistance of $0,5 \Omega$ and an unknown emf (ϵ) is connected to three resistors, a high resistance voltmeter and an ammeter of negligible resistance, as shown in the circuit diagram below.

The resistance of the connecting wires must be ignored.



8.1 Define the term *emf* of a battery. (2)

The reading on the voltmeter DECREASES by $1,5 \text{ V}$ when switch **S** is closed.

8.2 Give a reason why the voltmeter reading decreases. (2)

8.3 Calculate the following when switch **S** is closed:

8.3.1 Reading on the ammeter (3)

8.3.2 Total external resistance of the circuit (4)

8.3.3 Emf of the battery (3)

8.4 A learner makes the following statement:

The current through resistor R_3 is larger than the current through resistor R_2 .

Is this statement CORRECT? Choose from YES or NO. Explain the answer. (3)

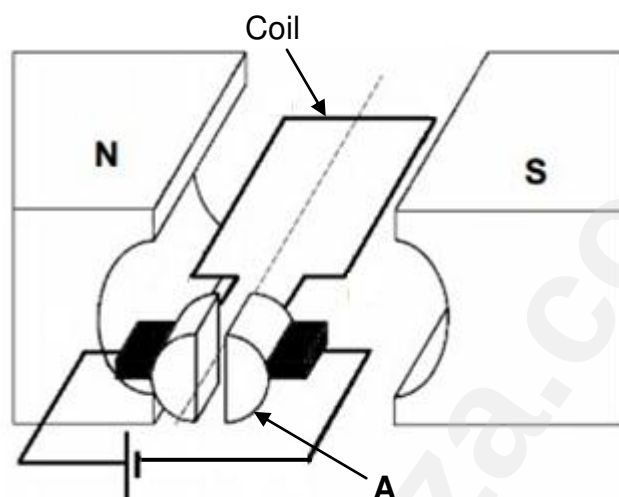
8.5 The 4Ω resistor is now removed from the circuit.

How will this affect the emf of the battery? Choose from INCREASES, DECREASES or REMAINS THE SAME.

(1)
[18]

QUESTION 9 (Start on a new page.)

9.1 A simplified diagram of an electrical machine is shown below.



9.1.1 Is this machine a DC motor or a DC generator? (1)

9.1.2 Write down the energy conversion that takes place while this machine is in operation. (2)

9.1.3 Write down the name of component **A** in the diagram. (1)

9.1.4 In which direction will the coil, shown in the diagram above, rotate? Choose from CLOCKWISE or ANTICLOCKWISE. (2)

9.2 An electrical device is marked 200 W ; 220 V.

9.2.1 Define the term *rms voltage*. (2)

9.2.2 Calculate the resistance of the device. (3)

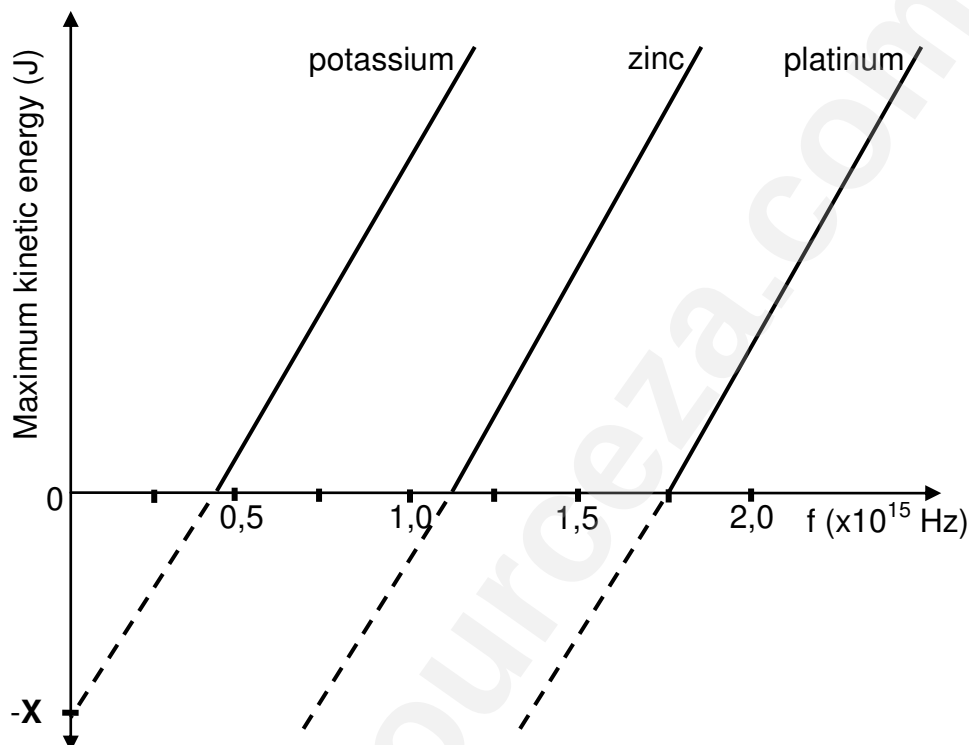
This device is now connected to a 150 V AC source.

9.2.3 Calculate the energy dissipated by the device in 10 minutes. (5)
[16]

QUESTION 10 (Start on a new page.)

An experiment is conducted to investigate the relationship between the frequency of light incident on a metal and the maximum kinetic energy of the emitted electrons from the surface of the metal. This experiment is conducted for three different metals.

The graph below represents the results obtained.



- 10.1 Name the phenomenon on which this experiment is based. (1)
- 10.2 Name the physical quantity represented by **X** on the graph. (1)
- 10.3 Which ONE of the three metals needs incident light with the *largest wavelength* for the emission of electrons? (1)
- Give a reason for the answer. (2)
- 10.4 Define the term *work function* in words. (2)
- 10.5 Calculate the: (3)
- 10.5.1 Work function of **platinum** (3)
- 10.5.2 Frequency of the incident light that will emit electrons from the surface of **platinum** with a maximum velocity of $5,60 \times 10^5 \text{ m}\cdot\text{s}^{-1}$ (4)
- [13]**

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$ / $P_{\text{gemid}} = F v_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or $E = W_0 + K_{\text{max}}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ / $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	
$E = W_0 + E_{k(\text{maks})}$ of $E = W_0 + K_{\text{maks}}$ waar $E = hf$ en $W_0 = hf_0$ en $E_{k(\text{maks})} = \frac{1}{2} mv_{\text{maks}}^2$ / $K_{\text{maks}} = \frac{1}{2} mv_{\text{maks}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ε) = $I(R + r)$ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE/SENIOR SERTIFIKAAT
NATIONAL SENIOR CERTIFICATE/
NASIONALE SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

NOVEMBER 2020

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 19 pages./
Hierdie nasienriglyne bestaan uit 19 bladsye.**

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | B ✓✓ | (2) |
| 1.2 | D ✓✓ | (2) |
| 1.3 | C ✓✓ | (2) |
| 1.4 | C ✓✓ | (2) |
| 1.5 | C ✓✓ | (2) |
| 1.6 | A ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | A ✓✓ | (2) |
| 1.10 | B ✓✓ | (2) |
| | | [20] |

QUESTION 2/VRAAG 2

2.1

Marking criteria/Nasienriglyne

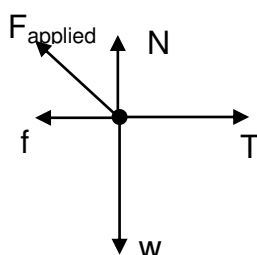
If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
 - 1 punt per woord/frase

The perpendicular force exerted by a surface on an object in contact with the surface. ✓✓

Die loodregte krag deur 'n oppervlak uitgeoefen op 'n voorwerp wat daarmee in kontak is.

(2)

2.2



	Accepted symbols/Aanvaarde simbole
N ✓	F_N /Normal/Normal force/173,5N /Normaal/Normaalkrag
f ✓	F_f / f_k /frictional force/wrywingskrag/kinetic frictional force/kinetiese wrywingskrag/5 N
w ✓	F_g /mg/Weight/ $F_{\text{Earth on block}}$ /Fw/Gewig/Gravitational force/Gravitasiekrag/196 N
T ✓	Tension/Spinning/ F_T
F_{applied} ✓ F_{toegepas}	F/Applied force/35 N/Toegepaste krag/ F_A

Notes/Aantekeninge

- Mark is awarded for label and arrow./Punt word toegeken vir byskrif en pyltjie.
- Do not penalise for length of arrows./Moenie vir die lengte van die pyltjies penaliseer nie.
- Deduct 1 mark for any additional force./Trek 1 punt af vir enige addisionele krag.
- If all forces are correctly drawn and labelled, but no arrows, deduct 1 mark. / Indien all kragte korrek geteken en benoem is, maar geen lyne nie, trek 1punt af.

(5)

2.3

For the/ Vir die 20 kg:

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ T - f - F_{Ax} &= ma \end{aligned} \right\} \checkmark$$

$$T - 5 - 35 \cos 40^\circ \checkmark = 0 \checkmark$$

$$T = 31,81 \text{ N}$$

For/ vir m:

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ mg - T &= ma \\ m(9,8) - 31,81 &= 0 \end{aligned} \right\} \checkmark$$

$$m = 3,25 \text{ kg} \checkmark$$

Marking criteria/Nasienriglyne

- Formula for 20 kg or m kg/Formule vir 20 kg of m kg / $F_{\text{net}} = ma$ ✓
- Substitution of zero into either formula ✓
Vervanging van nul in een van die formules
- All substitutions into F_{net} for 20 kg as shown ✓
Alle vervanging in F_{net} for 20 kg soos getoon
- Substitution of value of T in eqn for m
/Substitusie van waarde vir T in vgl vir m ✓
- Final answer/finale antwoord: 3,25 kg ✓

(5)

2.4.1 Decreases/Neem af ✓

(1)

2.4.2 **POSITIVE MARKING FROM QUESTION 2.3**

POSITIEWE NASIEN VANAF VRAAG 2.3

Moving to the right/Beweeg na regs

Velocity decreases/*snelheid neem af* ✓

Accelerates/Net force to left /*Versnelling/netto krag na links* ✓✓

OR/OF

As the tension force decreases, the net force/acceleration acts in the opposite direction of motion /to the left. ✓✓

Soos die spanning afneem, is daar 'n netto krag/versnelling in die teenoorgestelde rigting / na links

Moving to the left/Beweeg na links

Velocity increases/*snelheid neem toe* ✓

Accelerates/Net force to left /*Versnelling/netto krag na links* ✓✓

(3)
[16]

QUESTION 3/VRAAG 3

- 3.1 (Motion of an object) under the influence of gravity (weight) only. ✓✓ (2 or 0)
(Beweging van 'n voorwerp) slegs onder die invloed van gravitasie (gewig).

OR/OF

(Motion in which) the only force acting on the object is gravity (weight).
(Beweging waar) die enigste krag wat op die voorwerp inwerk, gravitasie (gewig) is.

(2)

- 3.2.1 $\Delta t = 0,67 - 0,64 = 0,03 \text{ s}$ ✓✓

(2)

3.2.2	<u>OPTION 1/OPSIE 1</u> $\Delta t = \frac{(1,90 - 0,67)}{2}$ ✓ $= 0,62 \text{ s}$ ✓ (0,615 s)	<u>OPTION 2/OPSIE 2</u> $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $(-1,85) = 0 + \frac{1}{2} (-9,8) \Delta t^2$ ✓ $\Delta t = 0,61 \text{ s}$ ✓ (0,6145 s)
	<u>OPTION 3/OPSIE 3</u> $\Delta t = \frac{(1,90 + 0,67)}{2} = 1,285 \text{ s}$ $\Delta t = 1,285 - 0,67$ ✓ $= 0,62 \text{ s}$ ✓ (0,615 s)	<u>OPTION 4/OPSIE 4</u> $v_f^2 = v_i^2 + 2a\Delta x$ $0 = v_i^2 + 2(-9,8)(1,85)$ $v_i = 6,02 \text{ m} \cdot \text{s}^{-1}$ $v_f = v_i + a\Delta t$ $0 = 6,02 + (-9,8)\Delta t$ ✓ $\Delta t = 0,61 \text{ s}$ ✓

(2)

3.2.3

POSITIVE MARKING FROM QUESTION 3.2.2 POSITIEWE NASIEN VANAF VRAAG 3.2.2	
Marking Criteria/Nasienriglyne - Any appropriate formula/<i>Enige geskikte formule</i> ✓ - Correct substitution/<i>Korrekte vervanging</i> ✓ - Final answer/<i>Finale antwoord</i>: 5,94 to 6,08 m·s⁻¹ ✓	
OPTION 1/OPSIE 1 Upwards positive/ <i>Opwaarts positief</i> $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (-9,8)(0,62)$ ✓ $v_i = 6,08 \text{ m}\cdot\text{s}^{-1} (6,076 \text{ m}\cdot\text{s}^{-1})$ ✓	OPTION 2/OPSIE 2 Upwards positive/ <i>Opwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,85 = v_i(0,62) + \frac{1}{2}(-9,8)(0,62)^2$ ✓ $v_i = 6,02 \text{ m}\cdot\text{s}^{-1} (6,022 \text{ m}\cdot\text{s}^{-1})$ ✓
Downwards positive/ <i>Afwaarts positief</i> $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (9,8)(0,62)$ ✓ $v_i = -6,08$ $\therefore 6,08 \text{ m}\cdot\text{s}^{-1} (6,076 \text{ m}\cdot\text{s}^{-1})$ ✓	Downwards positive/ <i>Afwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,85 = v_i(0,62) + \frac{1}{2}(9,8)(0,62)^2$ ✓ $v_i = -6,02$ $\therefore v_i = 6,02 \text{ m}\cdot\text{s}^{-1} (6,022 \text{ m}\cdot\text{s}^{-1})$ ✓
OPTION 3/OPSIE 3 Motion from top to bottom / <i>Beweging vanaf bo na onder</i> Downwards positive/ <i>Afwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(9,8)(1,85)$ ✓ $v_f = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓ initial velocity/ <i>beginsnelheid</i> =6,02 m·s ⁻¹ Upwards positive/ <i>Opwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(-9,8)(-1,85)$ ✓ $v_f = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓ initial velocity/ <i>beginsnelheid</i> =6,02 m·s ⁻¹ Motion from bottom to top <i>Beweging vanaf onder na bo</i> Downwards positive/ <i>Afwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(9,8)(-1,85)$ ✓ $v_i = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓ Upwards positive/ <i>Opwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(-9,8)(1,85)$ ✓ $v_i = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓	OPTION 4/OPSIE 4 Upwards positive/ <i>Opwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = v_i(1,23) + \frac{1}{2}(-9,8)(1,23)^2$ ✓ $v_i = 6,03 \text{ m}\cdot\text{s}^{-1}$ ✓ Downwards positive/ <i>Afwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = v_i(1,23) + \frac{1}{2}(9,8)(1,23)^2$ ✓ $v_i = -6,03 \text{ m}\cdot\text{s}^{-1}$ speed/ <i>spoed</i> = 6,03 m·s ⁻¹ ✓ OPTION 5/OPSIE 5 $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $1,85 = \left(\frac{0 + v_i}{2}\right)(0,62)$ ✓ $v_i = 5,97 \text{ m}\cdot\text{s}^{-1}$ ✓ OPTION 6/OPSIE 6 $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ $m(9,8)(0,62) = m(0 - v_i)$ ✓ $v_i = 6,08 \text{ m}\cdot\text{s}^{-1}$ ✓
OPTION 7/OPSIE 7 $(E_p + E_k)_{\text{floor/vloer}} = (E_p + E_k)_{\text{top/bo}}$ ✓ $(mgh + \frac{1}{2}mv^2)_{\text{floor/vloer}} = (mgh + \frac{1}{2}mv^2)_{\text{top/bo}}$ $0 + \frac{1}{2}v^2 = (9,8)(1,85) + 0$ ✓ $v = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓	

(3)

3.2.4

OPTION/OPSIE 1, 2, 3, 4: Marking criteria/Nasienriglyne	
Calculate initial velocity: Bereken aanvanklike snelheid: - Appropriate formula/Geskikte formule ✓ - Substitution/Vervanging ✓	Calculate/Bereken Δt: - Appropriate formula/Geskikte formule ✓ - Substitution/Vervanging ✓ $1,97 \text{ s} + \Delta t$ ✓ - Fin answer/Fin antwoord: $2,95 - 2,97 \text{ s}$ ✓
Calculate initial velocity: Bereken beginsnelheid	Calculate time Δt Bereken tyd Δt
OPTION 1/OPSIE 1 Downwards positive/Afwaarts positief $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(9,8)(-1,2)$ ✓ $v_i = -4,85 \text{ m}\cdot\text{s}^{-1}$ Upwards positive/Opwaarts positief $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(-9,8)(1,2)$ ✓ $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$	Upwards positive Opwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,2 = (4,85)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 0,4898 \text{ s} / 0,5 \text{ s}$ $t = 1,97 + 2(0,4898)$ ✓ $= 2,95 \text{ s} / 2,97 \text{ s}$ ✓ OR/OF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (4,85)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 0,9898 \text{ s (or } \Delta t = 0)$ $t = 1,97 + 0,9898$ ✓ = $2,96 \text{ s}$ ✓ Downwards positive Afwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,2 = (-4,85)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 0,4898 \text{ s} / 0,5 \text{ s}$ $t = 1,97 + 2(0,4898)$ ✓ $= 2,95 \text{ s} / 2,97 \text{ s}$ ✓ OR/OF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (4,85)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 0,9898 \text{ s (or } \Delta t = 0)$ $t = 1,97 + 0,9898$ ✓ = $2,96 \text{ s}$ ✓ OR/OF $v_f = v_i + a\Delta t$ ✓ $-4,85 = 4,85 + (-9,8)\Delta t$ ✓ $\Delta t = 0,9898 \text{ s}$ $\Delta t = 1,97 + 0,9898$ ✓ = $2,96 \text{ s}$ ✓ OR/OF Upwards positive Opwaarts positief $v_f = v_i + a\Delta t$ ✓ $0 = 4,85 + (-9,8)\Delta t$ ✓ $\Delta t = 0,4949 \text{ s}$ $\Delta t = 1,97 + (2)(0,4949)$ ✓ $= 2,96 \text{ s}$ ✓ OR/OF $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $1,2 = \left(\frac{0 + 4,85}{2}\right)\Delta t$ ✓ $\Delta t = 0,4948 \text{ s}$ $\Delta t_{\text{total}} = 2(0,4948) = 0,99 \text{ s}$ $\Delta t = 1,97 + 0,99$ ✓ = $2,96 \text{ s}$ ✓
OPTION 2/OPSIE 2 $(E_{\text{mech}})_{\text{top}} = (E_{\text{mech}})_{\text{bot/ond}}$ } ✓ Any one/ $(E_p + E_k)_{\text{top}} = (E_p + E_k)_{\text{Bot/Ond}}$ } Enige een $(mgh + \frac{1}{2}mv^2)_{\text{top}} = (mgh + \frac{1}{2}mv^2)_{\text{Bot/Ond}}$ $(9,8)(1,2) + 0 = 0 + \frac{1}{2}v^2$ ✓ $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$ upwards /opwaarts	
OPTION 3/OPSIE 3 $W_{\text{nc}} = \Delta E_p + \Delta E_k$ $0 = (0 - mgh) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/ $0 = -(9,8)(1,2) + \frac{1}{2}v_i^2$ } Enige een $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$ upwards /opwaarts	
OPTION 4/OPSIE 4 $W_{\text{net}} = \Delta E_k$ $w\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/ $(9,8)(1,2)\cos 180^\circ = \frac{1}{2}v_i^2$ } Enige een $v_i = -4,85 \text{ m}\cdot\text{s}^{-1}$	

OPTION 5/OPSIE 5 Downwards positive/Afwaarts positief $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $1,2 \checkmark = 0 + \frac{1}{2}(9,8) \Delta t^2 \checkmark$ $\Delta t = 0,49 \text{ s}$ $t = 1,97 + \checkmark 2(0,49) \checkmark$ $= 2,96 \text{ s} \checkmark$ Upwards positive/Opwaarts positief $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $-1,2 \checkmark = 0 + \frac{1}{2}(-9,8) \Delta t^2 \checkmark$ $\Delta t = 0,49 \text{ s}$ $t = 1,97 + \checkmark 2(0,49) \checkmark$ $= 2,96 \text{ s} \checkmark$	OPTION 5: Marking criteria/OPSIE 5: Nasienriglyne • Formula ✓/Formule • Substitution/Vervanging $\Delta y = 1,2 \checkmark$ • Substitution/Vervanging $0 + \frac{1}{2}(9,8) \Delta t^2$ • $1,97 \text{ s} + \checkmark$ • $2 \Delta t \checkmark$ • Final answer/Finale antwoord: 2,95 - 2,97 s ✓
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(6)
[15]

QUESTION 4/VRAAG 4

- 4.1 (Linear) momentum (of an object) is the product of mass and velocity. ✓✓
 (Liniêre) momentum (van 'n voorwerp) is die produk van massa en snelheid.
 (2 or/of 0)

(2)

4.2.1

OPTION 1/OPSIE 1 East as positive/Oos as positief $\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf} \checkmark$ Any one/Enige een $(0,16)(10) + (0,2)(-15) \checkmark = (0,16)(-5) + (0,2)v_{Qf} \checkmark$ $v_{Qf} = -3 \text{ m} \cdot \text{s}^{-1}$ $v_{Qf} = 3 \text{ m} \cdot \text{s}^{-1} \checkmark$ west/wes ✓
OPTION 2/OPSIE 2 West as positive/Wes as positief $\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf} \checkmark$ Any one/Enige een $(0,16)(-10) + (0,2)(15) \checkmark = (0,16)(5) + (0,2)v_{Qf} \checkmark$ $v_{Qf} = 3 \text{ m} \cdot \text{s}^{-1} \checkmark$ west/wes ✓
OPTION 3/OPSIE 3 $\Delta p_p = -\Delta p_Q \checkmark$ $(0,16)(-5 - 10) \checkmark = -(0,2)(v - (-15)) \checkmark$ $v = -3 \text{ m} \cdot \text{s}^{-1}$ $= 3 \text{ m} \cdot \text{s}^{-1} \checkmark$ west/wes ✓

(5)

4.2.2

For ball/ Vir bal P: West as negative/ Wes as negatief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $\Delta p = m(v_{\text{Pf}} - v_{\text{Pi}})$ $= 0,16(-5 - 10) \checkmark$ $= -2,4$ $\therefore 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$ OR/OF West as positive / Wes as positief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $= m(v_{\text{Pf}} - v_{\text{Pi}})$ $= 0,16(5 - (-10)) \checkmark$ $= 2,4 \text{ N}\cdot\text{s} \checkmark$	POSITIVE MARKING FROM QUESTION 4.2.1 / POSITIEWE NASIEN VANAF VRAAG 4.2.1 For ball/ Vir bal Q: West as negative/ Wes as negatief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $= m(v_{\text{Qf}} - v_{\text{Qi}})$ $= 0,2[-3 - (-15)] \checkmark$ $= 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$ OR/OF West as positive / Wes as positief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $= m(v_{\text{Qf}} - v_{\text{Qi}})$ $= 0,16(3 - (15)) \checkmark$ $= -2,4 \text{ N}\cdot\text{s}$ $\therefore 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$
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(3)
[10]

QUESTION 5/ VRAAG 5

5.1

Marking criteria/Nasienriglyne

If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase. However, **IF**: The word “work” is omitted 0 marks
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
- 1 punt per woord/frase. Maar, **INDIEN**: Die woord “arbeid” uitgelaat is, 0 punte

A force is non-conservative if the work it does on an object (which is moving between two points) depends on the path taken. $\checkmark\checkmark$

'n Krag is nie-konserwatief indien die arbeid wat dit verrig (op 'n voorwerp wat tussen twee punte beweeg) afhanklik is van die pad.

OR/OF

A force is non-conservative if the work it does on an object depends on the path taken. $\checkmark\checkmark$

'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhanklik is van die pad.

OR/OF

A force is non-conservative if the work it does in moving an object around a closed path is non-zero. $\checkmark\checkmark$

'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg, nie-nul is nie.

(2)

5.2

$$\begin{aligned}
 K &= \frac{1}{2} mv^2 / E_k = \frac{1}{2} mv^2 \\
 \Delta K &= K_f - K_i \\
 \Delta K &= \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2 \\
 &= \frac{1}{2} m(v_f^2 - v_i^2) \\
 &= \frac{1}{2} (200)(2^2 - 4^2) \checkmark \\
 \Delta K &= -1\,200 \text{ J} \checkmark
 \end{aligned}
 \quad \left. \vphantom{\begin{aligned} K &= \frac{1}{2} mv^2 \\ \Delta K &= K_f - K_i \\ \Delta K &= \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2 \\ &= \frac{1}{2} m(v_f^2 - v_i^2) \\ &= \frac{1}{2} (200)(2^2 - 4^2) \checkmark \end{aligned}} \right\} \checkmark \text{ Any one / Enige een}$$

(3)

5.3

POSITIVE MARKING FROM QUESTION 5.2.

POSITIEWE NASIEN VANAF VRAAG 5.2.

Marking criteria/Nasienriglyne

- Appropriate formula/Geskikte formule ✓
- Substitution into appropriate formula together with/Vervanging in geskikte formule saam met $-3,40 \times 10^3$ ✓✓
- Final answer/Finale antwoord: 8,88 m ✓

OPTION 1/OPSIE 1

$$\begin{aligned} W_{nc} &= \Delta K + \Delta U \\ W_{nc} &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \quad \left. \begin{aligned} &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \\ &= \frac{1}{2}(200)(4^2 - 2^2) + (200)(9,8)(h - 10) \end{aligned} \right\} \checkmark \text{ Any one/Enige een} \\ -3,40 \times 10^3 &\checkmark = -1\,200 + 200(9,8)(h - 10) \checkmark \\ h &= 8,88 \text{ m } \checkmark \quad (8,87765 \text{ m}) \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned} E_{(\text{mech/meg})A} + W_f &= E_{(\text{mech})B} \\ (E_p + E_k)_A + W_f &= (E_p + E_k)_B \quad \left. \begin{aligned} &(mgh + \frac{1}{2}mv^2)_A + W_f = (mgh + \frac{1}{2}mv^2)_B \\ &200(9,8)(10) + \frac{1}{2}(200)(4^2) - 3,40 \times 10^3 \checkmark = 200(9,8)(h) + \frac{1}{2}(200)(2)^2 \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een} \\ h &= 8,88 \text{ m } \checkmark \quad (8,87755) \end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned} W_{net} &= \Delta K \\ W_f + W_w &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ W_f - \Delta E_p &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \left. \begin{aligned} &W_f - mg(h_f - h_i) = \frac{1}{2}m(v_f^2 - v_i^2) \\ &-3,40 \times 10^3 - 200(9,8)(h - 10) \checkmark = -1\,200 \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een} \\ h &= 8,88 \text{ m } \checkmark \quad (8,87755 \text{ m}) \end{aligned}$$

(4)

5.4

OPTION 1 AND 2/OPSIE 1 EN 2: Marking criteria /Nasienriglyne

- Appropriate formula/Geskikte formule ✓✓
- Work done by friction/Arbeid verrig deur wrywing ✓✓
- Substitution of/Vervanging van $(200)(9,8)(13,12)$ ✓
- Appropriate formula/Geskikte formule
- Substitution into power formula/Vervanging in drywingformule
- Final answer /Finale antwoord: 1 814,35 W

OPTION 1/OPSIE 1

$$\begin{aligned} W_{nc} &= \Delta K + \Delta U \\ W_{engine} + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \quad \left. \begin{aligned} &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \\ &W_{engine} + (50)(15)(2)\cos 180^\circ \checkmark \checkmark = 0 + 200(9,8)\checkmark(22 - 8,88) \end{aligned} \right\} \checkmark \checkmark \text{ Any one/Enige een} \\ W_{engine} &= 27\,215,20 \text{ J} \\ P_{engine} &= \frac{W_{engine}}{\Delta t} \\ &= \frac{27\,215,20}{15} \\ &= 1\,814,35 \text{ W} \end{aligned}$$

OPTION 2/OPSIE 2

$$\left. \begin{aligned} W_{\text{net}} &= \Delta K \\ W_N + W_{\text{engine}} + W_w + W_f &= 0 \\ W_N + W_{\text{engine}} - \Delta E_p + W_f &= 0 \end{aligned} \right\} \checkmark\checkmark \text{ Any one/Enige een}$$

$$0 + W_{\text{engine}} - (200)(9,8) \checkmark (13,12) + (50)(2)(15)\cos 180^\circ \checkmark\checkmark = 0$$

$$W_{\text{engine}} = 27\,215,20 \text{ J}$$

OR/OF

$$W_{\text{net}} = \Delta K \checkmark\checkmark$$

$$W_N + W_{\text{engine}} + W_{w\parallel} + W_f = 0$$

$$W_N + W_{\text{engine}} + mg\sin\theta\Delta x\cos 180^\circ + W_f = 0$$

$$0 + W_{\text{engine}} - (200)(9,8) \checkmark \left(\frac{13,12}{\Delta x} \right) \Delta x(-1) + (50)(2)(15)\cos 180^\circ \checkmark\checkmark = 0$$

$$W_{\text{engine}} = 27\,215,20 \text{ J}$$

$$P_{\text{engine}} = \frac{W_{\text{engine}}}{\Delta t}$$

$$= \frac{27\,215,20}{15}$$

$$= 1\,814,35 \text{ W}$$

OPTION/OPSIE 3: Marking criteria/Nasienriglyne Opsie 3

- Appropriate formula/Geskikte formule $\checkmark\checkmark$
- Substitution of/Vervanging van - 50 $\checkmark\checkmark$
- Substitution of/Vervanging van $(-200)(9,8)(0,4373)$ or/of $(-200)(9,8)(0,44) \checkmark$
- Appropriate formula/Geskikte formule
- Substitution into/Vervanging in $P_{\text{ave}} = Fv_{\text{ave}}$
- Final answer/Finale antwoord: 1 814,35 W - 1 824,8 W

OPTION 3/OPSIE 3

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ F_{\text{engine}} + F_{\text{friction}} + F_{g\parallel} &= 0 \end{aligned} \right\} \checkmark\checkmark \text{ Any one/Enige een}$$

$$F_{\text{engine}} + (-50) \checkmark\checkmark + (-200)(9,8) \checkmark (0,4373) = 0$$

$$F_{\text{engine}} = 906,52 \text{ N } (906,52 - 912,4)$$

$$P_{\text{ave}} = Fv_{\text{ave}}$$

$$P_{\text{ave}} = (908,52)(2)$$

$$= 1\,813,04 \text{ W } (1\,824,8 \text{ W})$$

OR/OF

$$W = F_{\text{engine}}\Delta x\cos\theta$$

$$= (906,52)(30)\cos 0^\circ$$

$$= 27\,195,6 \text{ J } (27\,372 \text{ W})$$

$$P = \frac{W}{\Delta t} = \frac{27\,195,6}{15} = 1\,813,04 \text{ W } \checkmark \quad (1\,824,8 \text{ W})$$

$$\sin\theta = \frac{h}{\Delta x}$$

$$= \frac{13,12}{2(15)}$$

$$= 0,4373$$

(5)
[14]

QUESTION 6/VRAAG 6

6.1

Marking criteria/Nasienriglyne

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
 - 1 punt per woord/frase

The change in frequency✓ (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓

Die verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/OF

An (apparent) change in (observed/detected) frequency (pitch), as a result of the relative motion between a source and an observer (listener).

'n (Skynbare) verandering in (waargenome) frekwensie (toonhoogte), as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar.

(2)

6.2

Towards/Nader ✓

(1)

6.3

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v}{v - v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v}{v + v_s} f_s$$

$$3148 = \frac{340 + 0}{340 - v_s} f_s \quad \text{OR/OF} \quad 2073 = \frac{340 - 0}{340 + v_s} f_s$$

$$\frac{3148(340 - v_s)}{340 + 0} = \frac{2073(340 + v_s)}{340 - 0}$$

$$v_s = 70 \text{ m} \cdot \text{s}^{-1} \quad (69,95 - 70,16 \text{ m} \cdot \text{s}^{-1})$$

(6)

6.4

POSITIVE MARKING FROM QUESTION 6.3 **POSITIEWE NASIEN VANAF VRAAG 6.3**

OPTION 1/OPSIE 1

$$\Delta t = \frac{\Delta x}{v}$$

$$\Delta t = \frac{350}{70} \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

OPTION 2/OPSIE 2

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$350 = 70 \Delta t + 0 \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

OPTION 3/OPSIE 3

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$350 = \left(\frac{70 + 70}{2} \right) \Delta t \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

(2)

[11]

QUESTION 7/VRAAG 7

7.1

$$n = \frac{Q}{e} \checkmark$$
$$= \frac{(-) 4 \times 10^{-6}}{(-) 1,6 \times 10^{-19}} \checkmark$$
$$= 2,5 \times 10^{13} \checkmark \quad (3)$$

7.2 **Electrostatic force on B due to A:/Elektrostatiese krag op B a.g.v. A:**

$$F_{AB} = \frac{kQ_1Q_2}{r^2} \checkmark$$
$$= \left[\frac{9 \times 10^9 (4 \times 10^{-6})(3 \times 10^{-6})}{0,2^2} \right] \checkmark$$
$$= 2,7 \text{ N} \checkmark \quad (3)$$

Ignore negative signs
Ignoreer negatiewe tekens

7.3 **Marking criteria/Nasienriglyne**

If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
- 1 punt per woord/frase

Electric field is a region (in space) where (in which) an (electric) charge experiences a (electric) force. ✓✓
Elektriese veld is 'n gebied (in die ruimte) waarin 'n (elektriese) lading 'n (elektriese) krag ondervind. (2)

7.4

Marking criteria/Nasienriglyne

- Appropriate formula/*Geskikte formule* ✓
- Correct substitution for A and B/*Korrekte vervanging van A en B* ✓✓
- Subtraction of electric fields/*Aftrek van elektrieseveld* ✓
- Final answer/*Finale antwoord*: $2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1}$ ✓

OPTION 1/OPSIE 1

Electric field at M due to / *Elektriese veld by M as gevolg van*: $-4 \times 10^{-6} \text{ C}$

$$E_{AM} = k \frac{Q}{r^2} \checkmark$$

$$= 9 \times 10^9 \frac{(4 \times 10^{-6})}{(0,3)^2} \checkmark$$

$$= 4,0 \times 10^5 \text{ N}\cdot\text{C}^{-1} \text{ (to left /links)}$$

Electric field at M due to / *Elektriese veld by M as gevolg van*: $+3 \times 10^{-6} \text{ C}$,

$$E_{BM} = k \frac{Q}{r^2}$$

$$= 9 \times 10^9 \frac{(3 \times 10^{-6})}{(0,1)^2} \checkmark$$

$$= 2,7 \times 10^6 \text{ N}\cdot\text{C}^{-1} \text{ (to right /regs)}$$

Net electric field at M / *Netto elektrieseveld by M*

$$E_{\text{net}} = E_{BM} + E_{AM}$$

$$= 4,0 \times 10^5 - 2,7 \times 10^6 \checkmark$$

$$= 2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1} \checkmark \text{ (right/regs)}$$

OR/OF

Net electric field at M / *Netto elektrieseveld by M*

$$E_{\text{net}} = E_{BM} + E_{AM}$$

$$= -4,0 \times 10^5 + 2,7 \times 10^6 \checkmark$$

$$= -2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1}$$

$$= 2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1} \checkmark \text{ (right)}$$

OPTION 2/OPSIE 2

$$F_{AM} = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(4 \times 10^{-6})Q}{(0,3)^2} \checkmark = 4 \times 10^5 Q \text{ N}$$

$$F_{BM} = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(3 \times 10^{-6})Q}{(0,1)^2} \checkmark = 2,7 \times 10^6 Q \text{ N}$$

$$F_{\text{net}} = 2,7 \times 10^6 Q + (-4 \times 10^5 Q) \checkmark = 2,3 \times 10^6 Q$$

$$E = \frac{F}{q} \checkmark = \frac{2,3 \times 10^6 Q}{Q} = 2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1} \checkmark \text{ (right/regs)}$$

(5)

7.5 Positive/Positief ✓

(1)

7.6

POSITIVE MARKING FROM 7.2/POSITIEWE NASIEN VANAF 7.2

Marking criteria/Nasienriglyne

- Correct substitution into Pythagoras's equation/Korrekte vervanging in Pythagoras se vergelyking ✓
- Correct substitution into Coulomb's Law/Korrekte vervanging in Coulomb se wet ✓
- Correct answer/Korrekte antwoord ✓

$$(F_{\text{net}})^2 = (F_{\text{AD}})^2 + (F_{\text{AB}})^2$$

$$(7,69)^2 = (F_{\text{AD}})^2 + (2,7)^2 \quad \checkmark$$

$$F_{\text{AD}} = 7,2 \text{ N}$$

$$F_{\text{AD}} = \frac{kQ_1Q_2}{r^2}$$

$$7,2 = \frac{(9 \times 10^9)(4 \times 10^{-6})Q}{(0,15)^2} \quad \checkmark$$

$$Q_D = 4,5 \times 10^{-6} \text{ C} \quad \checkmark$$

OR/OF

$$F_{\text{AD}} = k \frac{Q_1Q_2}{r^2}$$

$$= 9 \times 10^9 \frac{(4 \times 10^{-6})Q}{0,15^2} \quad \checkmark$$

$$= 1,6 \times 10^6 Q$$

$$F_{\text{net}} = \sqrt{F_{\text{AB}}^2 + F_{\text{AD}}^2} \quad \text{OR/OF} \quad F_{\text{net}}^2 = F_{\text{AB}}^2 + F_{\text{AD}}^2$$

$$7,69 = \sqrt{2,7^2 + (1,6 \times 10^6 Q)^2} \quad \checkmark$$

$$Q = 4,50 \times 10^{-6} \text{ C} \quad \checkmark$$

(3)
[17]

QUESTION 8/VRAAG 8

8.1

Marking criteria/Nasienriglyne

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
 - 1 punt per woord/frase

(Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it. ✓✓

(Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheidslading wat daardeur beweeg.

Work done by the battery to move a unit coulomb of charge across the circuit./Arbeid verrig deur die battery om 'n eenheidslading oor die stroombaan te beweeg.

(2)

8.2

Energy (per coulomb of charge) is converted to heat in the battery due to the internal resistance. ✓✓

Energie (per coulomb lading) word na hitte omskep binne-in die battery a.g.v. interne weerstand.

(2)

8.3.1

$$I = \frac{V}{R} \checkmark$$

$$I = \frac{1,5}{0,5} \checkmark$$

$$= 3 \text{ A} \checkmark$$

(3)

8.3.2

OPTION 1/OPSIE 1

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$$

$$\frac{1}{R_p} = \frac{1}{25} + \frac{1}{15} \checkmark$$

$$R_p = 9,375 \Omega$$

$$R_{\text{ext}} = 9,375 + 4 \checkmark = 13,38 \Omega \checkmark$$

(13,375 Ω)

OPTION 2/OPSIE 2

$$R_p = \frac{R_1 R_2}{R_1 + R_2} \checkmark$$

$$R_p = \frac{(25)(15)}{25+15} \checkmark$$

$$R_p = 9,375 \Omega$$

$$R_{\text{ext}} = 9,375 + 4 \checkmark = 13,38 \Omega \checkmark$$

(13,375 Ω)

(4)

8.3.3

POSITIVE MARKING FROM QUESTIONS 8.3.1 AND 8.3.2.
POSITIEWE NASIEN VANAF VRAAG 8.3.1 EN 8.3.2.

OPTION 1/OPSIE 1

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ &= 3(13,38 + 0,5) \checkmark \\ &= 41,64 \text{ V} \checkmark \quad (\text{Range/Gebied: } 41,625 - 41,64)\end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}\mathcal{E} &= V_{\text{ext/eks}} + V_{\text{int}} \checkmark \\ &= (3)(13,38) + 1,5 \checkmark \\ &= 41,64 \text{ V} \checkmark \quad (\text{Range/Gebied: } 41,625 - 41,64)\end{aligned}$$

(3)

8.4 Yes. $\checkmark$ /Ja

For the same voltage/potential difference, $\checkmark$

a larger current will flow through a smaller resistor ($I = \frac{V}{R}$) $\checkmark$

Vir dieselfde spanning/ potensiaalverskil

sal 'n groter stroom deur die kleiner weerstand vloei ($I = \frac{V}{R}$).

OR/OF

$$I \propto \frac{1}{R} \checkmark, V = \text{constant /konstant} \checkmark$$

I is inversely proportional to R and V is constant.

I is omgekeerd eweredig aan R en V is konstant.

OR/OF

$$\begin{aligned}V_{\parallel} &= IR \\ &= (3)(9,38) \\ &= 28,14 \text{ V}\end{aligned}$$

$$I_{R2} = \frac{V}{R} = \frac{28,14}{25} = 1,13 \text{ A} \checkmark$$

$$I_{R3} = \frac{V}{R} = \frac{28,14}{15} = 1,88 \text{ A} \checkmark$$

OR/OF

V is the same / V is dieselfde $\checkmark$

$$\left. \begin{aligned}I_{15\Omega} &= \frac{25}{40} I \\ I_{25\Omega} &= \frac{15}{40} I\end{aligned} \right\} \checkmark$$

(3)

8.5 Remains the same/*Bly dieselfde* $\checkmark$

(1)

[18]

QUESTION 9/VRAAG 9

9.1.1 (DC) motor/(GS-)motor ✓ (1)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1**

POSITIEWE NASIEN VANAF VRAAG 9.1.1

Electrical to mechanical /kinetic (energy) ✓✓ (2 or 0)

Elektriese na meganiese/kinetiese (energie) (2 of 0) (2)

9.1.3 Split ring/commutator/Splitring/kommutator ✓ (1)

9.1.4 Anticlockwise/antikloksgewys ✓✓ (2)

9.2.1 (The rms voltage/value of AC is) the AC voltage/potential difference which dissipates the same amount of energy/heat/power as an equivalent DC voltage/potential difference. ✓✓ (2 or 0)

(Die wgk-waarde van WS is) die WS-potensiaalverskil/spanning wat dieselfde hoeveelheid energie/hitte/drywing verbruik as 'n ekwivalente GS-spanning/potensiaalverskil. (2 of 0)

ACCEPT/AANVAAR

The rms voltage/value of AC is the DC potential difference which dissipates the same amount of energy/heat/power as AC.

Die wgk-waarde van WS is die GS-potensiaalverskil wat dieselfde hoeveelheid energie/hitte/drywing verbruik as die WS. (2)

9.2.2 **Marking criteria/Nasienriglyne**

- Appropriate formula for P_{ave} /Gesikte formule vir P_{ave} ✓
- Substitution to calculate/Vervanging vir berekening van R ✓
- Final answer/Finale antwoord: 242Ω ✓

<u>OPTION 1/OPSIE 1</u>	<u>OPTION 2/OPSIE 2</u>	<u>OPTION 3/OPSIE 3</u>
$P_{ave} = \frac{V_{rms}^2}{R} \checkmark$ $200 = \frac{220^2}{R} \checkmark$ $R = 242 \Omega \checkmark$	$P_{ave} = V_{rms} I_{rms} \checkmark$ $200 = I_{rms} (220)$ $I_{rms} = 0,909 \text{ A (0,91)}$ $R = \frac{V_{rms}}{I_{rms}} \text{ or/of } R = \frac{V}{I}$ $R = \frac{220}{0,909} \checkmark$ $R = 242 \Omega \checkmark (241,76 \Omega)$	$P_{ave} = V_{rms} I_{rms} \checkmark$ $200 = I_{rms} (220)$ $I_{rms} = 0,909 \text{ A (0,91)}$ $P_{ave} = I_{rms}^2 R$ $200 = (0,909)^2 R \checkmark$ $R = 242 \Omega \checkmark$ $(241,52 \Omega)$

(3)

9.2.3

Marking criteria for options 1,2 and 3 /Nasienriglyne vir opsies 1,2 en 3

- Appropriate formula to calculate P or I_{rms} /Geskikte formule om P of I_{rms} te bereken ✓
- Substitution/Vervanging ✓
- Formula for P or W containing Δt /Formule vir P of W wat Δt bevat ✓
- Substitution/Vervanging ✓
- Final answer/Finale antwoord: 55 785,12 J ✓

POSITIVE MARKING FROM QUESTION 9.2.2.

POSITIEWE NASIEN VANAF VRAAG 9.2.2.

OPTION 1/OPSIE 1

Marking criteria / Nasienriglyne

- Appropriate formula for W containing V/Geskikte formule vir W wat V bevat ✓✓
- Substitution/Vervanging ✓✓
- Final answer/Finale antwoord: 55 785,12 J ✓

$$W = \frac{V^2 \Delta t}{R} \checkmark \checkmark$$

$$= \frac{(150^2)(10 \times 60)}{242} \checkmark$$

$$= 55\,785,12 \text{ J} \checkmark$$

OPTION 2/OPSIE 2

$$P_{ave} = \frac{V_{rms}^2}{R} \checkmark$$

$$= \frac{150^2}{242} \checkmark$$

$$P_{av} = 92,975 \text{ W}$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$92,975 = \frac{W}{(10)(60)} \checkmark$$

$$W = 55\,785,12 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

OPTION 3/OPSIE 3

$$R = \frac{V_{rms}}{I_{rms}} \checkmark / R = \frac{V}{I}$$

$$242 = \frac{150}{I_{rms}} \checkmark$$

$$I_{rms} = 0,620 \text{ A}$$

$$P_{ave} = I_{rms} V_{rms}$$

$$= (0,62)(150)$$

$$= 92,97 \text{ W (93 W)}$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$92,975 = \frac{W}{(10)(60)} \checkmark$$

$$W = 55\,785,12 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

OPTION 4/OPSIE 4

$$R = \frac{V_{rms}}{I_{rms}} \checkmark / R = \frac{V}{I}$$

$$242 = \frac{150}{I_{rms}} \checkmark$$

$$I_{rms} = 0,620 \text{ A}$$

$$W = I^2 R \Delta t \checkmark$$

$$= (0,62)^2 (242)(10)(60) \checkmark$$

$$= 55\,814,88 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

OR/OF

$$W = VI \Delta t$$

$$= (150)(0,62)(600)$$

$$= 55\,800 \text{ J}$$

OPTION 5/OPSIE 5

$$P_{ave} = \frac{V_{rms}^2}{R} \checkmark = \frac{150^2}{242} \checkmark = 92,975 \text{ W}$$

$$P_{ave} = I_{rms}^2 R$$

$$92,975 = I_{rms}^2 (242)$$

$$I_{rms} = 0,6198 \text{ A}$$

$$W = I^2 R \Delta t \checkmark$$

$$= (0,6198)^2 (242)(10)(60) \checkmark$$

$$= 55\,778,88 \text{ J} \checkmark$$

(5)
 [16]

QUESTION 10/VRAAG 10

10.1 Photoelectric effect/Fotoëlektriese effek ✓ (1)

10.2 Work function (of potassium)/Werksfunksie/Arbeidsfunksie (van kalium) ✓ (1)

10.3 Potassium/Kalium ✓
 It has the lowest work function / threshold frequency / highest threshold wavelength. ✓
 Dit het die laagste arbeidsfunksie / drumpelfrekwensie / hoogste drumpel golflengte. (2)

10.4 **Marking criteria/Nasienriglyne**
 If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.
 Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
 1 punt per woord/frase

The work function of a metal is the minimum energy that an electron (in the metal) needs✓ to be emitted/ejected from the metal / surface. ✓
 Die werksfunksie/arbeidsfunksie van 'n metaal is die minimum energie benodig om 'n elektron vanaf 'n oppervlak / metaal vry te stel. (2)

10.5.1 $W_o = hf_o$ ✓
 $= (6,63 \times 10^{-34})(1,75 \times 10^{15})$ ✓
 $= 1,160 \times 10^{-18} \text{ J}$ ✓

OR/OF

$$\left. \begin{array}{l} E = W_o + E_{k(\max)} \\ hf = W_o + E_{k(\max)} \end{array} \right\} \text{✓ Any one / Enigeen}$$

$$(6,63 \times 10^{-34})(1,75 \times 10^{15}) = W_o + 0 \text{ ✓}$$

$$W_o = 1,160 \times 10^{-18} \text{ J} \text{ ✓} \quad (3)$$

10.5.2 **POSITIVE MARKING FROM QUESTION 10.5.1.**
POSITIEWE NASIEN VANAF VRAAG 10.5.1.

$$\left. \begin{array}{l} E = W_o + E_{k(\max)} \\ hf = hf_o + \frac{1}{2}mv_{\max}^2 \end{array} \right\} \text{✓ Any one/Enige een}$$

$$(6,63 \times 10^{-34})f \text{ ✓} = \frac{1,160 \times 10^{-18}}{2} + \frac{1}{2} (9,11 \times 10^{-31}) (5,60 \times 10^5)^2 \text{ ✓}$$

$$\therefore f = 1,97 \times 10^{15} \text{ Hz} \text{ ✓} \quad (4)$$

[13]

TOTAL/TOTAAL: 150



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2021

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

- 1.1 A constant net force acts on an object moving in a straight line. Which ONE of the following quantities associated with the object will remain constant during the motion?

A Velocity
B Momentum
C Acceleration
D Kinetic energy

(2)

- 1.2 The weight of an object on the surface of the Earth is w . What will be the weight of the object on the surface of another planet of the SAME mass as that of the Earth, but TWICE the radius of the Earth?

A $\frac{1}{4}w$
B $\frac{1}{2}w$
C $2w$
D $4w$

(2)

- 1.3 The diagram below shows a cricket player moving his hands downwards from position 1 to 2 to 3 while catching a ball.



Which ONE of the following statements CORRECTLY explains why the cricket player moves his hands downwards?

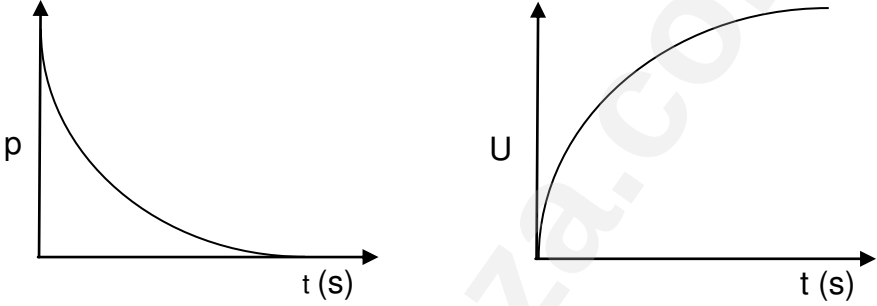
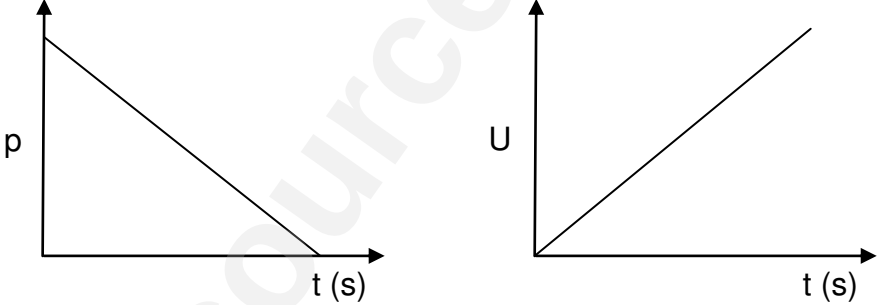
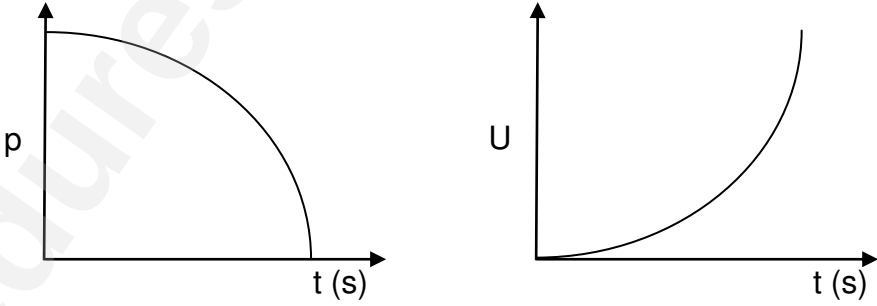
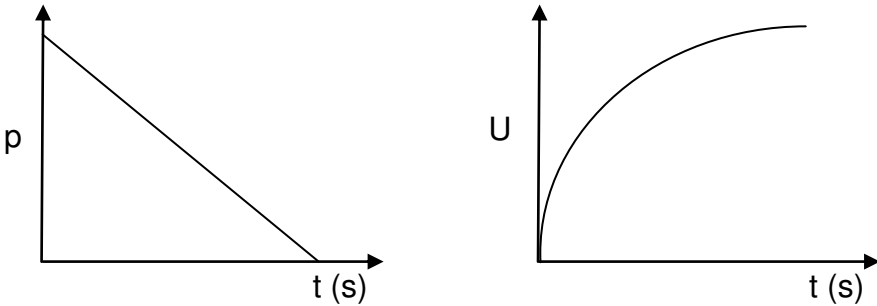
A The impulse on the ball is decreased.
B The change in momentum of the ball is increased.
C The change in momentum of the ball is decreased.
D The time it takes to change the momentum of the ball is increased.

(2)

- 1.4 Consider the motion of a small stone thrown vertically upwards until it reaches its maximum height.

Ignore the effects of friction.

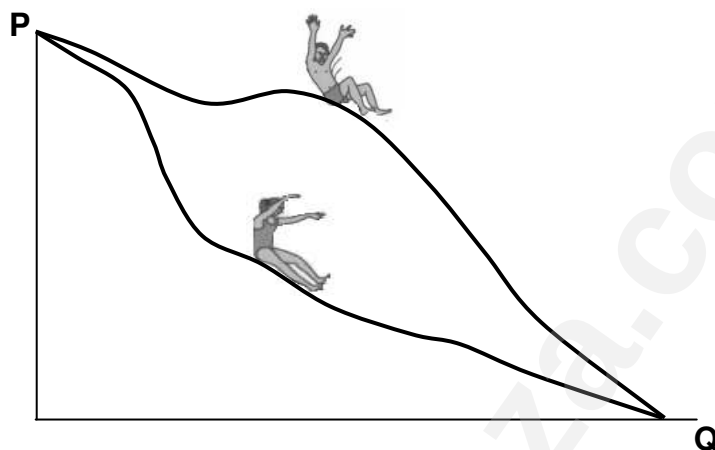
Which ONE of the following combinations of graphs CORRECTLY shows how the momentum p and the gravitational potential energy U of the stone change with time?

A	
B	
C	
D	

(2)

- 1.5 A boy and a girl, having DIFFERENT masses, are initially at rest at point **P**. They slide down different paths of a water slide, as shown in the diagram below.

Ignore the effects of friction.



Consider the statements below regarding the boy and the girl:

- I Only conservative forces act on both the boy and the girl while they are sliding downwards.
- II The boy and the girl each have the same gravitational potential energy at point **P**.
- III On reaching point **Q**, the speed of the girl is equal to that of the boy.

Which of the above statements is/are CORRECT?

- A I only
- B I and III only
- C II and III only
- D I, II and III

(2)

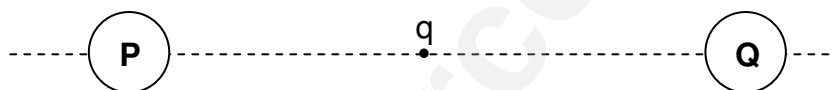
- 1.6 An astronomer observes that the light spectrum of a star has been blue shifted.

How have the observed frequency of light from the star and the distance between the star and Earth changed?

	OBSERVED FREQUENCY OF LIGHT	DISTANCE BETWEEN THE STAR AND EARTH
A	Increased	Increased
B	Increased	Decreased
C	Decreased	Increased
D	Decreased	Decreased

(2)

- 1.7 A small negative point charge (q) is situated halfway between two identical spheres, **P** and **Q**, carrying IDENTICAL charges, as shown below.



Sphere **P** exerts an electrostatic force of magnitude **F** on sphere **Q**. What is the magnitude of the net electrostatic force experienced by the point charge?

- A Zero
- B $\frac{1}{2}F$
- C F
- D 2F

(2)

1.8 Consider the statements below regarding AC power and DC power:

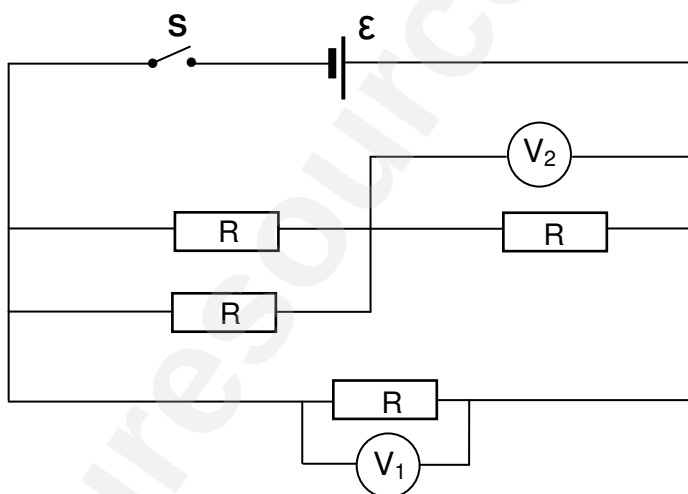
- I AC voltage can be changed during AC power transmission.
- II DC power transmission requires transformers.
- III AC power transmission is more energy efficient.

Which of the above statement(s) is/are CORRECT?

- A I only
- B II only
- C I and III only
- D II and III only

(2)

1.9 In the circuit diagram below, all resistors are IDENTICAL. Ignore the internal resistance of the cell and the resistance of the connecting wires.



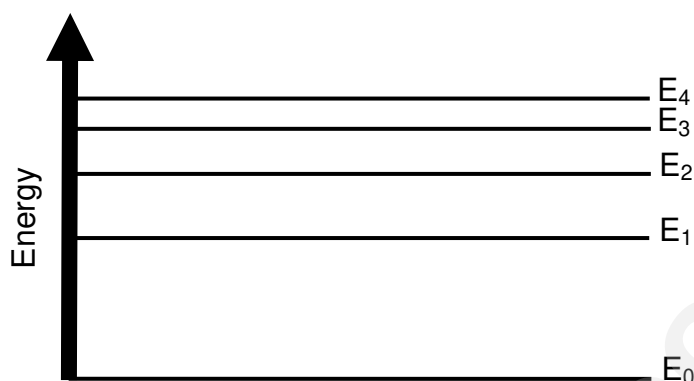
When switch **S** is CLOSED, the reading on voltmeter V_1 is 3 V.

What will be the reading on voltmeter V_2 ?

- A 1 V
- B 1,5 V
- C 2 V
- D 3 V

(2)

1.10 Some of the energy levels of an atom are represented in the diagram below.



E_0 represents the ground state energy.

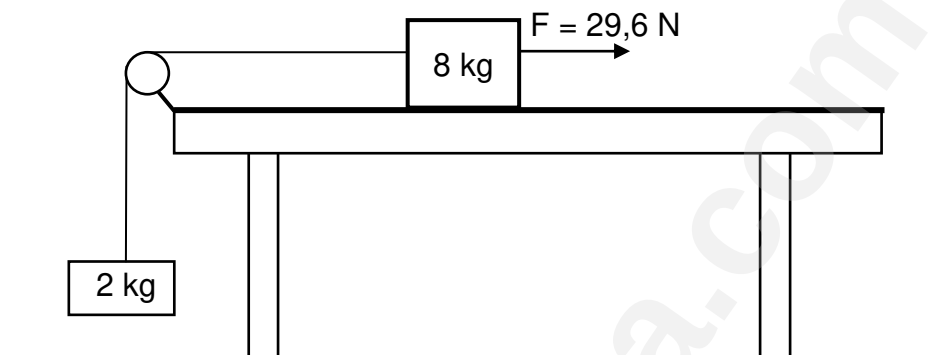
Which ONE of the energy transitions below represents the absorption of light of the lowest frequency by the atom?

- A E_0 to E_4
- B E_1 to E_3
- C E_3 to E_4
- D E_0 to E_3

(2)
[20]

QUESTION 2 (Start on a new page.)

An 8-kg block, on a rough horizontal surface, is connected to a 2-kg block by a light inextensible string passing over a frictionless pulley, as shown below. The 8-kg block moves at a **constant speed** when pulled by a 29,6 N horizontal force to the right. The frictional force acting on the 8-kg block is 10 N.



- 2.1 State *Newton's Second Law of Motion* in words. (2)
- 2.2 Draw a labelled free-body diagram for the 8-kg block. (5)
- 2.3 Calculate the tension in the string. (3)

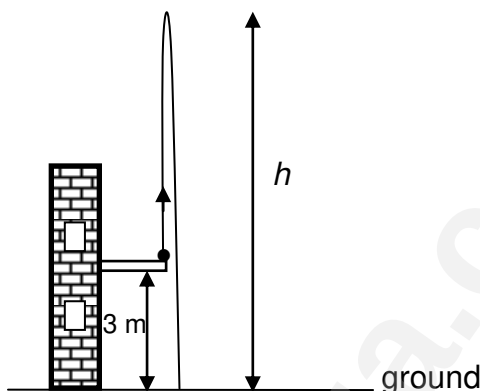
The 29,6 N horizontal force is now increased to 50 N.

- 2.4 Apply Newton's Second Law to EACH block and calculate the:
- 2.4.1 Magnitude of the acceleration of the 8-kg block (5)
- 2.4.2 Tension in the string (2)
- [17]**

QUESTION 3 (Start on a new page.)

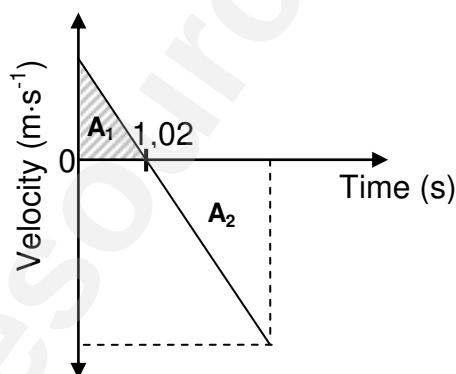
A ball, of mass 0,06 kg, is thrown vertically upwards from the balcony of a building, 3 m above the ground. The ball reaches a maximum height h above the ground, as shown in the diagram below.

Ignore the effects of air resistance.



- 3.1 Name the force acting on the ball while it is in free fall. (1)

The velocity-time graph below represents the motion of the ball from the instant it is thrown upwards until it hits the ground.



- 3.2 Write down the acceleration of the ball at time $t = 1,02$ s. (2)
- 3.3 Consider the areas A_1 and A_2 shown in the graph above. Write down the numerical value represented by the DIFFERENCE in areas A_1 and A_2 . (1)
- 3.4 Calculate the:
- 3.4.1 Speed at which the ball is thrown upwards (3)
- 3.4.2 Height h (4)

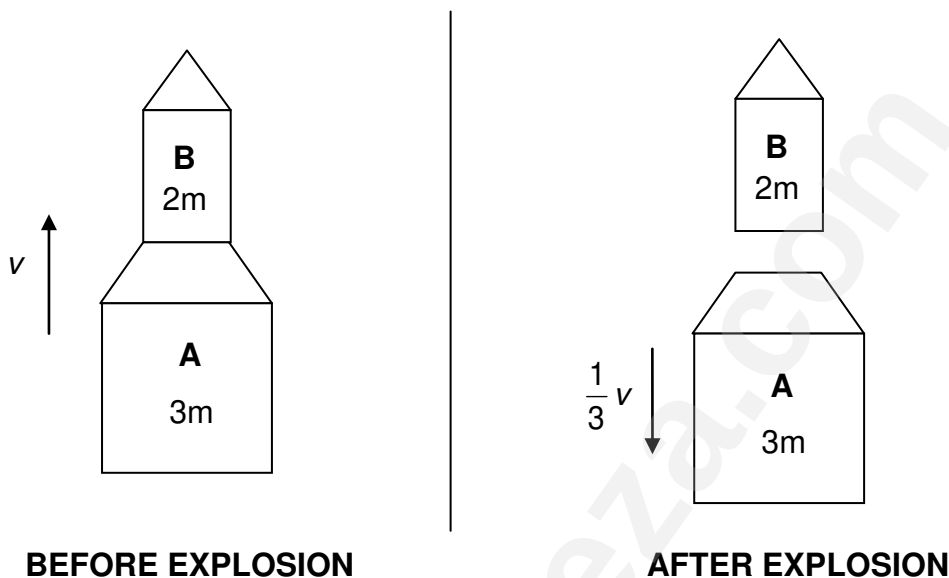
After hitting the ground, the ball bounces vertically upwards and reaches a new maximum height in 1,1 s.

- 3.5 Calculate the work done by the ground on the ball while the ball is in contact with the ground. (6)

[17]

QUESTION 4 (Start on a new page.)

A simple rocket system consists of two parts, **A** of mass $3m$, and **B** of mass $2m$, as shown in the diagram below. **B** is stacked on top of **A**.



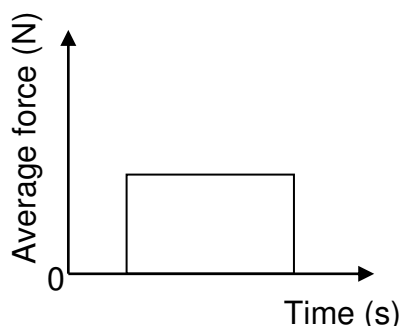
- 4.1 State the *principle of conservation of momentum* in words. (2)

The rocket is travelling vertically upwards at a constant speed v when an internal explosion causes **A** to move DOWNWARDS at a speed $\frac{1}{3}v$.

Ignore ALL external forces on the rocket.

- 4.2 Calculate the velocity of **B** in terms of v immediately after the internal explosion. (5)

The graph below shows the average force exerted by **A** on **B** during the internal explosion as a function of time.



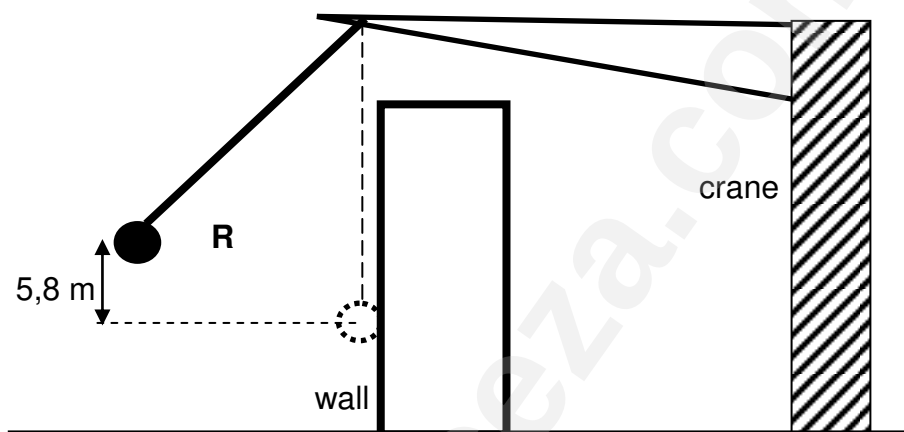
- 4.3 Name the physical quantity represented by the area under the graph. (1)
- 4.4 Redraw the graph in your ANSWER BOOK. On the same set of axes, sketch the graph of the average force that **B** exerts on **A** as a function of time. (2)
- [10]**

QUESTION 5 (Start on a new page.)

A demolition ball is used by a crane to break the wall of a building.

The demolition ball, of mass 1 250 kg, is lifted by the crane to a point **R** at a height of 5,8 m above its lowest position in 60 s.

Ignore air friction.



5.1 Define the term *power* in words. (2)

5.2 Calculate the average power dissipated by the crane in lifting the demolition ball to point **R**. (3)

The demolition ball is released from point **R** and strikes the wall at the lowest point of its swing. The ball then moves 0,25 m HORIZONTALLY into the wall before coming to rest.

5.3 Define the term *conservative force*. (2)

5.4 Is the force which the wall exerts on the ball a CONSERVATIVE or a NON-CONSERVATIVE force? (1)

5.5 State the energy conversion that takes place during the downward swing of the demolition ball. (1)

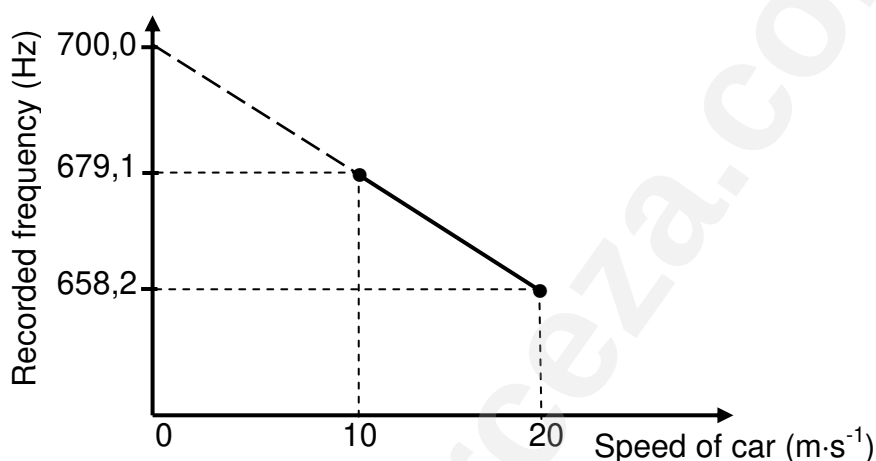
5.6 Using *energy principles*, calculate the magnitude of the average force exerted on the ball while it moves into the wall. (5)
[14]

QUESTION 6 (Start on a new page.)

A learner in a car, moving at a constant speed of $10 \text{ m}\cdot\text{s}^{-1}$ along a straight horizontal road, records the frequency of sound emitted by a distant stationary source.

The learner then repeats the recording of the frequency of the sound when the car travels at a new constant speed of $20 \text{ m}\cdot\text{s}^{-1}$.

The graph below, not drawn to scale, is obtained from the results.



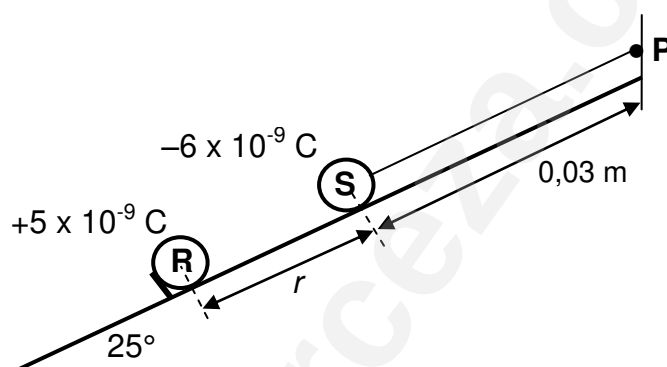
- 6.1 State the *Doppler effect*. (2)
- 6.2 Use the graph to answer the following questions.
- 6.2.1 Write down the frequency of the sound emitted by the stationary source. (2)
- Give a reason for the answer. (2)
- 6.2.2 In which direction is the car moving relative to the source? Choose from TOWARDS or AWAY. (2)
- Give a reason for the answer. (2)
- 6.2.3 Calculate the speed of sound in air. (5)
- [11]

QUESTION 7 (Start on a new page.)

Two charged spheres, **R** and **S**, are both stationary on a smooth, insulated surface inclined at an angle of 25° to the horizontal. Sphere **S**, of mass $0,01 \text{ kg}$ and carrying a charge of $-6 \times 10^{-9} \text{ C}$, is connected to a $0,03 \text{ m}$ long, light inextensible string attached to point **P** at the top of the incline.

Sphere **R**, carrying a charge of $+5 \times 10^{-9} \text{ C}$, is held such that the distance between the centres of the spheres is r , as shown in the diagram below.

Ignore the effects of friction.



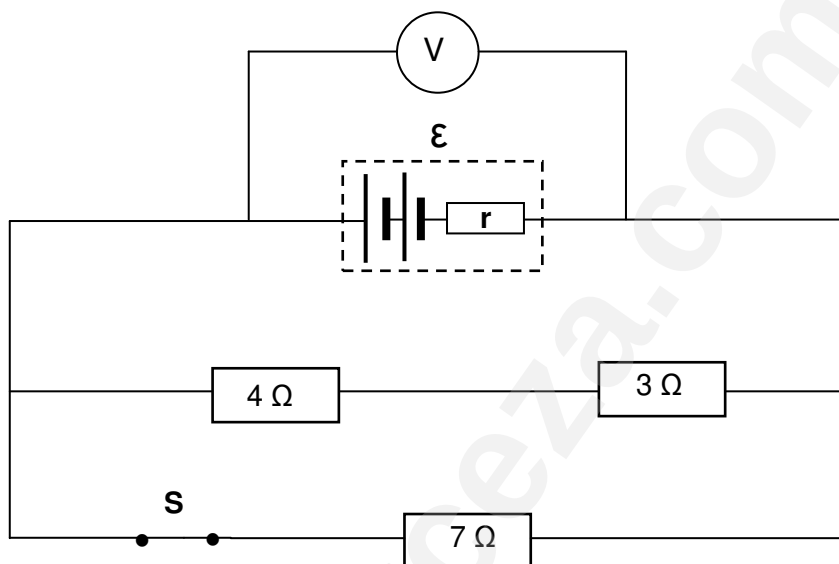
Sphere **R** exerts an electrostatic force of magnitude $1,2 \times 10^{-3} \text{ N}$ on sphere **S**.

- 7.1 State Coulomb's law in words. (2)
 - 7.2 Calculate the distance r between the spheres. (3)
 - 7.3 Draw a labelled free-body diagram for sphere **S**. (4)
 - 7.4 Calculate the:
 - 7.4.1 Tension in the string (4)
 - 7.4.2 Net electric field at point **P** (5)
- [18]**

QUESTION 8 (Start on a new page.)

Three resistors are connected to a battery with an unknown emf and unknown internal resistance r , as shown below.

Ignore the resistance of the connecting wires.



- 8.1 In the definition of the emf of a battery given below, (a) and (b) represent missing words or phrases.

The emf of the battery is the maximum (a) ... supplied by a battery per (b) passing through it.

Write down (a) and (b) in your ANSWER BOOK and next to each the missing word or phrase.

(2)

With switch **S** CLOSED, the voltmeter reads 2,63 V.

- 8.2 Calculate the equivalent external resistance of the circuit.

(4)

Switch **S** is now OPENED and the voltmeter reads 2,8 V.

- 8.3 Calculate:

8.3.1 The internal resistance of the battery

(8)

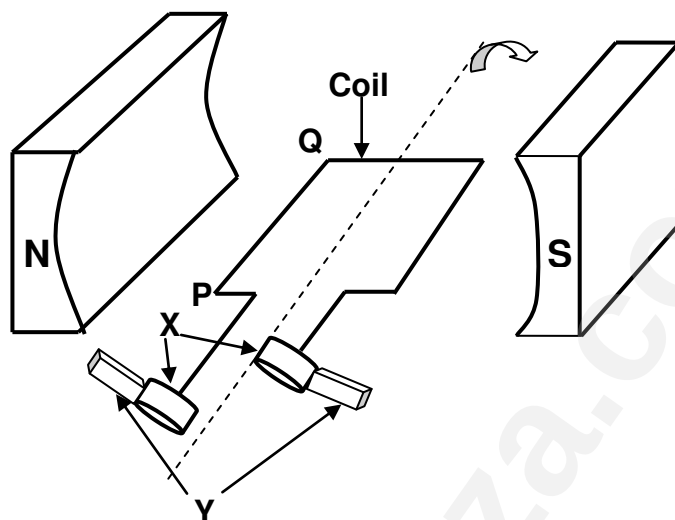
8.3.2 The emf of the battery

(2)

[16]

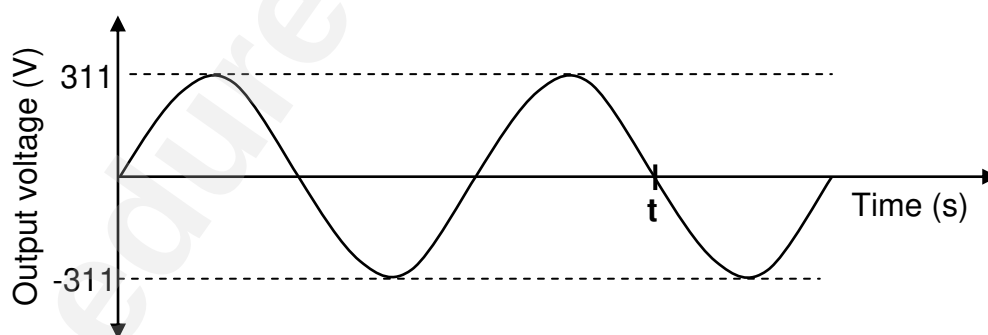
QUESTION 9 (Start on a new page.)

The diagram below is a simplified representation of an AC generator. The coil is rotated in a clockwise direction in the magnetic field.



- 9.1 Write down the name of component **X**. (1)
- 9.2 Write down the function of component **Y**. (1)
- 9.3 Use the relevant principle to explain why an emf is induced in the coil when the coil is rotated in the magnetic field. (2)
- 9.4 The coil rotates **CLOCKWISE** from the position shown in the diagram. In which direction will current be induced in segment **PQ** of the coil? Choose from '**P to Q**' or '**Q to P**'. (2)

The output voltage versus time graph below was obtained for the above generator.



The output voltage is generated at a frequency of 50 Hz.

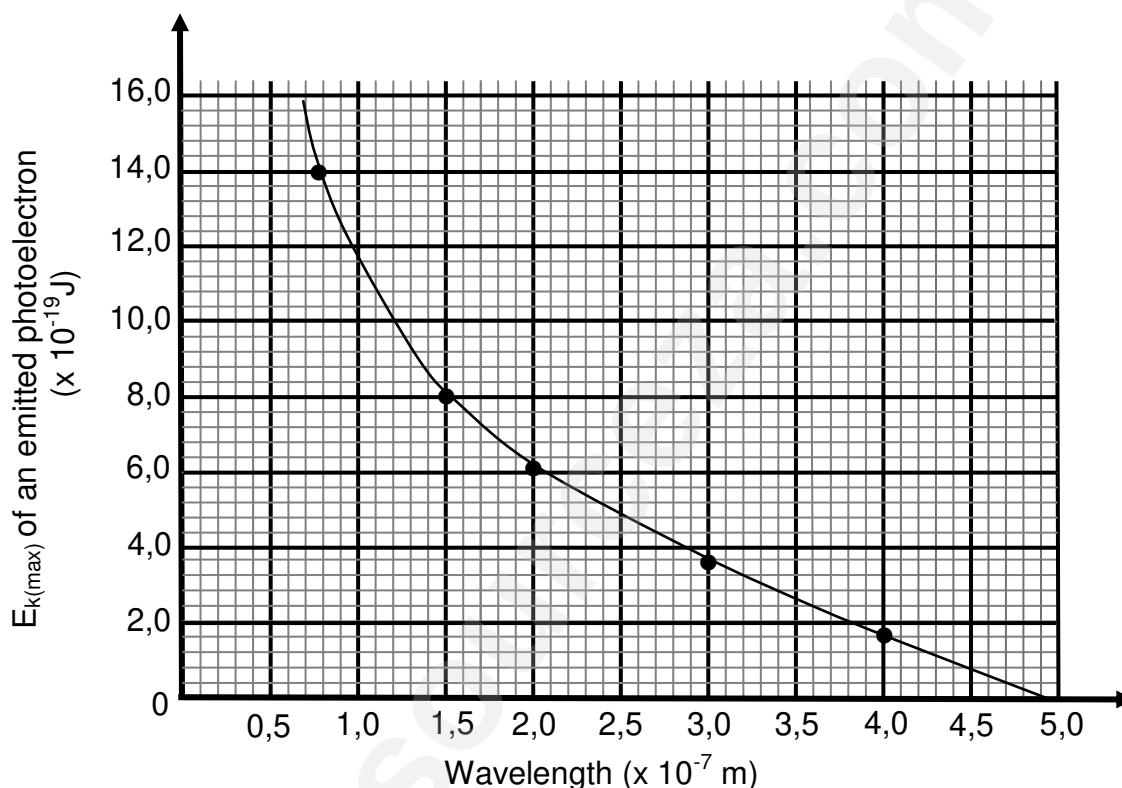
- 9.5 Calculate the time **t** indicated in the above graph. (3)
- 9.6 The generator is now connected to an appliance with a resistance of 100 Ω . Calculate the energy dissipated when the appliance is in operation for ONE minute. (5)

[14]

QUESTION 10 (Start on a new page.)

When light of various frequencies is incident on the metal cathode of a photocell, photoelectrons are emitted from the surface of the cathode.

The graph below shows the relationship between the maximum kinetic energy ($E_{k(\max)}$) of an emitted photoelectron and the wavelength of the incident light.



- 10.1 Use the graph to determine the maximum kinetic energy of the emitted photoelectron when the wavelength of the incident light is $1,0 \times 10^{-7} \text{ m}$. (1)
- 10.2 What relationship between the maximum kinetic energy of the emitted photoelectron and the wavelength of the incident light can be deduced from the graph? (2)
- 10.3 Define the term *work function* in words. (2)
- 10.4 Use the graph to calculate the work function of the metal used as cathode of this photocell. (4)
- 10.5 Calculate the maximum kinetic energy of the emitted photoelectron when the wavelength of the incident light is $0,5 \times 10^{-7} \text{ m}$. (4)

[13]**TOTAL: 150**

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Speed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or $E = W_0 + K_{\text{max}}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ or $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	
$E = W_0 + E_{k(\text{maks})}$ of $E = W_0 + K_{\text{maks}}$ waar $E = hf$ en $W_0 = hf_0$ en $E_{k(\text{maks})} = \frac{1}{2} mv_{\text{maks}}^2$ of $K_{\text{maks}} = \frac{1}{2} mv_{\text{maks}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ϵ) = $I(R + r)$ emk (ϵ) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
--	---



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE/SENIOR SERTIFIKAAT
NATIONAL SENIOR CERTIFICATE/
NASIONALE SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

NOVEMBER 2020

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 19 pages./
Hierdie nasienriglyne bestaan uit 19 bladsye.**

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | B ✓✓ | (2) |
| 1.2 | D ✓✓ | (2) |
| 1.3 | C ✓✓ | (2) |
| 1.4 | C ✓✓ | (2) |
| 1.5 | C ✓✓ | (2) |
| 1.6 | A ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | A ✓✓ | (2) |
| 1.10 | B ✓✓ | (2) |
| | | [20] |

QUESTION 2/VRAAG 2

2.1

Marking criteria/Nasienriglyne

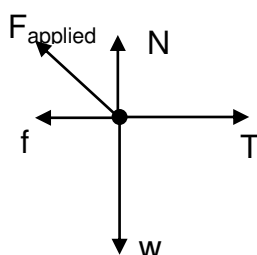
If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
 - 1 punt per woord/frase

The perpendicular force exerted by a surface on an object in contact with the surface. ✓✓

Die loodregte krag deur 'n oppervlak uitgeoefen op 'n voorwerp wat daarmee in kontak is.

(2)

2.2



	Accepted symbols/Aanvaarde simbole
N ✓	F_N /Normal/Normal force/173,5N /Normaal/Normaalkrag
f ✓	F_f / f_k /frictional force/wrywingskrag/kinetic frictional force/kinetiese wrywingskrag/5 N
w ✓	F_g /mg/Weight/ $F_{\text{Earth on block}}$ /Fw/Gewig/Gravitational force/Gravitasiekrag/196 N
T ✓	Tension/Spinning/ F_T
F_{applied} ✓ F_{toegepas}	F/Applied force/35 N/Toegepaste krag/ F_A

Notes/Aantekeninge

- Mark is awarded for label and arrow./Punt word toegeken vir byskrif en pyltjie.
- Do not penalise for length of arrows./Moenie vir die lengte van die pyltjies penaliseer nie.
- Deduct 1 mark for any additional force./Trek 1 punt af vir enige addisionele krag.
- If all forces are correctly drawn and labelled, but no arrows, deduct 1 mark. / Indien all kragte korrek geteken en benoem is, maar geen lyne nie, trek 1punt af.

(5)

2.3

For the/ Vir die 20 kg:

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ T - f - F_{Ax} &= ma \end{aligned} \right\} \checkmark$$

$$T - 5 - 35 \cos 40^\circ \checkmark = 0 \checkmark$$

$$T = 31,81 \text{ N}$$

For/vir m:

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ mg - T &= ma \end{aligned} \right\} \checkmark$$

$$m(9,8) - 31,81 \checkmark = 0$$

$$m = 3,25 \text{ kg} \checkmark$$

Marking criteria/Nasienriglyne

- Formula for 20 kg or m kg/Formule vir 20 kg of m kg / $F_{\text{net}} = ma$ ✓
- Substitution of zero into either formula ✓
Vervanging van nul in een van die formules
- All substitutions into F_{net} for 20 kg as shown ✓
Alle vervanging in F_{net} for 20 kg soos getoon
- Substitution of value of T in eqn for m
/Substitusie van waarde vir T in vgl vir m ✓
- Final answer/finale antwoord: 3,25 kg ✓

(5)

2.4.1 Decreases/Neem af ✓

(1)

2.4.2 **POSITIVE MARKING FROM QUESTION 2.3**

POSITIEWE NASIEN VANAF VRAAG 2.3

Moving to the right/Beweeg na regs

Velocity decreases/snelheid neem af ✓

Accelerates/Net force to left /Versnelling/netto krag na links ✓✓

OR/OF

As the tension force decreases, the net force/acceleration acts in the opposite direction of motion /to the left. ✓✓

Soos die spanning afneem, is daar 'n netto krag/versnelling in die teenoorgestelde rigting / na links

Moving to the left/Beweeg na links

Velocity increases/snelheid neem toe ✓

Accelerates/Net force to left /Versnelling/netto krag na links ✓✓

(3)
[16]

QUESTION 3/VRAAG 3

- 3.1 (Motion of an object) under the influence of gravity (weight) only. ✓✓ (2 or 0)
 (Beweging van 'n voorwerp) slegs onder die invloed van gravitasie (gewig).

OR/OF

(Motion in which) the only force acting on the object is gravity (weight).

(Beweging waar) die enigste krag wat op die voorwerp inwerk, gravitasie (gewig) is.

(2)

- 3.2.1 $\Delta t = 0,67 - 0,64 = 0,03 \text{ s}$ ✓✓

(2)

3.2.2	OPTION 1/OPSIE 1 $\Delta t = \frac{(1,90 - 0,67)}{2} \checkmark$ $= 0,62 \text{ s } \checkmark (0,615 \text{ s})$	OPTION 2/OPSIE 2 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $(-1,85) = 0 + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$ $\Delta t = 0,61 \text{ s } \checkmark (0,6145 \text{ s})$
	OPTION 3/OPSIE 3 $\Delta t = \frac{(1,90 + 0,67)}{2} = 1,285 \text{ s}$ $\Delta t = 1,285 - 0,67 \checkmark$ $= 0,62 \text{ s } \checkmark (0,615 \text{ s})$	OPTION 4/OPSIE 4 $v_f^2 = v_i^2 + 2a\Delta x$ $0 = v_i^2 + 2(-9,8)(1,85)$ $v_i = 6,02 \text{ m} \cdot \text{s}^{-1}$ $v_f = v_i + a\Delta t$ $0 = 6,02 + (-9,8)\Delta t \checkmark$ $\Delta t = 0,61 \text{ s } \checkmark$

(2)

3.2.3

POSITIVE MARKING FROM QUESTION 3.2.2 POSITIEWE NASIEN VANAF VRAAG 3.2.2	
Marking Criteria/Nasienriglyne - Any appropriate formula/<i>Enige geskikte formule</i> ✓ - Correct substitution/<i>Korrekte vervanging</i> ✓ - Final answer/<i>Finale antwoord</i>: 5,94 to 6,08 m·s⁻¹ ✓	
OPTION 1/OPSIE 1 Upwards positive/ <i>Opwaarts positief</i> $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (-9,8)(0,62)$ ✓ $v_i = 6,08 \text{ m}\cdot\text{s}^{-1}$ (6,076 m·s ⁻¹) ✓	OPTION 2/OPSIE 2 Upwards positive/ <i>Opwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,85 = v_i(0,62) + \frac{1}{2}(-9,8)(0,62)^2$ ✓ $v_i = 6,02 \text{ m}\cdot\text{s}^{-1}$ (6,022 m·s ⁻¹) ✓
Downwards positive/ <i>Afwaarts positief</i> $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (9,8)(0,62)$ ✓ $v_i = -6,08$ $\therefore 6,08 \text{ m}\cdot\text{s}^{-1}$ (6,076 m·s ⁻¹) ✓	Downwards positive/ <i>Afwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,85 = v_i(0,62) + \frac{1}{2}(9,8)(0,62)^2$ ✓ $v_i = -6,02$ $\therefore v_i = 6,02 \text{ m}\cdot\text{s}^{-1}$ (6,022 m·s ⁻¹) ✓
OPTION 3/OPSIE 3 Motion from top to bottom / <i>Beweging vanaf bo na onder</i> Downwards positive/ <i>Afwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(9,8)(1,85)$ ✓ $v_f = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓ initial velocity/ <i>beginsnelheid</i> =6,02 m·s ⁻¹ Upwards positive/ <i>Opwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(-9,8)(-1,85)$ ✓ $v_f = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓ initial velocity/ <i>beginsnelheid</i> =6,02 m·s ⁻¹ Motion from bottom to top <i>Beweging vanaf onder na bo</i> Downwards positive/ <i>Afwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(9,8)(-1,85)$ ✓ $v_i = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓ Upwards positive/ <i>Opwaarts positief</i> $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(-9,8)(1,85)$ ✓ $v_i = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓	OPTION 4/OPSIE 4 Upwards positive/ <i>Opwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = v_i(1,23) + \frac{1}{2}(-9,8)(1,23)^2$ ✓ $v_i = 6,03 \text{ m}\cdot\text{s}^{-1}$ ✓ Downwards positive/ <i>Afwaarts positief</i> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = v_i(1,23) + \frac{1}{2}(9,8)(1,23)^2$ ✓ $v_i = -6,03 \text{ m}\cdot\text{s}^{-1}$ speed/ <i>spoed</i> = 6,03 m·s ⁻¹ ✓ OPTION 5/OPSIE 5 $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $1,85 = \left(\frac{0 + v_i}{2}\right)(0,62)$ ✓ $v_i = 5,97 \text{ m}\cdot\text{s}^{-1}$ ✓ OPTION 6/OPSIE 6 $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ $m(9,8)(0,62) = m(0 - v_i)$ ✓ $v_i = 6,08 \text{ m}\cdot\text{s}^{-1}$ ✓
OPTION 7/OPSIE 7 $(E_p + E_k)_{\text{floor/vloer}} = (E_p + E_k)_{\text{top/bo}}$ ✓ $(mgh + \frac{1}{2}mv^2)_{\text{floor/vloer}} = (mgh + \frac{1}{2}mv^2)_{\text{top/bo}}$ $0 + \frac{1}{2}v^2 = (9,8)(1,85) + 0$ ✓ $v = 6,02 \text{ m}\cdot\text{s}^{-1}$ ✓	

(3)

3.2.4

OPTION/OPSIE 1, 2, 3, 4: Marking criteria/Nasienriglyne	
Calculate initial velocity: Bereken aanvanklike snelheid: - Appropriate formula/Geskikte formule ✓ - Substitution/Vervanging ✓	Calculate/Bereken Δt: - Appropriate formula/Geskikte formule ✓ - Substitution/Vervanging ✓ $1,97 \text{ s} + \Delta t$ ✓ - Fin answer/Fin antwoord: $2,95 - 2,97 \text{ s}$ ✓
Calculate initial velocity: Bereken beginsnelheid	Calculate time Δt Bereken tyd Δt
OPTION 1/OPSIE 1 Downwards positive/Afwaarts positief $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(9,8)(-1,2)$ ✓ $v_i = -4,85 \text{ m}\cdot\text{s}^{-1}$ Upwards positive/Opwaarts positief $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(-9,8)(1,2)$ ✓ $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$	Upwards positive Opwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,2 = (4,85)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 0,4898 \text{ s} / 0,5 \text{ s}$ $t = 1,97 + 2(0,4898)$ ✓ $= 2,95 \text{ s} / 2,97 \text{ s}$ ✓ OR/OF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (4,85)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 0,9898 \text{ s} \text{ (or } \Delta t = 0)$ $t = 1,97 + 0,9898$ ✓ = $2,96 \text{ s}$ ✓ Downwards positive Afwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,2 = (-4,85)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 0,4898 \text{ s} / 0,5 \text{ s}$ $t = 1,97 + 2(0,4898)$ ✓ $= 2,95 \text{ s} / 2,97 \text{ s}$ ✓ OR/OF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (4,85)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 0,9898 \text{ s} \text{ (or } \Delta t = 0)$ $t = 1,97 + 0,9898$ ✓ = $2,96 \text{ s}$ ✓ OR/OF $v_f = v_i + a\Delta t$ ✓ $-4,85 = 4,85 + (-9,8)\Delta t$ ✓ $\Delta t = 0,9898 \text{ s}$ $\Delta t = 1,97 + 0,9898$ ✓ = $2,96 \text{ s}$ ✓ OR/OF Upwards positive Opwaarts positief $v_f = v_i + a\Delta t$ ✓ $0 = 4,85 + (-9,8)\Delta t$ ✓ $\Delta t = 0,4949 \text{ s}$ $\Delta t = 1,97 + (2)(0,4949)$ ✓ $= 2,96 \text{ s}$ ✓ OR/OF $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $1,2 = \left(\frac{0 + 4,85}{2}\right)\Delta t$ ✓ $\Delta t = 0,4948 \text{ s}$ $\Delta t_{\text{total}} = 2(0,4948) = 0,99 \text{ s}$ $\Delta t = 1,97 + 0,99$ ✓ = $2,96 \text{ s}$ ✓
OPTION 2/OPSIE 2 $(E_{\text{mech}})_{\text{top}} = (E_{\text{mech}})_{\text{bot/ond}}$ } ✓ Any one/ $(E_p + E_k)_{\text{top}} = (E_p + E_k)_{\text{Bot/Ond}}$ } Enige een $(mgh + \frac{1}{2}mv^2)_{\text{top}} = (mgh + \frac{1}{2}mv^2)_{\text{Bot/Ond}}$ $(9,8)(1,2) + 0 = 0 + \frac{1}{2}v^2$ ✓ $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$ upwards /opwaarts	
OPTION 3/OPSIE 3 $W_{\text{nc}} = \Delta E_p + \Delta E_k$ $0 = (0 - mgh) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/ $0 = -(9,8)(1,2) + \frac{1}{2}v_i^2$ } Enige een $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$ upwards /opwaarts	
OPTION 4/OPSIE 4 $W_{\text{net}} = \Delta E_k$ $w\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/ $(9,8)(1,2)\cos 180^\circ = \frac{1}{2}v_i^2$ } Enige een $v_i = -4,85 \text{ m}\cdot\text{s}^{-1}$	

OPTION 5/OPSIE 5 Downwards positive/Afwaarts positief $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $1,2 \checkmark = 0 + \frac{1}{2}(9,8) \Delta t^2 \checkmark$ $\Delta t = 0,49 \text{ s}$ $t = 1,97 + \checkmark 2(0,49) \checkmark$ $= 2,96 \text{ s} \checkmark$ Upwards positive/Opwaarts positief $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $-1,2 \checkmark = 0 + \frac{1}{2}(-9,8) \Delta t^2 \checkmark$ $\Delta t = 0,49 \text{ s}$ $t = 1,97 + \checkmark 2(0,49) \checkmark$ $= 2,96 \text{ s} \checkmark$	OPTION 5: Marking criteria/OPSIE 5: Nasienriglyne • Formula ✓/Formule • Substitution/Vervanging $\Delta y = 1,2 \checkmark$ • Substitution/Vervanging $0 + \frac{1}{2}(9,8) \Delta t^2$ • $1,97 \text{ s} + \checkmark$ • $2 \Delta t \checkmark$ • Final answer/Finale antwoord: 2,95 - 2,97 s ✓
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(6)
[15]

QUESTION 4/VRAAG 4

- 4.1 (Linear) momentum (of an object) is the product of mass and velocity. ✓✓
 (Liniêre) momentum (van 'n voorwerp) is die produk van massa en snelheid.
 (2 or/of 0)

(2)

4.2.1

OPTION 1/OPSIE 1 East as positive/Oos as positief $\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf} \checkmark$ Any one/Enige een $(0,16)(10) + (0,2)(-15) \checkmark = (0,16)(-5) + (0,2)v_{Qf} \checkmark$ $v_{Qf} = -3 \text{ m} \cdot \text{s}^{-1}$ $v_{Qf} = 3 \text{ m} \cdot \text{s}^{-1} \checkmark$ west/wes ✓
OPTION 2/OPSIE 2 West as positive/Wes as positief $\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf} \checkmark$ Any one/Enige een $(0,16)(-10) + (0,2)(15) \checkmark = (0,16)(5) + (0,2)v_{Qf} \checkmark$ $v_{Qf} = 3 \text{ m} \cdot \text{s}^{-1} \checkmark$ west/wes ✓
OPTION 3/OPSIE 3 $\Delta p_p = -\Delta p_Q \checkmark$ $(0,16)(-5 - 10) \checkmark = -(0,2)(v - (-15)) \checkmark$ $v = -3 \text{ m} \cdot \text{s}^{-1}$ $= 3 \text{ m} \cdot \text{s}^{-1} \checkmark$ west/wes ✓

(5)

4.2.2

For ball/ Vir bal P: West as negative/ Wes as negatief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $\Delta p = m(v_{\text{Pf}} - v_{\text{Pi}})$ $= 0,16(-5 - 10) \checkmark$ $= -2,4$ $\therefore 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$ OR/OF West as positive / Wes as positief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $= m(v_{\text{Pf}} - v_{\text{Pi}})$ $= 0,16(5 - (-10)) \checkmark$ $= 2,4 \text{ N}\cdot\text{s} \checkmark$	POSITIVE MARKING FROM QUESTION 4.2.1 / POSITIEWE NASIEN VANAF VRAAG 4.2.1 For ball/ Vir bal Q: West as negative/ Wes as negatief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $= m(v_{\text{Qf}} - v_{\text{Qi}})$ $= 0,2[-3 - (-15)] \checkmark$ $= 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$ OR/OF West as positive / Wes as positief Impulse = Δp $F_{\text{net}} \Delta t = \Delta p$ $= m(v_{\text{Qf}} - v_{\text{Qi}})$ $= 0,16(3 - (15)) \checkmark$ $= -2,4 \text{ N}\cdot\text{s}$ $\therefore 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$
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(3)
[10]

QUESTION 5/ VRAAG 5

5.1

Marking criteria/Nasienriglyne

If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase. However, **IF**: The word “work” is omitted 0 marks
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
- 1 punt per woord/frase. Maar, **INDIEN**: Die woord “arbeid” uitgelaat is, 0 punte

A force is non-conservative if the work it does on an object (which is moving between two points) depends on the path taken. $\checkmark\checkmark$

'n Krag is nie-konserwatief indien die arbeid wat dit verrig (op 'n voorwerp wat tussen twee punte beweeg) afhanklik is van die pad.

OR/OF

A force is non-conservative if the work it does on an object depends on the path taken. $\checkmark\checkmark$

'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhanklik is van die pad.

OR/OF

A force is non-conservative if the work it does in moving an object around a closed path is non-zero. $\checkmark\checkmark$

'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg, nie-nul is nie.

(2)

5.2

$$\left. \begin{aligned} K &= \frac{1}{2} mv^2 / E_k = \frac{1}{2} mv^2 \\ \Delta K &= K_f - K_i \\ \Delta K &= \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2 \\ &= \frac{1}{2} m(v_f^2 - v_i^2) \\ &= \frac{1}{2} (200)(2^2 - 4^2) \checkmark \\ \Delta K &= -1\,200 \text{ J} \checkmark \end{aligned} \right\} \checkmark \text{ Any one / Enige een}$$

(3)

5.3

POSITIVE MARKING FROM QUESTION 5.2.

POSITIEWE NASIEN VANAF VRAAG 5.2.

Marking criteria/Nasienriglyne

- Appropriate formula/Geskikte formule ✓
- Substitution into appropriate formula together with/Vervanging in geskikte formule saam met $-3,40 \times 10^3$ ✓✓
- Final answer/Finale antwoord: 8,88 m ✓

OPTION 1/OPSIE 1

$$\begin{aligned} W_{nc} &= \Delta K + \Delta U \\ W_{nc} &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \quad \left. \begin{aligned} &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \\ &= \frac{1}{2}(200)(4^2 - 2^2) + (200)(9,8)(h - 10) \end{aligned} \right\} \checkmark \text{ Any one/Enige een} \\ -3,40 \times 10^3 &\checkmark = -1\,200 + 200(9,8)(h - 10) \checkmark \\ h &= 8,88 \text{ m } \checkmark \quad (8,87765 \text{ m}) \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned} E_{(\text{mech/meg})A} + W_f &= E_{(\text{mech})B} \\ (E_p + E_k)_A + W_f &= (E_p + E_k)_B \quad \left. \begin{aligned} &(mgh + \frac{1}{2}mv^2)_A + W_f = (mgh + \frac{1}{2}mv^2)_B \\ &200(9,8)(10) + \frac{1}{2}(200)(4^2) - 3,40 \times 10^3 \checkmark = 200(9,8)(h) + \frac{1}{2}(200)(2)^2 \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een} \\ h &= 8,88 \text{ m } \checkmark \quad (8,87755) \end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned} W_{net} &= \Delta K \\ W_f + W_w &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ W_f - \Delta E_p &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \left. \begin{aligned} &W_f - mg(h_f - h_i) = \frac{1}{2}m(v_f^2 - v_i^2) \\ &-3,40 \times 10^3 - 200(9,8)(h - 10) \checkmark = -1\,200 \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een} \\ h &= 8,88 \text{ m } \checkmark \quad (8,87755 \text{ m}) \end{aligned}$$

(4)

5.4

OPTION 1 AND 2/OPSIE 1 EN 2: Marking criteria /Nasienriglyne

- Appropriate formula/Geskikte formule ✓✓
- Work done by friction/Arbeid verrig deur wrywing ✓✓
- Substitution of/Vervanging van $(200)(9,8)(13,12)$ ✓
- Appropriate formula/Geskikte formule
- Substitution into power formula/Vervanging in drywingformule
- Final answer /Finale antwoord: 1 814,35 W

OPTION 1/OPSIE 1

$$\begin{aligned} W_{nc} &= \Delta K + \Delta U \\ W_{engine} + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \quad \left. \begin{aligned} &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \\ &W_{engine} + (50)(15)(2)\cos 180^\circ \checkmark \checkmark = 0 + 200(9,8)\checkmark(22 - 8,88) \end{aligned} \right\} \checkmark \checkmark \text{ Any one/Enige een} \\ W_{engine} &= 27\,215,20 \text{ J} \\ P_{engine} &= \frac{W_{engine}}{\Delta t} \\ &= \frac{27\,215,20}{15} \\ &= 1\,814,35 \text{ W} \end{aligned}$$

OPTION 2/OPSIE 2

$$\left. \begin{aligned} W_{\text{net}} &= \Delta K \\ W_N + W_{\text{engine}} + W_w + W_f &= 0 \\ W_N + W_{\text{engine}} - \Delta E_p + W_f &= 0 \end{aligned} \right\} \checkmark\checkmark \text{ Any one/Enige een}$$

$$0 + W_{\text{engine}} - (200)(9,8) \checkmark (13,12) + (50)(2)(15)\cos 180^\circ \checkmark\checkmark = 0$$

$$W_{\text{engine}} = 27\,215,20 \text{ J}$$

OR/OF

$$W_{\text{net}} = \Delta K \checkmark\checkmark$$

$$W_N + W_{\text{engine}} + W_{w\parallel} + W_f = 0$$

$$W_N + W_{\text{engine}} + mg\sin\theta\Delta x\cos 180^\circ + W_f = 0$$

$$0 + W_{\text{engine}} - (200)(9,8) \checkmark \left(\frac{13,12}{\Delta x} \right) \Delta x(-1) + (50)(2)(15)\cos 180^\circ \checkmark\checkmark = 0$$

$$W_{\text{engine}} = 27\,215,20 \text{ J}$$

$$P_{\text{engine}} = \frac{W_{\text{engine}}}{\Delta t}$$

$$= \frac{27\,215,20}{15}$$

$$= 1\,814,35 \text{ W}$$

OPTION/OPSIE 3: Marking criteria/Nasienriglyne Opsie 3

- Appropriate formula/Geskikte formule $\checkmark\checkmark$
- Substitution of/Vervanging van - 50 $\checkmark\checkmark$
- Substitution of/Vervanging van $(-200)(9,8)(0,4373)$ or/of $(-200)(9,8)(0,44) \checkmark$
- Appropriate formula/Geskikte formule
- Substitution into/Vervanging in $P_{\text{ave}} = Fv_{\text{ave}}$
- Final answer/Finale antwoord: 1 814,35 W - 1 824,8 W

OPTION 3/OPSIE 3

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ F_{\text{engine}} + F_{\text{friction}} + F_{g\parallel} &= 0 \end{aligned} \right\} \checkmark\checkmark \text{ Any one/Enige een}$$

$$F_{\text{engine}} + (-50) \checkmark\checkmark + (-200)(9,8) \checkmark (0,4373) = 0$$

$$F_{\text{engine}} = 906,52 \text{ N } (906,52 - 912,4)$$

$$P_{\text{ave}} = Fv_{\text{ave}}$$

$$P_{\text{ave}} = (908,52)(2)$$

$$= 1\,813,04 \text{ W } (1\,824,8 \text{ W})$$

OR/OF

$$W = F_{\text{engine}}\Delta x\cos\theta$$

$$= (906,52)(30)\cos 0^\circ$$

$$= 27\,195,6 \text{ J } (27\,372 \text{ W})$$

$$P = \frac{W}{\Delta t} = \frac{27\,195,6}{15} = 1\,813,04 \text{ W } \checkmark \quad (1\,824,8 \text{ W})$$

$$\sin\theta = \frac{h}{\Delta x}$$

$$= \frac{13,12}{2(15)}$$

$$= 0,4373$$

(5)
 [14]

QUESTION 6/VRAAG 6

6.1

Marking criteria/Nasienriglyne

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
 - 1 punt per woord/frase

The change in frequency✓ (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓

Die verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/OF

An (apparent) change in (observed/detected) frequency (pitch), as a result of the relative motion between a source and an observer (listener).

'n (Skynbare) verandering in (waargenome) frekwensie (toonhoogte), as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar.

(2)

6.2

Towards/Nader ✓

(1)

6.3

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v}{v - v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v}{v + v_s} f_s$$

$$3148 = \frac{340 + 0}{340 - v_s} f_s \quad \text{OR/OF} \quad 2073 = \frac{340 - 0}{340 + v_s} f_s$$

$$\frac{3148(340 - v_s)}{340 + 0} = \frac{2073(340 + v_s)}{340 - 0}$$

$$v_s = 70 \text{ m} \cdot \text{s}^{-1} \quad (69,95 - 70,16 \text{ m} \cdot \text{s}^{-1})$$

(6)

6.4

POSITIVE MARKING FROM QUESTION 6.3 **POSITIEWE NASIEN VANAF VRAAG 6.3**

OPTION 1/OPSIE 1

$$\Delta t = \frac{\Delta x}{v}$$

$$\Delta t = \frac{350}{70} \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

OPTION 2/OPSIE 2

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$350 = 70 \Delta t + 0 \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

OPTION 3/OPSIE 3

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$350 = \left(\frac{70 + 70}{2} \right) \Delta t \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

(2)

[11]

QUESTION 7/VRAAG 7

7.1

$$n = \frac{Q}{e} \checkmark$$
$$= \frac{(-) 4 \times 10^{-6}}{(-) 1,6 \times 10^{-19}} \checkmark$$
$$= 2,5 \times 10^{13} \checkmark \quad (3)$$

7.2 **Electrostatic force on B due to A:/Elektrostatiese krag op B a.g.v. A:**

$$F_{AB} = \frac{kQ_1Q_2}{r^2} \checkmark$$
$$= \left[\frac{9 \times 10^9 (4 \times 10^{-6})(3 \times 10^{-6})}{0,2^2} \right] \checkmark$$
$$= 2,7 \text{ N} \checkmark \quad (3)$$

Ignore negative signs
Ignoreer negatiewe tekens

7.3 **Marking criteria/Nasienriglyne**

If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
- 1 punt per woord/frase

Electric field is a region (in space) where (in which) an (electric) charge experiences a (electric) force. ✓✓
Elektriese veld is 'n gebied (in die ruimte) waarin 'n (elektriese) lading 'n (elektriese) krag ondervind. (2)

7.4

Marking criteria/Nasienriglyne

- Appropriate formula/*Geskikte formule* ✓
- Correct substitution for A and B/*Korrekte vervanging van A en B* ✓✓
- Subtraction of electric fields/*Aftrek van elektrieseveld*✓
- Final answer/*Finale antwoord*: $2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1}$ ✓

OPTION 1/OPSIE 1

Electric field at M due to / *Elektriese veld by M as gevolg van*: $-4 \times 10^{-6} \text{ C}$

$$E_{AM} = k \frac{Q}{r^2} \checkmark$$

$$= 9 \times 10^9 \frac{(4 \times 10^{-6})}{(0,3)^2} \checkmark$$

$$= 4,0 \times 10^5 \text{ N}\cdot\text{C}^{-1} \text{ (to left /links)}$$

Electric field at M due to / *Elektriese veld by M as gevolg van*: $+3 \times 10^{-6} \text{ C}$,

$$E_{BM} = k \frac{Q}{r^2}$$

$$= 9 \times 10^9 \frac{(3 \times 10^{-6})}{(0,1)^2} \checkmark$$

$$= 2,7 \times 10^6 \text{ N}\cdot\text{C}^{-1} \text{ (to right /regs)}$$

Net electric field at M / *Netto elektrieseveld by M*

$$E_{\text{net}} = E_{BM} + E_{AM}$$

$$= 4,0 \times 10^5 - 2,7 \times 10^6 \checkmark$$

$$= 2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1} \checkmark \text{ (right/regs)}$$

OR/OF

Net electric field at M / *Netto elektrieseveld by M*

$$E_{\text{net}} = E_{BM} + E_{AM}$$

$$= -4,0 \times 10^5 + 2,7 \times 10^6 \checkmark$$

$$= -2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1}$$

$$= 2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1} \checkmark \text{ (right)}$$

OPTION 2/OPSIE 2

$$F_{AM} = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(4 \times 10^{-6})Q}{(0,3)^2} \checkmark = 4 \times 10^5 Q \text{ N}$$

$$F_{BM} = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(3 \times 10^{-6})Q}{(0,1)^2} \checkmark = 2,7 \times 10^6 Q \text{ N}$$

$$F_{\text{net}} = 2,7 \times 10^6 Q + (-4 \times 10^5 Q) \checkmark = 2,3 \times 10^6 Q$$

$$E = \frac{F}{q} \checkmark = \frac{2,3 \times 10^6 Q}{Q} = 2,3 \times 10^6 \text{ N}\cdot\text{C}^{-1} \checkmark \text{ (right/regs)}$$

(5)

7.5 Positive/Positief ✓

(1)

7.6

POSITIVE MARKING FROM 7.2/POSITIEWE NASIEN VANAF 7.2

Marking criteria/Nasienriglyne

- Correct substitution into Pythagoras's equation/Korrekte vervanging in Pythagoras se vergelyking ✓
- Correct substitution into Coulomb's Law/Korrekte vervanging in Coulomb se wet ✓
- Correct answer/Korrekte antwoord ✓

$$(F_{\text{net}})^2 = (F_{\text{AD}})^2 + (F_{\text{AB}})^2$$

$$(7,69)^2 = (F_{\text{AD}})^2 + (2,7)^2 \quad \checkmark$$

$$F_{\text{AD}} = 7,2 \text{ N}$$

$$F_{\text{AD}} = \frac{kQ_1Q_2}{r^2}$$

$$7,2 = \frac{(9 \times 10^9)(4 \times 10^{-6})Q}{(0,15)^2} \quad \checkmark$$

$$Q_D = 4,5 \times 10^{-6} \text{ C} \quad \checkmark$$

OR/OF

$$F_{\text{AD}} = k \frac{Q_1Q_2}{r^2}$$

$$= 9 \times 10^9 \frac{(4 \times 10^{-6})Q}{0,15^2} \quad \checkmark$$

$$= 1,6 \times 10^6 Q$$

$$F_{\text{net}} = \sqrt{F_{\text{AB}}^2 + F_{\text{AD}}^2} \quad \text{OR/OF} \quad F_{\text{net}}^2 = F_{\text{AB}}^2 + F_{\text{AD}}^2$$

$$7,69 = \sqrt{2,7^2 + (1,6 \times 10^6 Q)^2} \quad \checkmark$$

$$Q = 4,50 \times 10^{-6} \text{ C} \quad \checkmark$$

(3)
[17]

QUESTION 8/VRAAG 8

8.1

Marking criteria/Nasienriglyne

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:
 - 1 punt per woord/frase

(Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it. ✓✓

(Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheidslading wat daardeur beweeg.

Work done by the battery to move a unit coulomb of charge across the circuit. / Arbeid verrig deur die battery om 'n eenheidslading oor die stroombaan te beweeg.

(2)

8.2

Energy (per coulomb of charge) is converted to heat in the battery due to the internal resistance. ✓✓

Energie (per coulomb lading) word na hitte omskep binne-in die battery a.g.v. interne weerstand.

(2)

8.3.1

$$I = \frac{V}{R} \checkmark$$

$$I = \frac{1,5}{0,5} \checkmark$$

$$= 3 \text{ A} \checkmark$$

(3)

8.3.2

OPTION 1/OPSIE 1

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$$

$$\frac{1}{R_p} = \frac{1}{25} + \frac{1}{15} \checkmark$$

$$R_p = 9,375 \Omega$$

$$R_{\text{ext}} = 9,375 + 4 \checkmark = 13,38 \Omega \checkmark$$

(13,375 Ω)

OPTION 2/OPSIE 2

$$R_p = \frac{R_1 R_2}{R_1 + R_2} \checkmark$$

$$R_p = \frac{(25)(15)}{25+15} \checkmark$$

$$R_p = 9,375 \Omega$$

$$R_{\text{ext}} = 9,375 + 4 \checkmark = 13,38 \Omega \checkmark$$

(13,375 Ω)

(4)

8.3.3

POSITIVE MARKING FROM QUESTIONS 8.3.1 AND 8.3.2.
POSITIEWE NASIEN VANAF VRAAG 8.3.1 EN 8.3.2.

OPTION 1/OPSIE 1

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ &= 3(13,38 + 0,5) \checkmark \\ &= 41,64 \text{ V} \checkmark \quad (\text{Range/Gebied: } 41,625 - 41,64)\end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}\mathcal{E} &= V_{\text{ext/eks}} + V_{\text{int}} \checkmark \\ &= (3)(13,38) + 1,5 \checkmark \\ &= 41,64 \text{ V} \checkmark \quad (\text{Range/Gebied: } 41,625 - 41,64)\end{aligned}$$

(3)

8.4 Yes. $\checkmark$ /Ja

For the same voltage/potential difference, $\checkmark$

a larger current will flow through a smaller resistor ($I = \frac{V}{R}$) $\checkmark$

Vir dieselfde spanning/ potensiaalverskil

sal 'n groter stroom deur die kleiner weerstand vloei ($I = \frac{V}{R}$).

OR/OF

$$I \propto \frac{1}{R} \checkmark, V = \text{constant /konstant} \checkmark$$

I is inversely proportional to R and V is constant.

I is omgekeerd eweredig aan R en V is konstant.

OR/OF

$$\begin{aligned}V_{\parallel} &= IR \\ &= (3)(9,38) \\ &= 28,14 \text{ V}\end{aligned}$$

$$I_{R2} = \frac{V}{R} = \frac{28,14}{25} = 1,13 \text{ A} \checkmark$$

$$I_{R3} = \frac{V}{R} = \frac{28,14}{15} = 1,88 \text{ A} \checkmark$$

OR/OF

V is the same / V is dieselfde $\checkmark$

$$\left. \begin{aligned}I_{15\Omega} &= \frac{25}{40} I \\ I_{25\Omega} &= \frac{15}{40} I\end{aligned} \right\} \checkmark$$

(3)

8.5 Remains the same/Bly dieselfde $\checkmark$

(1)

[18]

QUESTION 9/VRAAG 9

9.1.1 (DC) motor/(GS-)motor ✓ (1)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1**

POSITIEWE NASIEN VANAF VRAAG 9.1.1

Electrical to mechanical /kinetic (energy) ✓✓ (2 or 0)

Elektriese na meganiese/kinetiese (energie) (2 of 0) (2)

9.1.3 Split ring/commutator/Splitring/kommutator ✓ (1)

9.1.4 Anticlockwise/antikloksgewys ✓✓ (2)

9.2.1 (The rms voltage/value of AC is) the AC voltage/potential difference which dissipates the same amount of energy/heat/power as an equivalent DC voltage/potential difference. ✓✓ (2 or 0)

(Die wgk-waarde van WS is) die WS-potensiaalverskil/spanning wat dieselfde hoeveelheid energie/hitte/drywing verbruik as 'n ekwivalente GS-spanning/potensiaalverskil. (2 of 0)

ACCEPT/AANVAAR

The rms voltage/value of AC is the DC potential difference which dissipates the same amount of energy/heat/power as AC.

Die wgk-waarde van WS is die GS-potensiaalverskil wat dieselfde hoeveelheid energie/hitte/drywing verbruik as die WS. (2)

9.2.2 **Marking criteria/Nasienriglyne**

- Appropriate formula for P_{ave} /Gesikte formule vir P_{ave} ✓
- Substitution to calculate/Vervanging vir berekening van R ✓
- Final answer/Finale antwoord: 242Ω ✓

<u>OPTION 1/OPSIE 1</u>	<u>OPTION 2/OPSIE 2</u>	<u>OPTION 3/OPSIE 3</u>
$P_{ave} = \frac{V_{rms}^2}{R} \checkmark$ $200 = \frac{220^2}{R} \checkmark$ $R = 242 \Omega \checkmark$	$P_{ave} = V_{rms} I_{rms} \checkmark$ $200 = I_{rms} (220)$ $I_{rms} = 0,909 \text{ A (0,91)}$ $R = \frac{V_{rms}}{I_{rms}} \text{ or/of } R = \frac{V}{I}$ $R = \frac{220}{0,909} \checkmark$ $R = 242 \Omega \checkmark (241,76 \Omega)$	$P_{ave} = V_{rms} I_{rms} \checkmark$ $200 = I_{rms} (220)$ $I_{rms} = 0,909 \text{ A (0,91)}$ $P_{ave} = I_{rms}^2 R$ $200 = (0,909)^2 R \checkmark$ $R = 242 \Omega \checkmark$ $(241,52 \Omega)$

(3)

9.2.3

Marking criteria for options 1,2 and 3 /Nasienriglyne vir opsies 1,2 en 3

- Appropriate formula to calculate P or I_{rms} /Geskikte formule om P of I_{rms} te bereken ✓
- Substitution/Vervanging ✓
- Formula for P or W containing Δt /Formule vir P of W wat Δt bevat ✓
- Substitution/Vervanging ✓
- Final answer/Finale antwoord: 55 785,12 J ✓

POSITIVE MARKING FROM QUESTION 9.2.2.

POSITIEWE NASIEN VANAF VRAAG 9.2.2.

OPTION 1/OPSIE 1

Marking criteria / Nasienriglyne

- Appropriate formula for W containing V/Geskikte formule vir W wat V bevat ✓✓
- Substitution/Vervanging ✓✓
- Final answer/Finale antwoord: 55 785,12 J ✓

$$W = \frac{V^2 \Delta t}{R} \checkmark \checkmark$$

$$= \frac{(150^2)(10 \times 60)}{242} \checkmark$$

$$= 55\,785,12 \text{ J} \checkmark$$

OPTION 2/OPSIE 2

$$P_{ave} = \frac{V_{rms}^2}{R} \checkmark$$

$$= \frac{150^2}{242} \checkmark$$

$$P_{av} = 92,975 \text{ W}$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$92,975 = \frac{W}{(10)(60)} \checkmark$$

$$W = 55\,785,12 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

OPTION 3/OPSIE 3

$$R = \frac{V_{rms}}{I_{rms}} \checkmark / R = \frac{V}{I}$$

$$242 = \frac{150}{I_{rms}} \checkmark$$

$$I_{rms} = 0,620 \text{ A}$$

$$P_{ave} = I_{rms} V_{rms}$$

$$= (0,62)(150)$$

$$= 92,97 \text{ W (93 W)}$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$92,975 = \frac{W}{(10)(60)} \checkmark$$

$$W = 55\,785,12 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

OPTION 4/OPSIE 4

$$R = \frac{V_{rms}}{I_{rms}} \checkmark / R = \frac{V}{I}$$

$$242 = \frac{150}{I_{rms}} \checkmark$$

$$I_{rms} = 0,620 \text{ A}$$

$$W = I^2 R \Delta t \checkmark$$

$$= (0,62)^2 (242)(10)(60) \checkmark$$

$$= 55\,814,88 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

OR/OF

$$W = VI \Delta t$$

$$= (150)(0,62)(600)$$

$$= 55\,800 \text{ J}$$

OPTION 5/OPSIE 5

$$P_{ave} = \frac{V_{rms}^2}{R} \checkmark = \frac{150^2}{242} \checkmark = 92,975 \text{ W}$$

$$P_{ave} = I_{rms}^2 R$$

$$92,975 = I_{rms}^2 (242)$$

$$I_{rms} = 0,6198 \text{ A}$$

$$W = I^2 R \Delta t \checkmark$$

$$= (0,6198)^2 (242)(10)(60) \checkmark$$

$$= 55\,778,88 \text{ J} \checkmark$$

(5)
 [16]

QUESTION 10/VRAAG 10

10.1 Photoelectric effect/Fotoëlektriese effek ✓ (1)

10.2 Work function (of potassium)/Werksfunksie/Arbeidsfunksie (van kalium) ✓ (1)

10.3 Potassium/Kalium ✓
 It has the lowest work function / threshold frequency / highest threshold wavelength. ✓
 Dit het die laagste arbeidsfunksie / drumpelfrekwensie / hoogste drumpel golflengte. (2)

10.4 **Marking criteria/Nasienriglyne**
 If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.
 Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
 1 punt per woord/frase

The work function of a metal is the minimum energy that an electron (in the metal) needs✓ to be emitted/ejected from the metal / surface. ✓
 Die werksfunksie/arbeidsfunksie van 'n metaal is die minimum energie benodig om 'n elektron vanaf 'n oppervlak / metaal vry te stel. (2)

10.5.1 $W_o = hf_o$ ✓
 $= (6,63 \times 10^{-34})(1,75 \times 10^{15})$ ✓
 $= 1,160 \times 10^{-18} \text{ J}$ ✓

OR/OF

$E = W_o + E_{k(\max)}$ } ✓ Any one / Enigeen
 $hf = W_o + E_{k(\max)}$ }
 $(6,63 \times 10^{-34})(1,75 \times 10^{15}) = W_o + 0$ ✓
 $W_o = 1,160 \times 10^{-18} \text{ J}$ ✓ (3)

10.5.2 **POSITIVE MARKING FROM QUESTION 10.5.1.**
POSITIEWE NASIEN VANAF VRAAG 10.5.1.

$E = W_o + E_{k(\max)}$ } ✓ Any one/Enige een
 $hf = hf_o + \frac{1}{2}mv_{\max}^2$ }
 $(6,63 \times 10^{-34})f$ ✓ $= \frac{1,160 \times 10^{-18}}{2} + \frac{1}{2} (9,11 \times 10^{-31}) (5,60 \times 10^5)^2$ ✓
 $\therefore f = 1,97 \times 10^{15} \text{ Hz}$ ✓ (4)

[13]

TOTAL/TOTAAL: 150



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Consider the statement below.

The perpendicular force exerted by a surface on an object in contact with the surface.

Which ONE of the following forces is defined by the statement above?

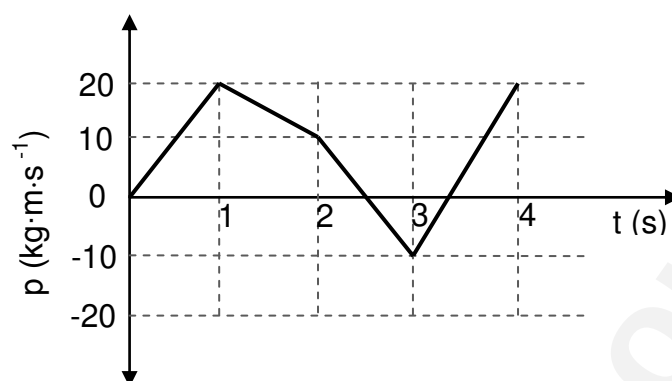
- A Normal force
- B Resultant force
- C Frictional force
- D Gravitational force (2)

1.2 Two balls of masses m and $2m$ are dropped simultaneously from the same height above the ground. Ignore air resistance.

When the balls strike the ground, which ONE of the following physical quantities will be the same for both balls?

- A Weight
- B Velocity
- C Momentum
- D Kinetic energy (2)

- 1.3 The graph below shows how the momentum (p) of an object changes with time (t).



During which ONE of the following time intervals, measured in seconds, is the magnitude of the net force acting on the object the greatest?

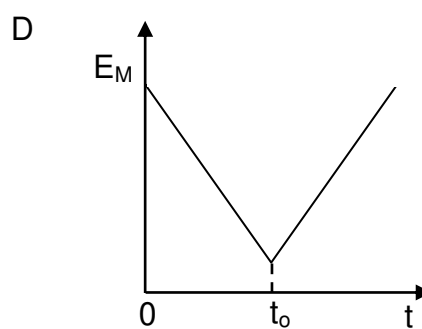
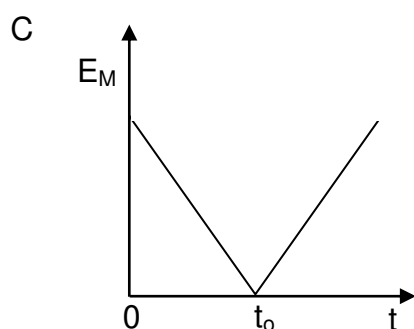
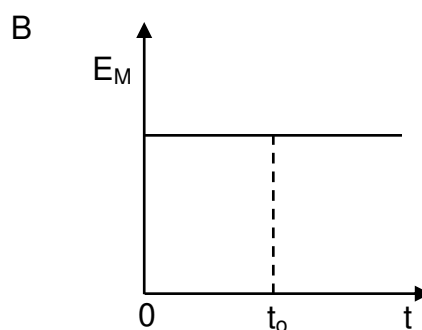
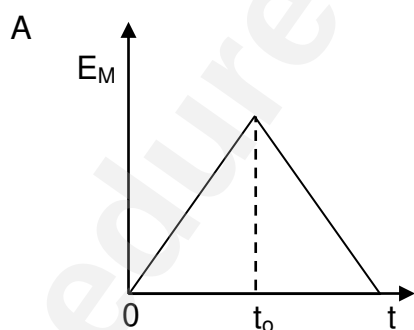
- A 0 to 1
- B 1 to 2
- C 2 to 3
- D 3 to 4

(2)

- 1.4 A ball is dropped from a height above a floor. The ball makes an elastic collision with the floor at time t_0 and bounces vertically upwards.

Ignore air resistance.

Which ONE of the following graphs shows how the total mechanical energy (E_M) of the ball changes with time?



(2)

1.5 Consider the two spectrum diagrams below.



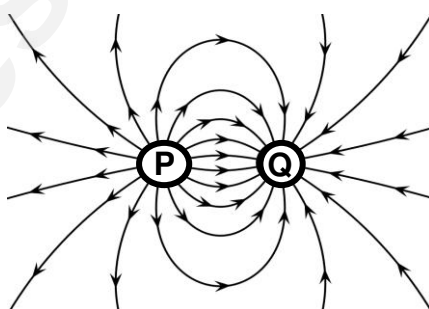
Diagram 1 represents the spectrum of an element in a laboratory on Earth.

Diagram 2 represents the spectrum of the same element from a distant star as observed from Earth.

Which ONE of the following can be deduced from the spectra above?

- A The star is moving towards Earth.
- B The star is at rest relative to Earth.
- C The star is moving away from Earth.
- D Both the star and Earth are moving towards each other. (2)

1.6 The diagram below shows the field lines for the combined electric field due to two small charged spheres **P** and **Q**.



Which ONE of the combinations below correctly shows the polarity of spheres **P** and **Q**?

	SPHERE P	SPHERE Q
A	Negative	Positive
B	Negative	Negative
C	Positive	Positive
D	Positive	Negative

(2)

- 1.7 Two identical spheres, **P** and **Q**, carry charges of $+q$ and $-2q$ respectively. Sphere **P** exerts an electrostatic force of magnitude F on sphere **Q**.

Which ONE of the following represents the magnitude of the electrostatic force exerted on sphere **P** by sphere **Q**?

A $\frac{1}{2}F$

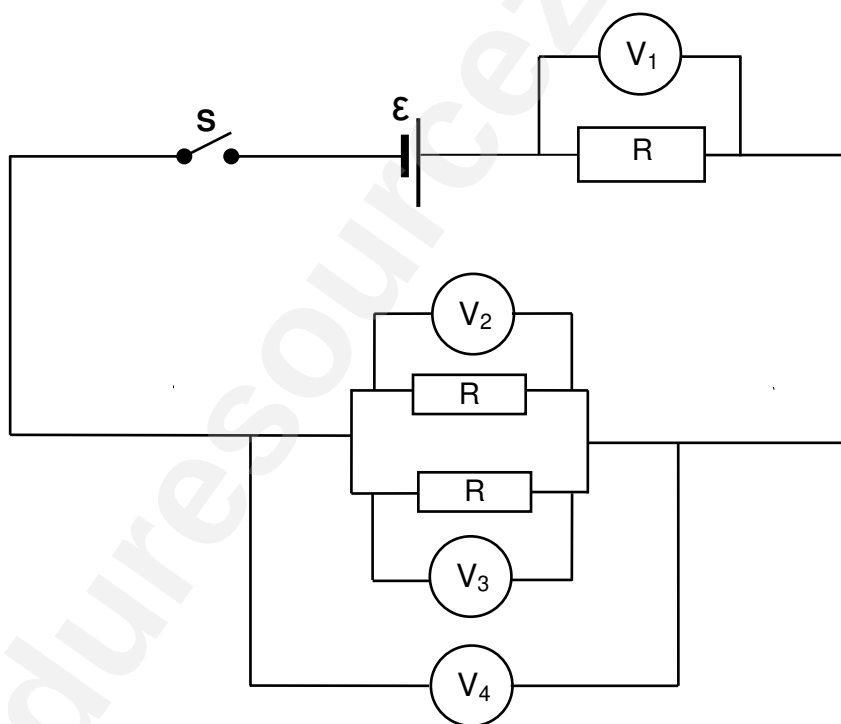
B F

C $2F$

D $4F$

(2)

- 1.8 In the circuit diagram shown below all the resistors are IDENTICAL. Ignore the internal resistance of the cell.



Which voltmeter will have the HIGHEST reading when switch **S** is closed?

A V_1

B V_2

C V_3

D V_4

(2)

1.9 In which ONE of the following electrical machines is electrical energy converted to mechanical energy?

- A AC generator
- B DC generator
- C AC dynamo
- D DC motor

(2)

1.10 Which ONE of the following combinations correctly links an emission spectrum and an absorption spectrum to the energy transitions of an electron in an atom?

	EMISSION SPECTRUM	ABSORPTION SPECTRUM
A	From low to high energy levels	From high to low energy levels
B	From low to high energy levels	From low to high energy levels
C	From high to low energy levels	From high to low energy levels
D	From high to low energy levels	From low to high energy levels

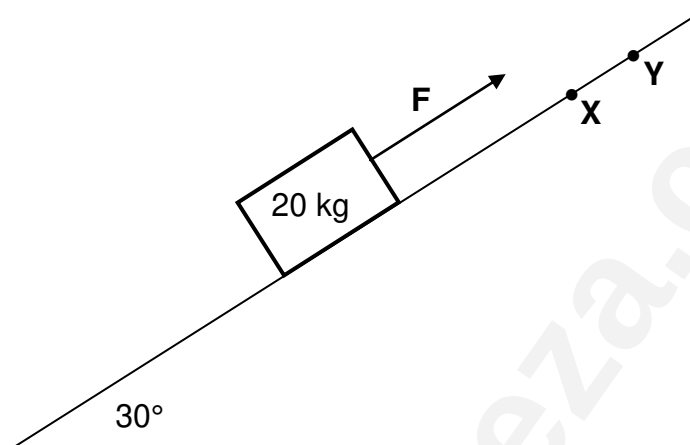
(2)

[20]

QUESTION 2 (Start on a new page.)

A 20 kg block is placed on a rough surface inclined at 30° to the horizontal. A constant force **F**, acting parallel to the surface, is applied on the block so that the block moves up the incline at a CONSTANT VELOCITY of $2 \text{ m}\cdot\text{s}^{-1}$. Refer to the diagram below.

A constant kinetic frictional force of 18 N acts on the block.



- 2.1 State *Newton's First Law* in words. (2)
- 2.2 Draw a labelled free-body diagram for the block. (4)
- 2.3 Calculate the magnitude of force **F**. (4)

Force **F** is removed when the block reaches point **X** on the surface. The block continues to move up the surface and comes to rest momentarily at point **Y**.

Assume that the kinetic frictional force acting on the block remains at 18 N as it moves from point **X** to point **Y**.

- 2.4 Write down the net force acting on the block as it moves from **X** to **Y**. (2)
- 2.5 Calculate the distance between points **X** and **Y**. (4)

[16]

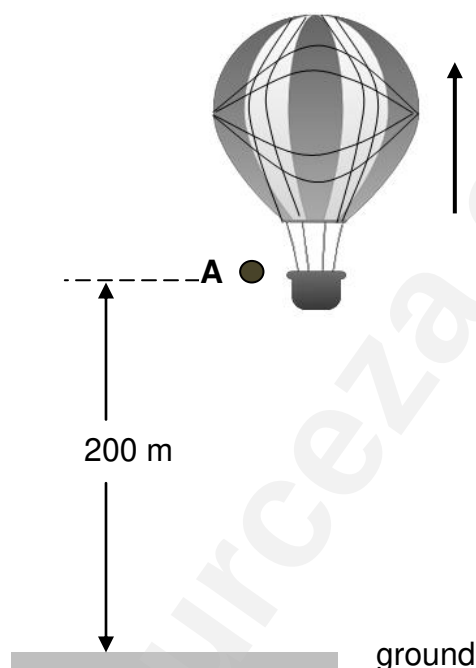
QUESTION 3 (Start on a new page.)

A hot-air balloon is moving upwards at a **CONSTANT UNKNOWN** speed.

3.1 Is the hot air balloon in free fall? Choose from YES or NO.

Give a reason for the answer.

(2)



When the balloon is 200 m above the ground, a small stone **A** is dropped from the balloon. See the diagram above. Another small stone **B** is dropped 5 s later from the balloon while the balloon is still moving upwards at constant velocity.

Stone **A** strikes the ground at a speed of $62,68 \text{ m} \cdot \text{s}^{-1}$.

Ignore air resistance.

3.2 Calculate the:

3.2.1 Speed of the hot air balloon (3)

3.2.2 Time it takes stone **A** to strike the ground (3)

3.2.3 Distance between the hot-air balloon and stone **B** at the instant when stone **A** strikes the ground (6)

3.3 On the same set of axes, draw position-time graphs for both the hot-air balloon and stone **A** from the moment the stone is dropped until it strikes the ground.

Use the ground as zero reference.

Label your graphs **BALLOON** and **A**.

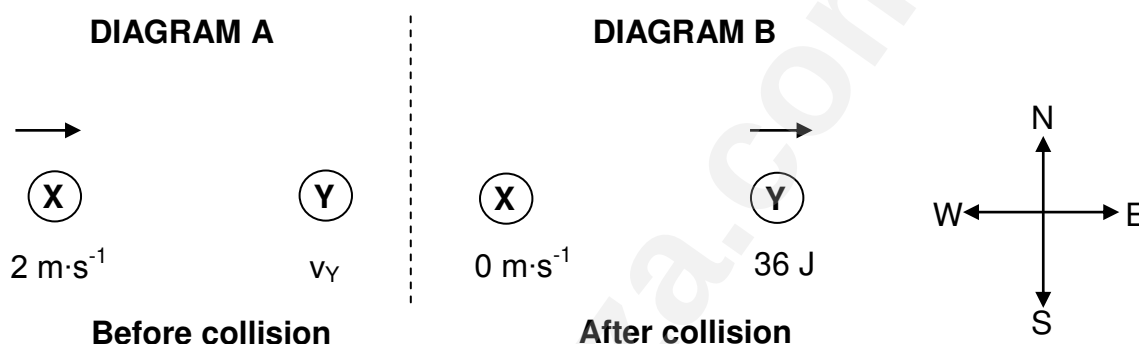
(4)

[18]

QUESTION 4 (Start on a new page.)

A ball **X**, of mass 10 kg, is moving eastwards with a velocity of $2 \text{ m}\cdot\text{s}^{-1}$. It collides ELASTICALLY with another ball, **Y**, of mass 2 kg which was moving with an unknown velocity v_Y (Diagram **A**). Immediately after the collision, ball **X** comes to rest and ball **Y** moves eastwards with a kinetic energy of 36 J (Diagram **B**).

Ignore friction.



4.1 Explain the meaning of the term *elastic collision*. (2)

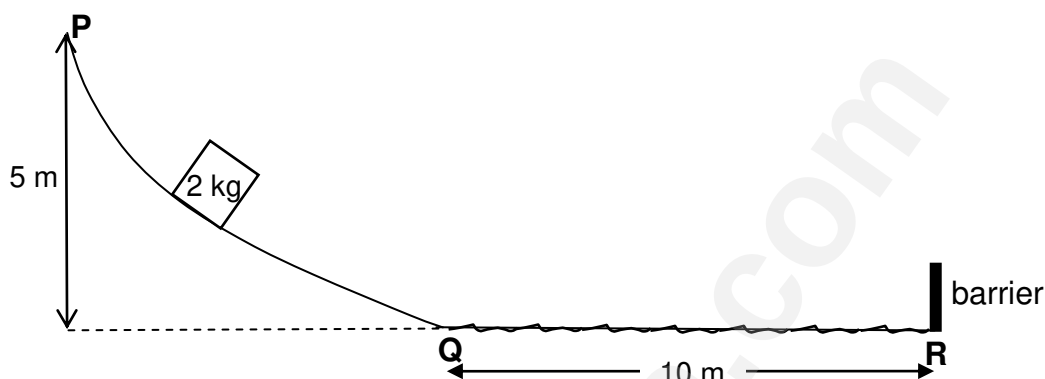
4.2 Calculate velocity v_Y . (5)

The balls were in contact with each other for 0,1 s during the collision.

4.3 Calculate the magnitude of the force that ball **X** exerted on ball **Y** during the collision. (3)
[10]

QUESTION 5 (Start on a new page.)

A 2 kg box is released from rest at point **P**, 5 m above the ground. It slides down a smooth frictionless curved track **PQ**. See the diagram below.



5.1 State the *principle of conservation of mechanical energy* in words. (2)

5.2 Use the PRINCIPLE OF CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the box when it reaches point **Q**. (3)

The box passes point **Q** and moves 10 m on a rough horizontal surface before striking a barrier at point **R** at a speed of $4 \text{ m}\cdot\text{s}^{-1}$.

5.3 Use ENERGY PRINCIPLES to calculate the magnitude of the average frictional force acting on the box as it moves from **Q** to **R**. (4)

The barrier exerts an impulse of $14 \text{ N}\cdot\text{s}$ to the LEFT on the box when the box strikes the barrier.

5.4 Calculate the change in kinetic energy of the box after striking the barrier. (5)
[14]

QUESTION 6 (Start on a new page.)

The siren of a stationary ambulance emits sound waves at a constant frequency of 680 Hz. A man is standing with a detector that records the wavelength of the sound emitted by the siren, as shown in the diagram below.



The speed of sound in air is $340 \text{ m}\cdot\text{s}^{-1}$.

6.1 Calculate the wavelength of the detected sound. (3)

The ambulance now moves at a constant speed along the road TOWARDS the man. The detector now records the wavelength of the sound, which differs from the previous reading by 0,05 m.

6.2 State the Doppler effect. (2)

6.3 How would EACH of the following have changed when the ambulance approached the detector compared to when the ambulance was stationary?

Choose from INCREASED, DECREASED or NO CHANGE.

6.3.1 Distance between the wave fronts (1)

6.3.2 Frequency of the detected waves (1)

6.4 Calculate the speed of the ambulance. (5)
[12]

QUESTION 7 (Start on a new page.)

7.1 A small neutral sphere acquires a charge of $-1,95 \times 10^{-6} \text{ C}$.

7.1.1 Were electrons ADDED TO or REMOVED FROM the sphere? (1)

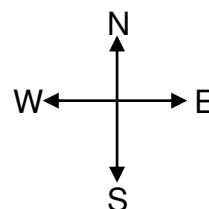
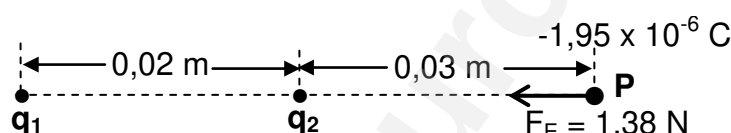
7.1.2 Calculate the number of electrons which were added or removed. (3)

7.1.3 Define the term *electric field at a point*. (2)

7.1.4 Calculate the magnitude of the electric field at a point 0,5 m from the centre of the charged sphere. (3)

7.2 Two point charges, q_1 and q_2 , are fixed 0,02 m apart. The magnitude of charges q_1 and q_2 is the same and q_1 is NEGATIVELY charged.

The small charged sphere with the charge of $-1,95 \times 10^{-6} \text{ C}$ is placed at point **P**, 0,03 m east of charge q_2 , as shown in the diagram below. The sphere at point **P** experiences a net electrostatic force of 1,38 N west.



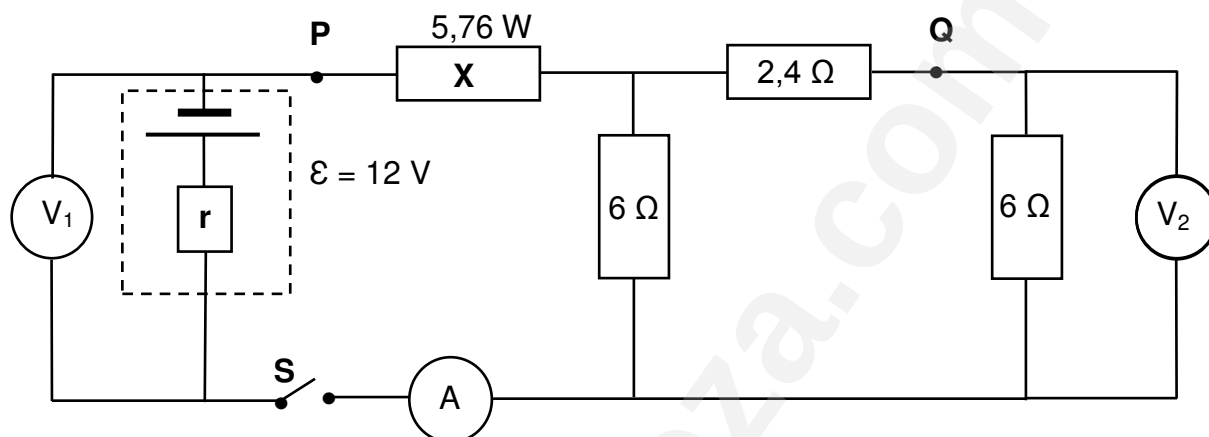
Calculate the magnitude of the charge on q_2 .

(5)
[14]

QUESTION 8 (Start on a new page.)

The battery in the circuit shown below has an emf of 12 V and an unknown internal resistance r .

The resistance of the connecting wires and the ammeter is negligible.



Switch **S** is OPEN.

8.1 Write down the reading on:

8.1.1 Voltmeter V_1 (1)

8.1.2 Voltmeter V_2 (1)

Switch **S** is now CLOSED.

The reading on the ammeter is 1,2 A and the power dissipated in resistor **X** is 5,76 W.

8.2 Define the term *power*. (2)

Calculate the:

8.3 Resistance of resistor **X** (3)

8.4 Total EXTERNAL resistance of the circuit (3)

8.5 Reading on voltmeter V_2 (5)

A length of wire of negligible resistance is used to connect point **P** to point **Q** in the circuit.

8.6 How will the reading on voltmeter V_1 be affected?

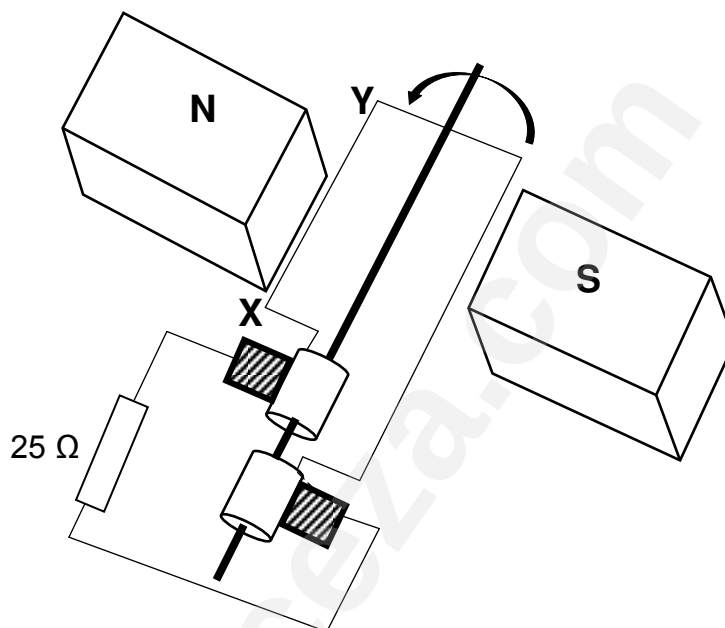
Choose from INCREASES, DECREASES or NO EFFECT.

Explain the answer.

(4)
[19]

QUESTION 9 (Start on a new page.)

A simplified diagram of an AC generator connected to a $25\ \Omega$ resistor is shown below. The coil rotates anticlockwise.

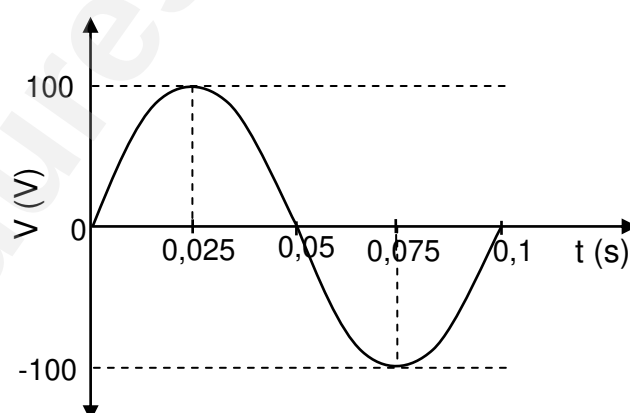


9.1 Name the component that distinguishes this generator from a DC generator. (1)

9.2 In which direction will the induced current flow in section **XY** of the coil?

Choose from **X to Y** OR **Y to X**. (2)

The graph below shows the output voltage of the generator for one cycle of rotation of the coil.



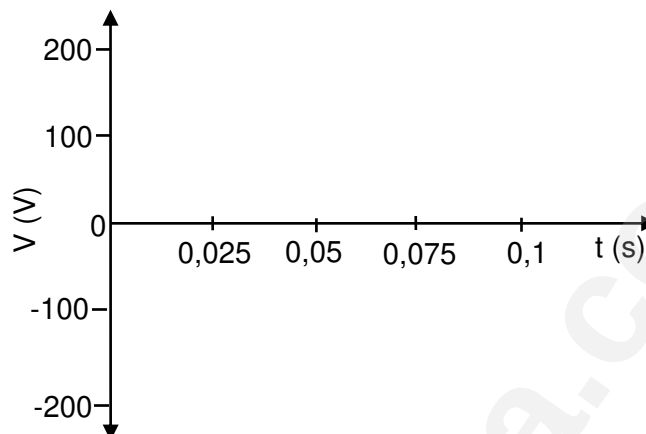
9.3 Define the term *rms potential difference*. (2)

9.4 Calculate the rms current in the circuit. (4)

9.5 Calculate the average power dissipated in the $25\ \Omega$ resistor. (3)

The speed of rotation of the coil in the generator is now DOUBLED.

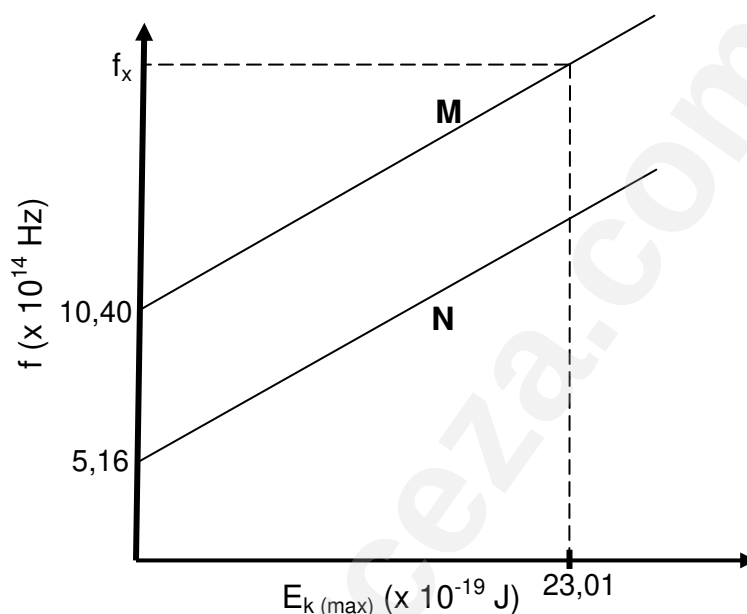
- 9.6 Copy the set of axes below in your ANSWER BOOK and sketch the graph of output voltage versus time for 0,1 s.



(3)
[15]

QUESTION 10 (Start on a new page.)

The relationship between frequency (f) and maximum kinetic energy ($E_{k(\max)}$) of photoelectrons emitted from two cathodes, **M** and **N**, of different photoelectric cells is investigated. The graphs below have been obtained from the results.



- 10.1 Define the term *threshold frequency*. (2)
- 10.2 How does the maximum kinetic energy of photoelectrons emitted from cathode **N** compare to the maximum kinetic energy of those emitted from cathode **M** when light of a frequency greater than $10,40 \times 10^{14}$ Hz is shone on each of the cathodes? (2)
- Choose from GREATER THAN, SMALLER THAN or EQUAL TO.
- 10.3 Calculate the value of frequency f_x indicated on the graph. (5)
- 10.4 The experiment is now repeated for cathode **M** using light of frequency f_x , but of higher intensity. How will EACH of the following be affected? (1)
- Choose from INCREASES, DECREASES or NO EFFECT.
- 10.4.1 The y-intercept of the graph (1)
- 10.4.2 The number of photoelectrons emitted per unit time (1)
- 10.4.3 The maximum kinetic energy of the emitted photoelectrons (1)
- [12]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$ / $P_{\text{gemid}} = F v_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or $E = W_0 + K_{\text{max}}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ / $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	
$E = W_0 + E_{k(\text{maks})}$ of $E = W_0 + K_{\text{maks}}$ waar $E = hf$ en $W_0 = hf_0$ en $E_{k(\text{maks})} = \frac{1}{2} mv_{\text{maks}}^2$ / $K_{\text{maks}} = \frac{1}{2} mv_{\text{maks}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ε) = $I(R + r)$ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

NOVEMBER 2021

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**This marking guidelines consists of 26 pages.
Hierdie nasienriglyne bestaan uit 26 bladsye.**

QUESTION 1/VRAAG 1

- 1.1 A ✓✓ (2)
- 1.2 B ✓✓ (2)
- 1.3 D ✓✓ (2)
- 1.4 B ✓✓ (2)
- 1.5 C ✓✓ (2)
- 1.6 D ✓✓ (2)
- 1.7 B or/of F ✓✓ (2)
- 1.8 A or/of V_1 ✓✓ (2)
- 1.9 D ✓✓ (2)
- 1.10 D ✓✓ (2)
- [20]**

QUESTION 2/VRAAG 2

2.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. /Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force/unbalanced force acts on it. ✓✓

'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.

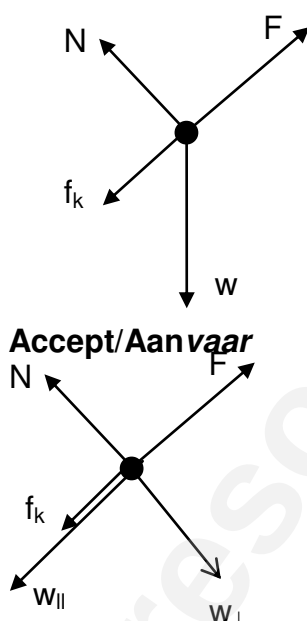
OR/OF

A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net /unbalanced force acts on it. ✓✓

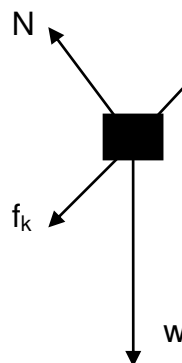
'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto/ongebalanseerde krag daarop inwerk.

(2)

2.2



Accept force diagram/ Aanvaar kragtediagram



Accepted labels/Aanvaarde benoemings	
w	F_g / F_w / weight / mg / 196 N / gravitational force F_g / F_w / gewig / mg / 196 N / gravitasiekrag
F	F_A / Applied force F_T / Toegepaste krag
f_k	(kinetic) Friction / (kineties)wrywing / F_f / f / 18 N / F_w / f_w
N	F_N / Normal / Normaal / 169,74 N

Notes/Aantekeninge:

- Mark awarded for label and arrow, but penalise only once if arrows are omitted /Punt toegeken vir benoeming en pyltjie, maar penaliseer slegs een keer indien pyle uitgelaat is.
- Do not penalise for length of arrows, drawing is not to scale. /Moenie vir die lengte van die pyltjies penaliseer nie, die tekening is nie volgens skaal nie.
- Any other additional force(s) deduct 1 mark. / Enige ander addisionele krag(te) trek 1 punt af.
- If force(s) do not make contact with body deduct 1 mark. /Indien krag(te) nie met die voorwerp kontak maak nie, trek 1 punt af.

(4)

2.3

OPTION 1/OPSIE 1

Positive up the incline/Positief opwaarts teen skuinsvlak

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ F + f_k + w_{\parallel} &= ma \\ F + (-f_k) + (-w_{\parallel}) &= ma \\ F - (f_k + w_{\parallel}) &= ma \\ F - [18 + (20)(9,8)(\sin 30^\circ)] &= 0 \checkmark \\ F &= 116 \text{ N} \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

NOTE/LET WEL

$$\begin{aligned} F_{\text{net}} &= 0 \checkmark \checkmark \\ F &= f_k + w_{\parallel} \checkmark \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

Positive up the incline/Positief opwaarts teen skuinsvlak

$$\begin{aligned} W_{\text{net}} &= \Delta E_k \checkmark \\ F\Delta x \cos 0^\circ + f\Delta x \cos 180^\circ + w\Delta x \cos 120^\circ &= 0 \checkmark \\ F\Delta x &= 18\Delta x + (20)(9,8)\Delta x(0,5) \\ F &= 116 \text{ N} \checkmark \end{aligned}$$

NOTE/LET WEL

$$\begin{aligned} W_{\text{net}} &= 0 \checkmark \checkmark \\ F\Delta x &= f\Delta x + w\Delta x(0,5) \checkmark \checkmark \end{aligned}$$

(4)

2.4

POSITIVE MARKING FROM QUESTION 2.3 /

POSITIEWE NASIEN VANAF VRAAG 2.3

116 N / $f + w_{\parallel} \checkmark$ Down the incline/opposite to direction of motion / Teen die helling af / in teenoorgestelde rigting van beweging $\checkmark$

ACCEPT/AANVAAR:

Downwards/down/Afwaarts/af

(2)

2.5

POSITIVE MARKING FROM QUESTION 2.4 /

POSITIEWE NASIEN VANAF VRAAG 2.4

OPTION 1/OPSIE 1

Up the incline positive/Teen skuinsvlak op positief

$$\begin{aligned} F_{\text{net}} &= ma \\ -116 &= 20a \checkmark \\ a &= -5,80 \text{ m} \cdot \text{s}^{-2} \end{aligned}$$

$$\begin{aligned} v_f^2 &= v_i^2 + 2a\Delta x \checkmark \\ 0 &= (2)^2 + (2)(-5,8)\Delta x \checkmark \\ \Delta x &= 0,34 \text{ m} \checkmark \end{aligned}$$

$$\begin{aligned} v_f &= v_i + \Delta t \\ 0 &= 2 + (-5,8)\Delta t \\ \Delta t &= 0,34 \text{ s} \end{aligned}$$

OR/OF

$$\begin{aligned} F_{\text{net}}\Delta t &= m(v_f - v_i) \\ (-116)\Delta t &= (20)(0 - 2) \\ \Delta t &= 0,34 \text{ s} \end{aligned}$$

$$\begin{aligned} \Delta x &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark \\ &= \frac{(2)(0,34) + \frac{1}{2}(-5,8)(0,34)^2}{1} \checkmark \\ &= 0,34 \text{ m} \checkmark \end{aligned}$$

$$\begin{aligned} v_f &= v_i + \Delta t \\ 0 &= 2 + (-5,8)\Delta t \\ \Delta t &= 0,34 \text{ s} \end{aligned}$$

OR/OF

$$\begin{aligned} F_{\text{net}}\Delta t &= m(v_f - v_i) \\ (-116)\Delta t &= (20)(0 - 2) \\ \Delta t &= 0,34 \text{ s} \end{aligned}$$

$$\begin{aligned} \Delta x &= \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark \\ &= \left(\frac{2 + 0}{2} \right) 0,34 \checkmark \\ &= 0,34 \text{ m} \checkmark \end{aligned}$$

OPTION 1/OPSIE 1 Down the incline positive / Teen skuinsvlak af positief $F_{\text{net}} = ma$ $116 = 20a \checkmark$ $a = 5,80 \text{ m} \cdot \text{s}^{-2}$		
$v_f^2 = v_i^2 + 2a\Delta x \checkmark$ $0 = (-2)^2 + (2)(5,8)\Delta x \checkmark$ $\Delta x = -0,34 \text{ m}$ Distance = 0,34 m $\checkmark$ <i>Afstand</i>	$v_f = v_i + a\Delta t$ $0 = -2 + (5,8)\Delta t$ $\Delta t = 0,34 \text{ s}$ OR/OF $F_{\text{net}}\Delta t = m(v_f - v_i)$ $(116)\Delta t = (20)(0 - (-2))$ $\Delta t = 0,34 \text{ s}$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $= (-2)(0,34) + \frac{1}{2}(5,8)(0,34)^2 \checkmark$ $= -0,34 \text{ m} \checkmark$ Distance/Afstand = 0,34 m $\checkmark$	$v_f = v_i + a\Delta t$ $0 = -2 + (5,8)\Delta t$ $\Delta t = 0,34 \text{ s}$ OR/OF $F_{\text{net}}\Delta t = m(v_f - v_i)$ $(116)\Delta t = (20)(0 - (-2))$ $\Delta t = 0,34 \text{ s}$ $\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$ $= \left(\frac{-2 + 0}{2} \right) 0,34 \checkmark$ $= -0,34 \text{ m} \checkmark$ Distance/Afstand = 0,34 m $\checkmark$
OPTION 2/OPSIE 2 $W_{\text{net}} = \Delta E_K$ $F_{\text{net}}\Delta x \cos \theta = \frac{1}{2}m(v_f^2 - v_i^2) \checkmark$ Any one/Enige een $(116)\Delta x \cos 180^\circ \checkmark = \frac{1}{2}(20)(0^2 - 2^2) \checkmark$ $\Delta x = 0,34 \text{ m} \checkmark$		
OPTION 3/OPSIE 3 $W_{\text{net}} = \Delta E_K$ $W_f + W_{\text{wll}} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $f\Delta x \cos \theta + (mg \sin 30^\circ)\Delta x \cos \theta = \frac{1}{2}m(v_f^2 - v_i^2) \checkmark$ Any one/Enige een $(18)\Delta x \cos 180^\circ + (20)(9,8)\sin 30^\circ \Delta x \cos 180^\circ \checkmark = \frac{1}{2}(20)(0^2 - 2^2) \checkmark$ $\Delta x = 0,34 \text{ m} \checkmark$		
OPTION 4/OPSIE 4 $W_{\text{net}} = \Delta E_K$ $W_f + W_w = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $f\Delta x \cos \theta + mg\Delta x \cos 120^\circ = \frac{1}{2}m(v_f^2 - v_i^2) \checkmark$ Any one/Enige een $(18)\Delta x \cos 180^\circ + (20)(9,8)\Delta x \cos 120^\circ \checkmark = \frac{1}{2}(20)(0^2 - 2^2) \checkmark$ $\Delta x = 0,34 \text{ m} \checkmark$		
OPTION 5/OPSIE 5 $W_{\text{nc}} = \Delta E_p + \Delta E_k$ $f\Delta x \cos \theta = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2) \checkmark$ Any one/Enige een $18\Delta x \cos 180^\circ \checkmark = 20(9,8)\Delta x + \frac{1}{2}(20)(0^2 - 2^2) \checkmark$ $-18\Delta x = 196\Delta x \sin 30^\circ - 40$ $\Delta x = 0,34 \text{ m} \checkmark$		

(4)
[16]

QUESTION 3/VRAAG 3

3.1 No/Nee ✓

ANY ONE/ENIGE EEN:

- Gravitational force is not the only force acting on the balloon. /There are other forces acting on the balloon. ✓
Gravitasiekrag is nie die enigste krag wat op die ballon inwerk nie./Daar is ander kragte wat op die ballon inwerk.
- Its acceleration is not $9,8 \text{ m}\cdot\text{s}^{-2}$ /is zero.
Sy versnelling is nie $9,8 \text{ m}\cdot\text{s}^{-2}$ /is nul.
- It has constant velocity/no acceleration.
Dit het 'n konstante snelheid/geen versnelling nie.

(2)

3.2.1

OPTION 1/OPSIE 1 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-62,68)^2 = v_i^2 + 2(-9,8)(-200)$ ✓ $v_i = 2,96 \text{ m}\cdot\text{s}^{-1}$ ✓	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(62,68)^2 = v_i^2 + 2(9,8)(200)$ ✓ $v_i = -2,96 \text{ m}\cdot\text{s}^{-1}$ $= 2,96 \text{ m}\cdot\text{s}^{-1}$ ✓
OPTION 2/OPSIE 2 $(E_{\text{mech/meg}})_{200 \text{ m}} = (E_{\text{mech/meg}})_{\text{bottom/onder}}$ $(E_P + E_K)_{200 \text{ m}} = (E_P + E_K)_{\text{bottom/onder}}$ $(mgh + \frac{1}{2}mv^2)_{200 \text{ m}} = (mgh + \frac{1}{2}mv^2)_{\text{bottom/onder}}$ $m(9,8)(200) + \frac{1}{2}m(v^2) = 0 + \frac{1}{2}m(62,68)^2$ ✓ $v_i = 2,96 \text{ m}\cdot\text{s}^{-1}$ ✓	
NOTE/LET WEL Mass may be omitted during substitution. <i>Massa mag uitgelaat word tydens vervanging.</i>	
OPTION 3/OPSIE 3 $W_{\text{nc}} = \Delta E_p + \Delta E_k$ $0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/Enige een $0 = m(9,8)(0 - 200) + \frac{1}{2}m(62,68^2 - v_i^2)$ ✓ $v_i = 2,96 \text{ m}\cdot\text{s}^{-1}$ ✓	
NOTE/LET WEL Mass may be omitted during substitution. <i>Massa mag uitgelaat word tydens vervanging.</i>	
OPTION 4/OPSIE 4 $W_{\text{net}} = \Delta E_k$ $F_{\text{net}}\Delta x \cos \theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/Enige een $mg\Delta x \cos \theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } $m(9,8)(200) = + \frac{1}{2}m(62,68^2 - v_i^2)$ ✓ $v_i = 2,96 \text{ m}\cdot\text{s}^{-1}$ ✓	
NOTE/LET WEL Mass may be omitted during substitution. <i>Massa mag uitgelaat word tydens vervanging.</i>	

(3)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1/
 POSITIEWE NASIEN VANAF VRAAG 3.2.1**

Marking criteria/Nasienkriteria - Formula to calculate Δt of stone A ✓ <i>Formule om Δt van klip A te bereken</i> - Substitution to calculate Δt of stone A ✓ <i>Vervanging om Δt van klip A te bereken</i> - Final answer/<i>Finale antwoord</i>: 6,70 s ✓ Accept/Aanvaar: (6,69 to/tot 6,7) NOTE: The calculation of Δt for A might be split up into two parts. LET WEL: Die berekening van Δt vir A kan in twee dele opgedeel word.	
OPTION 1/OPSIE 1 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $-62,68 = 2,96 + (-9,8)\Delta t$ ✓ $\Delta t = 6,70 \text{ s}$ ✓ (6,698)	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $62,68 = -2,96 + 9,8\Delta t$ ✓ $\Delta t = 6,70 \text{ s}$ ✓ (6,698)
OPTION 2/OPSIE 2 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-200 = (2,96)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 6,70 \text{ s}$ ✓ (6,697)	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $200 = (-2,96)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 6,70 \text{ s}$ ✓ (6,697)
OPTION 3/OPSIE 3 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-200 = \left(\frac{+2,96 + (-62,68)}{2}\right)\Delta t$ ✓ $\Delta t = 6,70 \text{ s}$ ✓ (6,698)	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $200 = \left(\frac{-2,96 + 62,68}{2}\right)\Delta t$ ✓ $\Delta t = 6,70 \text{ s}$ ✓ (6,698)
OPTION 4/OPSIE 4 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF From 200 m upwards: <i>Vanaf 200 m opwaarts:</i> $v_f = v_i + a\Delta t$ ✓ $0 = 2,96 + (-9,8)\Delta t$ ✓ $\Delta t = 0,3 \text{ s}$ (0,302) From max h downwards: <i>Vanaf maks h afwaarts:</i> $v_f = v_i + a\Delta t$ $-62,68 = 0 + (-9,8)\Delta t$ $\Delta t = 6,40 \text{ s}$ (6,369) $t_A = 0,3 + 6,40 = 6,7 \text{ s}$ ✓	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF From 200 m upwards: <i>Vanaf 200 m opwaarts:</i> $v = v_i + a\Delta t$ ✓ $0 = -2,96 + (9,8)\Delta t$ ✓ $\Delta t = 0,3 \text{ s}$ (0,302) From max h downwards: <i>Vanaf maks h afwaarts:</i> $v_f = v_i + a\Delta t$ $62,68 = 0 + (9,8)\Delta t$ $\Delta t = 6,40 \text{ s}$ (6,369) $t_A = 0,3 + 6,40 = 6,7 \text{ s}$ ✓

OPTION 5/OPSIE 5 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF From 200 m upwards: <i>Vanaf 200 m opwaarts:</i> $v_f = v_i + a\Delta t$ ✓ $0 = 2,96 + (-9,8)\Delta t$ ✓ $\Delta t = 0,3 \text{ s } (0,302)$ From 200 m downwards: <i>Vanaf 200 m afwaarts:</i> $v_f = v_i + a\Delta t$ $-62,68 = -2,96 + (-9,8)\Delta t$ $\Delta t = 6,09 \text{ s } (6,094)$ $t_A = 2(0,3) + 6,09 = 6,69 \text{ s } \checkmark$	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF From 200 m upwards: <i>Vanaf 200 m opwaarts:</i> $v_f = v_i + a\Delta t$ ✓ $0 = -2,96 + (9,8)\Delta t$ ✓ $\Delta t = 0,3 \text{ s } (0,302)$ From 200 m downwards: <i>Vanaf 200 m afwaarts:</i> $v_f = v_i + a\Delta t$ $62,68 = 2,96 + (9,8)\Delta t$ $\Delta t = 6,09 \text{ s } (6,094)$ $t_A = 2(0,3) + 6,09 = 6,69 \text{ s } \checkmark$
OPTION 6/OPSIE 6 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $F_{\text{net}}\Delta t = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ $g\Delta t = v_f - v_i$ $(-9,8)\Delta t = (-62,68) - (2,96)$ ✓ $\Delta t = 6,69 \text{ s } \checkmark$	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $F_{\text{net}}\Delta t = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ $g\Delta t = v_f - v_i$ $(9,8)\Delta t = 62,68 - (-2,96)$ ✓ $\Delta t = 6,69 \text{ s } \checkmark$

(3)

3.2.3 **POSITIVE MARKING FROM QUESTION 3.2.1 and QUESTION 3.2.2/
 POSITIEWE NASIEN VANAF VRAAG 3.2.1 en VRAAG 3.2.2**

Marking criteria/Nasienkriteria

- Formula to calculate Δy of stone **B** ✓
*Formule om Δy van klip **B** te bereken*
- Substitution of $t = 1,7$ s ✓ ($t_A - 5$)
Vervanging van $t = 1,7$ s ($t_A - 5$)
- Substitution to calculate Δy of stone **B** ✓
*Vervanging om Δy van klip **B** te bereken*
- Substitution to calculate Δy of balloon ✓
Vervanging om Δy van ballon te bereken
- Calculating distance between balloon and stone **B** ✓
*Berekening van afstand tussen ballon en klip **B***
- Final answer/*Finale antwoord*: 14,16 m ✓ (14,11 to/tot 14,16)

OPTION 1/OPSIE 1

**UPWARDS AS POSITIVE/
 OPWAARTS AS POSITIEF**

Stone B/Klip B:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= \underline{2,96(6,7 - 5) + \frac{1}{2}(-9,8)(6,7 - 5)^2} \checkmark$$

$$= -9,13 \text{ m } (-9,09 \text{ to/tot } -9,13)$$

Distance travelled by stone **B**: 9,13 m

*Afstand afgelê deur klip **B**: 9,13 m*

Hot-air balloon/Lugballon

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$= \underline{2,96(6,7 - 5)} \checkmark + 0$$

$$= 5,03 \text{ m}$$

Distance travelled by hot-air balloon/

Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/

*Afstand tussen lugballon en klip **B** = $\underline{9,13 + 5,03} \checkmark$*

$$= 14,16 \text{ m } \checkmark (14,11 - 14,16)$$

**DOWNWARDS AS POSITIVE/
 AFWAARTS AS POSITIEF**

Stone B/Klip B:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= \underline{-2,96(6,7 - 5) + \frac{1}{2}(9,8)(6,7 - 5)^2} \checkmark$$

$$= 9,13 \text{ m } (9,09 \text{ to/tot } 9,13)$$

Distance travelled by stone **B**: 9,13 m

*Afstand afgelê deur klip **B**: 9,13 m*

Hot-air balloon/Lugballon

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$= \underline{-2,96(6,7 - 5)} \checkmark + 0$$

$$= -5,03 \text{ m}$$

Distance travelled by hot-air balloon/

Afstand afgelê deur lugballon: 5,03 m

Distance between hot-air balloon and stone **B**/

*Afstand tussen lugballon en klip **B** = $\underline{9,13 + 5,03} \checkmark$*

$$= 14,16 \text{ m } \checkmark (14,11 - 14,16)$$

OPTION 2/OPSIE 2 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF Stone B/Klip B: $v_f = v_i + a\Delta t$ $= 2,96 + (-9,8)(6,70 - 5)$ $= -13,7 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-13,7)^2 = (2,96)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = -9,13 \text{ m}$ Distance travelled by stone B: 9,13 m <i>Afstand afgelê deur klip B</i>: 9,13 m Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \underline{-2,96(6,70 - 5) + 0}$ ✓ $= -5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon</i>: 5,03 m Distance between hot-air balloon and stone B/Afstand afgelê deur lugballon en klip B = 9,13 + 5,03 ✓ $= 14,16 \text{ m}$ ✓ (14,11 - 14,16)	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF Stone B/Klip B: $v_f = v_i + a\Delta t$ $= -2,96 + (9,8)(6,70 - 5)$ $= 13,7 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(13,7)^2 = (-2,96)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = 9,13 \text{ m}$ Distance travelled by stone B: 9,13 m <i>Afstand afgelê deur klip B</i>: 9,13 m Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \underline{-2,96(6,70 - 5) + 0}$ ✓ $= -5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon</i>: 5,03 m Distance between hot-air balloon and stone B/Afstand afgelê deur lugballon en klip B = 9,13 + 5,03 ✓ $= 14,16 \text{ m}$ ✓ (14,11 - 14,16)
OPTION 3/OPSIE 3 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF Stone B/Klip B: $v_f = v_i + a\Delta t$ $= 2,96 + (-9,8)(6,70 - 5)$ $= -13,7 \text{ m}\cdot\text{s}^{-1}$ $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{+2,96 + (-13,7)}{2}\right)(6,70 - 5)$ ✓ $= -9,13 \text{ m}$ Distance travelled by stone B: 9,13 m <i>Afstand afgelê deur klip B</i>: 9,13 m Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \underline{2,96(6,70 - 5) + 0}$ ✓ $= 5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon</i>: 5,03 m Distance between hot-air balloon and stone B/Afstand afgelê deur lugballon en klip B = 9,13 + 5,03 ✓ $= 14,16 \text{ m}$ ✓ (14,11 - 14,16)	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF Stone B/Klip B: $v_f = v_i + a\Delta t$ $= -2,96 + (9,8)(6,70 - 5)$ $= 13,7 \text{ m}\cdot\text{s}^{-1}$ $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{-2,96 + (13,7)}{2}\right)(6,70 - 5)$ ✓ $= 9,13 \text{ m}$ Distance travelled by stone B: 9,13 m <i>Afstand afgelê deur klip B</i>: 9,13 m Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= \underline{-2,96(6,70 - 5) + 0}$ ✓ $= -5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon</i>: 5,03 m Distance between hot-air balloon and stone B/Afstand afgelê deur lugballon en klip B = 9,13 + 5,03 ✓ $= 14,16 \text{ m}$ ✓ (14,11 - 14,16)

OPTION 4/OPSIE 4 UPWARDS POSITIVE/ OPWAARTS POSITIEF: Stone B/Klip B: $v_f = v_i + a\Delta t$ $= 2,96 + (-9,8)(6,70 - 5)$ $= -13,7 \text{ m}\cdot\text{s}^{-1}$ Balloon's height after 5 s: 214,8 m <i>Ballon se hoogte na 5 s: 214,8 m</i> $E_{\text{mech/meg}}(214,8 \text{ m}) = (E_{\text{mech/meg}})_{1,7 \text{ s}}$ $(E_P + E_K)_{214,8 \text{ m}} = (E_P + E_K)_{1,7 \text{ s}}$ $(mgh + \frac{1}{2}mv^2) = (mgh + \frac{1}{2}mv^2)_{1,7 \text{ s}}$ $(9,8)(214,8) + \frac{1}{2}(2,96)^2 =$ $(9,8)h + \frac{1}{2}(13,7)^2$ $\therefore h = 205,67 \text{ m}$ Distance travelled by stone B/ <i>Afstand afgelê deur klip B:</i> $214,8 - 205,67 = 9,13 \text{ m}$ Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= 2,96(6,70 - 5) + 0$ $= 5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon: 5,03 m</i> Distance between hot-air balloon and stone B/<i>Afstand tussen lugballon en</i> <i>klip B: 9,13 + 5,03 = 14,16 m</i> (14,11 to/tot 14,16)	DOWNWARDS POSITIVE/ AFWAARTS POSITIEF: Stone B/Klip B: $v_f = v_i + a\Delta t$ $= -2,96 + (9,8)(6,70 - 5)$ $= 13,7 \text{ m}\cdot\text{s}^{-1}$ Balloon's height after 5 s: 214,8 m <i>Ballon se hoogte na 5 s: 214,8 m</i> $(E_{\text{mech/meg}})_{214,8 \text{ m}} = (E_{\text{mech/meg}})_{1,7 \text{ s}}$ $(E_P + E_K)_{214,8 \text{ m}} = (E_P + E_K)_{1,7 \text{ s}}$ $(mgh + \frac{1}{2}mv^2) = (mgh + \frac{1}{2}mv^2)_{1,7 \text{ s}}$ $(9,8)(214,8) + \frac{1}{2}(2,96)^2 =$ $(9,8)h + \frac{1}{2}(13,7)^2$ $\therefore h = 205,67 \text{ m}$ Distance travelled by stone B/ <i>Afstand afgelê deur klip B:</i> $214,8 - 205,67 = 9,13 \text{ m}$ Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= -2,96(6,70 - 5) + 0$ $= -5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon: 5,03 m</i> Distance between hot-air balloon and stone B/<i>Afstand tussen lugballon en</i> <i>klip B: 9,13 + 5,03 = 14,16 m</i> (14,11 to/tot 14,16)
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OPTION 5/OPSIE 5 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF Stone B/Klip B: $v_f = v_i + a\Delta t$ $= 2,96 + (-9,8)(6,70 - 5)$ $= -13,7 \text{ m}\cdot\text{s}^{-1}$ $W_{\text{net}} = \Delta E_K$ ✓ $F_{\text{net}}\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $= \frac{1}{2}m(v_f^2 - v_i^2)$ $(9,8)\Delta h \cos 0^\circ = \frac{1}{2}(13,7^2 - 2,96^2)$ ✓ $\Delta h = 9,13 \text{ m}$ Distance travelled by stone B/ <i>Afstand afgelê deur klip B:</i> 9,13 m Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= 2,96(6,70 - 5)$ ✓ + 0 $= 5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon:</i> 5,03 m Distance between hot-air balloon and stone B/Afstand tussen lugballon en <i>klip B:</i> $9,13 + 5,03$ ✓ = 14,16 m ✓ (14,11 to/tot 14,16)	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF Stone B/Klip B: $v_f = v_i + a\Delta t$ $= -2,96 + (9,8)(6,70 - 5)$ $= 13,7 \text{ m}\cdot\text{s}^{-1}$ $W_{\text{net}} = \Delta E_K$ ✓ $F_{\text{net}}\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $= \frac{1}{2}m(v_f^2 - v_i^2)$ $(9,8)\Delta h \cos 0^\circ = \frac{1}{2}(13,7^2 - 2,96^2)$ ✓ $\Delta h = 9,13 \text{ m}$ Distance travelled by stone B/ <i>Afstand afgelê deur klip B:</i> 9,13 m Hot-air balloon/Lugballon $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= -2,96(6,70 - 5)$ ✓ + 0 $= -5,03 \text{ m}$ Distance travelled by hot-air balloon/ <i>Afstand afgelê deur lugballon:</i> 5,03 m Distance between hot-air balloon and stone B/Afstand tussen lugballon en <i>klip B:</i> $9,13 + 5,03$ ✓ = 14,16 m ✓ (14,11 to/tot 14,16)
OPTION 6/OPSIE 6 Using relative velocities/Deur relatiewe snelhede te gebruik: UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (2,96 - 2,96)(1,7) + \frac{1}{2}(-9,8)(1,7)^2$ $= -14,16 \text{ m}$ Distance between hot-air balloon and stone B/Afstand tussen lugballon en <i>klip B:</i> 14,16 m ✓	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (2,96 - 2,96)(1,7) + \frac{1}{2}(9,8)(1,7)^2$ $= 14,16 \text{ m}$ ✓

OPTION 7/OPSIE 7

**UPWARDS AS POSITIVE/
 OPWAARTS AS POSITIEF**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= \frac{(2,96)(1,7)}{2} + \frac{1}{2} (-9,8)(1,7)^2 \checkmark$$

$$= -9,13 \text{ m}$$

Distance travelled by stone **B**: 9,13 m
 Afstand afgelê deur klip **B**: 9,13 m

**DOWNWARDS AS POSITIVE/
 AFWAARTS AS POSITIEF**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= \frac{(-2,96)(1,7)}{2} + \frac{1}{2} (9,8)(1,7)^2 \checkmark$$

$$= 9,13 \text{ m}$$

Height of stone B from the ground = $200 + 14,8 - 9,13 = 205,63 \text{ m}$

Hoogte van klip B vanaf die grond:

Height of balloon from the ground = $200 + (6,7)(2,96) \checkmark = 219,83 \text{ m}$

Hoogte van ballon vanaf die grond:

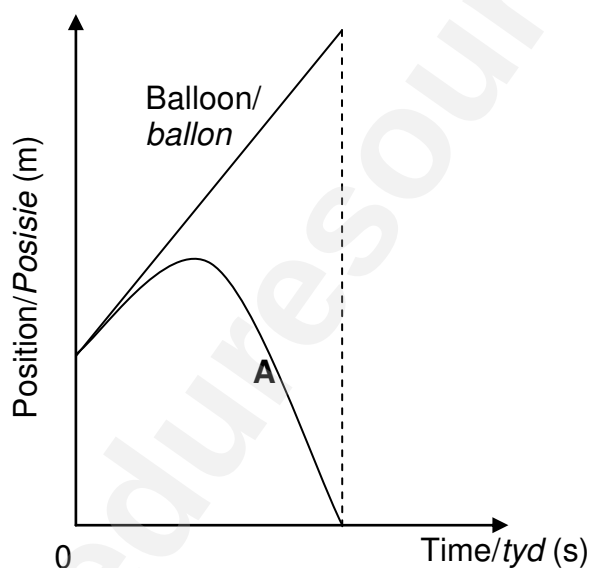
Distance between B and the balloon = $219,83 - 205,63 \checkmark = 14,16 \text{ m} \checkmark$

Afstand tussen B en die ballon:

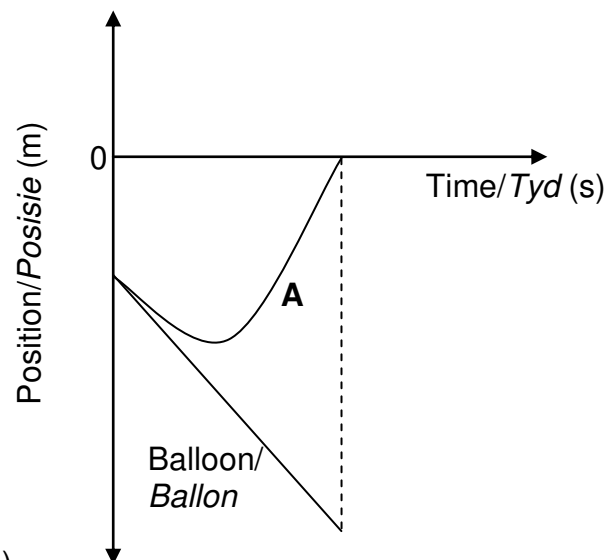
(6)

3.3

**UPWARDS POSITIVE
 OPWAARTS POSITIEF**



**DOWNWARDS POSITIVE
 AFWAARTS POSITIEF**



Criteria for graph/Kriteria vir grafiek	
Correct shape for stone A not starting from 0 m./Korrekte vorm vir klip A wat nie by 0 m begin nie.	✓
Correct shape and initial position for hot-air balloon. /Korrekte vorm en aanvanklike posisie vir lugballon.	✓
Gradient for hot-air balloon is higher than that of stone A until stone A reaches the maximum height./Gradiënt vir lugballon is groter as dié vir klip A totdat klip A sy maksimum hoogte bereik.	✓
Both graphs starting at the same position and ending at the same time. / Beide grafieke begin by dieselfde posisie en eindig by dieselfde tyd.	✓

(4)
 [18]

QUESTION 4/VRAAG 4

4.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. /Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

NOTE/LET WEL

If "total" is omitted: minus 1 mark / Indien "totaal" uitgelaat is: minus 1 punt

A collision in which both the total momentum and total kinetic energy are conserved. ✓✓

'n Botsing waar die totale momentum en die totale kinetiese energie behoue bly.

(2)

4.2

OPTION 1/OPSIE 1

$$\sum E_{Ki} = \sum E_{Kf}$$

$$\frac{1}{2}m_1v_{i1}^2 + \frac{1}{2}m_2v_{i2}^2 = \frac{1}{2}m_1v_{f1}^2 + \frac{1}{2}m_2v_{f2}^2 \quad \left. \begin{array}{l} \checkmark \text{ Any one/Enige een} \\ \checkmark \text{ Any one/Enige een} \end{array} \right\}$$

$$\frac{1}{2}m_xv_{ix}^2 + \frac{1}{2}m_yv_{iy}^2 = \frac{1}{2}m_xv_{fx}^2 + \frac{1}{2}m_yv_{fy}^2$$

$$\frac{1}{2}(10)(2)^2 + \frac{1}{2}(2)v_{iy}^2 \quad \checkmark = 0 + 36 \quad \checkmark$$

$$v_y = \pm 4 \text{ m} \cdot \text{s}^{-1}$$

$$v_y = 4 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \quad \text{west/wes} \quad \checkmark$$

ACCEPT/AANVAAR: left/links

OPTION 2/OPSIE 2

$$E_{Ki} = \frac{1}{2} m_Y v_f^2$$

$$36 = \frac{1}{2} (2) v_f^2$$

$$v_f = 6 \text{ m} \cdot \text{s}^{-1}$$

$$\sum p_i = \sum p_f$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f} \quad \left. \begin{array}{l} \checkmark \text{ Any one/Enige een} \\ \checkmark \text{ Any one/Enige een} \end{array} \right\}$$

$$m_xv_{xi} + m_yv_{yi} = m_xv_{xf} + m_yv_{yf}$$

$$(10)(2) + (2)v_y \quad \checkmark = 0 + (2)(6) \quad \checkmark$$

$$v_y = -4 \text{ m} \cdot \text{s}^{-1}$$

$$v_y = 4 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \quad \text{west/wes} \quad \checkmark$$

ACCEPT/AANVAAR: left/links

OPTION 3/OPSIE 3

$$E_{Ki} = \frac{1}{2} m_Y v_f^2$$

$$36 = \frac{1}{2} (2) v_f^2$$

$$v_f = 6 \text{ m} \cdot \text{s}^{-1}$$

$$\Delta p_x = -\Delta p_y$$

$$m_x(v_{xf} - v_{xi}) = -m_y(v_{yf} - v_{yi}) \quad \left. \begin{array}{l} \checkmark \text{ Any one/Enige een} \\ \checkmark \text{ Any one/Enige een} \end{array} \right\}$$

$$(10)(0 - 2) \quad \checkmark = -(2)(6 - v_y) \quad \checkmark$$

$$v_{yf} = -4 \text{ m} \cdot \text{s}^{-1}$$

$$v_y = 4 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \quad \text{west/wes} \quad \checkmark$$

ACCEPT/AANVAAR: left/links

(5)

4.3

POSITIVE MARKING FROM QUESTION 4.2 FOR Y; OPTIONS 1, 3 and 6
POSITIEWE NASIEN VANAF VRAAG 4.2 VIR Y; OPSIES 1, 3 en 6

OPTION 1/OPSIE 1 EAST POSITIVE/OOS POSITIEF: For Y/Vir Y: $F_{\text{net}}\Delta t = \Delta p$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ Any one/ Enige een $F_{\text{net}}(0,1) = 2\{6 - (-4)\}$ ✓ $F_{\text{net}} = 200 \text{ N}$ ✓	WEST POSITIVE/WES POSITIEF: For Y/Vir Y: $F_{\text{net}}\Delta t = \Delta p$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ Any one/ Enige een $F_{\text{net}}(0,1) = 2(-6 - 4)$ ✓ $F_{\text{net}} = -200 \text{ N}$ $F_{\text{net}} = 200 \text{ N}$ ✓
OPTION 2/OPSIE 2 EAST POSITIVE/OOS POSITIEF: For X/Vir X: $F_{\text{net}}\Delta t = \Delta p$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ Any one/ Enige een $F_{\text{net}}(0,1) = 10(0 - 2)$ ✓ $F_{\text{net}} = -200 \text{ N}$ $F_{\text{net}} = 200 \text{ N}$ ✓	WEST POSITIVE/WES POSITIEF For X/Vir X: $F_{\text{net}}\Delta t = \Delta p$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ Any one/ Enige een $F_{\text{net}}(0,1) = 10\{0 - (-2)\}$ ✓ $F_{\text{net}} = 200 \text{ N}$ ✓
OPTION 3/OPSIE 3 EAST POSITIVE/OOS POSITIEF: For Y/Vir Y: $v_f = v_i + a\Delta t$ $6 = -4 + a(0,1)$ $a = 100 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= \underline{2(100)}$ ✓ $= 200 \text{ N}$ ✓	WEST POSITIVE/WES POSITIEF For Y/Vir Y: $v_f = v_i + a\Delta t$ $-6 = 4 + a(0,1)$ $a = -100 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= \underline{2(-100)}$ ✓ $= -200 \text{ N}$ $F_{\text{net}} = 200 \text{ N}$ ✓
OPTION 4/OPSIE 4 EAST POSITIVE/OOS POSITIEF: For X/Vir X: $v_f = v_i + a\Delta t$ $0 = 2 + a(0,1)$ $a = -20 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= \underline{10(-20)}$ ✓ $= -200 \text{ N}$ $F_{\text{net}} = 200 \text{ N}$ ✓	WEST POSITIVE/WES POSITIEF For X/Vir X: $v_f = v_i + a\Delta t$ $0 = -2 + a(0,1)$ $a = 20 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= \underline{10(20)}$ ✓ $F_{\text{net}} = 200 \text{ N}$ ✓
OPTION 5/OPSIE 5 EAST POSITIVE/OOS POSITIEF: For X/Vir X: $v_f = v_i + a\Delta t$ $0 = 2 + a(0,1)$ $a = -20 \text{ m}\cdot\text{s}^{-2}$ $v_f^2 = v_i^2 + 2a\Delta x$ $0 = (2)^2 + 2(-20)\Delta x$ $\Delta x = 0,10 \text{ m}$ $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ $= \left(\frac{0+2}{2}\right)(0,1)$ $= 0,10 \text{ m}$ $W_{\text{net}} = \Delta E_k$ ✓ $F_{\text{net}}\Delta x \cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$ $F_{\text{net}}(0,1)\cos 180^\circ = \frac{1}{2} (10)(0^2 - 2^2)$ ✓ $F_{\text{net}} = 200 \text{ N}$ ✓	

OPTION 5/OPSIE 5

WEST POSITIVE/WES POSITIEF:

For X/Vir X:

$$\begin{aligned} v_f &= v_i + a\Delta t & v_f^2 &= v_i^2 + 2a\Delta x & \Delta x &= \left(\frac{v_f + v_i}{2} \right) \Delta t \\ 0 &= -2 + a(0,1) & 0 &= (-2)^2 + 2(20)\Delta x & &= \left(\frac{0 + (-2)}{2} \right) (0,1) \\ a &= 20 \text{ m}\cdot\text{s}^{-2} & \Delta x &= -0,10 \text{ m} & &= -0,10 \text{ m} \end{aligned}$$

$$\begin{aligned} W_{\text{net}} &= \Delta E_k \checkmark \\ F_{\text{net}} \Delta x \cos \theta &= \frac{1}{2} m(v_f^2 - v_i^2) \\ F_{\text{net}}(0,1) \cos 180^\circ &= \frac{1}{2} (10)(0^2 - 2^2) \checkmark \\ F_{\text{net}} &= 200 \text{ N} \checkmark \end{aligned}$$

OPTION 6/OPSIE 6

EAST POSITIVE/OOS POSITIEF:

For Y/Vir Y:

$$\begin{aligned} v_f &= v_i + a\Delta t & v_f^2 &= v_i^2 + 2a\Delta x & \Delta x &= \left(\frac{v_f + v_i}{2} \right) \Delta t \\ 6 &= -4 + a(0,1) & (6)^2 &= (-4)^2 + 2(100)\Delta x & &= \left(\frac{6 - 4}{2} \right) (0,1) \\ a &= 100 \text{ m}\cdot\text{s}^{-2} & \Delta x &= 0,10 \text{ m} & &= 0,10 \text{ m} \end{aligned}$$

$$\begin{aligned} W_{\text{net}} &= \Delta E_k \checkmark \\ F_{\text{net}} \Delta x \cos \theta &= \frac{1}{2} m(v_f^2 - v_i^2) \\ F_{\text{net}}(0,1) \cos 0^\circ &= \frac{1}{2} (2)(6^2 - (-4)^2) \checkmark \\ F_{\text{net}} &= 200 \text{ N} \checkmark \end{aligned}$$

OPTION 6/OPSIE 6

WEST POSITIVE/WES POSITIEF:

For Y/Vir Y:

$$\begin{aligned} v_f &= v_i + a\Delta t & v_f^2 &= v_i^2 + 2a\Delta x & \Delta x &= \left(\frac{v_f + v_i}{2} \right) \Delta t \\ -6 &= 4 + a(0,1) & (-6)^2 &= (4)^2 + 2(-100)\Delta x & &= \left(\frac{-6 + 4}{2} \right) (0,1) \\ a &= -100 \text{ m}\cdot\text{s}^{-2} & \Delta x &= -0,10 \text{ m} & &= -0,10 \text{ m} \end{aligned}$$

$$\begin{aligned} W_{\text{net}} &= \Delta E_k \checkmark \\ F_{\text{net}} \Delta x \cos \theta &= \frac{1}{2} m(v_f^2 - v_i^2) \\ F_{\text{net}}(0,1) \cos 0^\circ &= \frac{1}{2} (2)((-6)^2 - (4)^2) \checkmark \\ F_{\text{net}} &= 200 \text{ N} \checkmark \end{aligned}$$

(3)
[10]

QUESTION 5/VRAAG 5

5.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. /Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

ACCEPT/AANVAAR

For isolated system:

- Closed system/Geslote sisteem.
- Only conservative forces act on the system/Slegs konserwatiewe kragte werk in op die sisteem.
- No external forces act on system/Geen eksterne kragte werk in op die sisteem.

The total mechanical energy in an isolated system remains constant / the same. ✓✓

Die totale meganiese energie in 'n geïsoleerde sisteem bly konstant / dieselfde.

OR/OF

The sum of the kinetic and gravitational potential energies in an isolated system remains constant/the same.

Die som van die kinetiese en gravitasie potensiële energie in 'n geïsoleerde/geslote sisteem bly konstant/dieselfde.

(2)

5.2

NOTE/LET WEL

- Mass may be omitted during substitution. /Massa mag uitgelaat word tydens vervanging.
- If equations of motion are used. Max 1/3 for correct answer. / Indien bewegingsvergelykings gebruik word. Maks 1/3 vir korrekte antwoord.

OPTION 1/OPSIE 1

$$E_{P/mech\ top/meg\ bo} = E_{Q/mech\ ground\ /meg\ grond}$$

$$(E_p + E_k)_{P/top/bo} = (E_p + E_k)_{Q/bottom/onder}$$

$$(mgh + \frac{1}{2}mv^2)_{P/top/bo} = (mgh + \frac{1}{2}mv^2)_{Q/bottom/onder}$$

$$(2)(9,8)(5) + 0 = 0 + \frac{1}{2}(2)v_f^2 \quad \checkmark$$

$$v_f = 9,90\ m \cdot s^{-1} \quad \checkmark \quad (9,899)$$

✓ Any one/Enige een

OPTION 2/OPSIE 2

$$\Delta E_p + \Delta E_k = 0$$

$$(mgh_f - mgh_i) + \frac{1}{2}m(v_f^2 - v_i^2) = 0$$

$$0 - (2)(9,8)(5) + \frac{1}{2}(2)(v_f^2 - 0) \quad \checkmark = 0$$

$$v_f = 9,90\ m \cdot s^{-1} \quad \checkmark \quad (9,899)$$

✓ Any one/Enige een

(3)

5.3

POSITIVE MARKING FROM QUESTION 5.2.

POSITIEWE NASIEN VANAF VRAAG 5.2.

OPTION 1/OPSIE 1

$$W_{net} = \Delta E_k$$

$$W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$W_N + W_f + W_w = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$f\Delta x \cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$f(10)\cos 180^\circ \quad \checkmark = \frac{1}{2}(2)(4^2 - 9,90^2) \quad \checkmark$$

$$f = 8,2\ N \quad \checkmark$$

✓ Any one/Enige een

OPTION 2/OPSIE 2

$$\left. \begin{aligned} W_{nc} &= \Delta E_K + \Delta E_p \\ W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ W_N + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ f\Delta x \cos\theta &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \\ \underline{f(10)\cos 180^\circ} &= \frac{1}{2}(2)(4^2 - 9,90^2) + 0 \\ f &= 8,2 \text{ N} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

(4)

5.4

LEFT NEGATIVE/LINKS NEGATIEF

$$\left. \begin{aligned} F_{net}\Delta t &= \Delta p \\ F_{net}\Delta t &= mv_f - mv_i \\ F_{net}\Delta t &= m(v_f - v_i) \\ \underline{-14 = 2(v_f - 4)} &\checkmark \\ v_f &= -3 \text{ m}\cdot\text{s}^{-1} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

ACCEPT/AANVAAR
 Impulse/Impuls = $m\Delta v$

$$\begin{aligned} \Delta E_K &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark \\ &= \frac{1}{2}(2)[(-3)^2 - 4^2] \checkmark \\ &= -7 \text{ J} \checkmark \end{aligned}$$

Do not penalise if +3 is substituted.
 Moenie penaliseer indien +3 vervang is.

ACCEPT/AANVAAR

$$\begin{aligned} \Delta E_K &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark \\ &= \frac{1}{2}(2)[(0)^2 - (-3)^2] \checkmark \\ &= -9 \text{ J} \checkmark \end{aligned}$$

Do not penalise if +3 is substituted.
 Moenie penaliseer indien +3 vervang is.

RIGHT NEGATIVE/REGS NEGATIEF

$$\left. \begin{aligned} F_{net}\Delta t &= \Delta p \\ F_{net}\Delta t &= mv_f - mv_i \\ F_{net}\Delta t &= m(v_f - v_i) \\ \underline{14 = 2(v_f - (-4))} &\checkmark \\ v_f &= 3 \text{ m}\cdot\text{s}^{-1} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

ACCEPT/AANVAAR
 Impulse/Impuls = $m\Delta v$

$$\begin{aligned} \Delta E_K &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark \\ &= \frac{1}{2}(2)[(3)^2 - (-4)^2] \checkmark \\ &= -7 \text{ J} \checkmark \end{aligned}$$

Do not penalise if +4 is substituted.
 Moenie penaliseer indien +4 vervang is.

ACCEPT/AANVAAR

$$\begin{aligned} \Delta E_K &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark \\ &= \frac{1}{2}(2)[(0)^2 - (-3)^2] \checkmark \\ &= -9 \text{ J} \checkmark \end{aligned}$$

Do not penalise if +3 is substituted.
 Moenie penaliseer indien +3 vervang is.

(5)

[14]

QUESTION 6/VRAAG 6

6.1 $v = f\lambda$ ✓
 $340 = 680\lambda$ ✓
 $\lambda = 0,5 \text{ m}$ ✓

(3)

6.2

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

The change in frequency/pitch/wavelength of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓

Die verandering in frekwensie/toonhoogte/golflengte van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting het.

OR/OF

An (apparent) change in observed/detected frequency/pitch/wavelength, as a result of the relative motion between a source and an observer (listener). ✓✓

'n (Skynbare) verandering in waargenome frekwensie/toonhoogte/golflengte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.3.1 Decreased/Afgeneem ✓

(1)

6.3.2 Increased/Toegeneem ✓

(1)

6.4 **POSITIVE MARKING FROM QUESTION 6.1 /**
POSITIEWE NASIEN VANAF VRAAG 6.1

OPTION 1/OPSIE 1

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR } f_L = \frac{v}{v - v_s} f_s \checkmark$$

$$f_L = \frac{v}{\lambda_L}$$

$$= \frac{340}{0,5 - 0,05} \checkmark$$

$$= \frac{340}{0,45}$$

$$= 755,56 \text{ Hz}$$

$$755,56 = \left(\frac{340 + 0}{340 - v_s} \right) 680 \checkmark$$

$$v_s = 34 \text{ m} \cdot \text{s}^{-1} \checkmark \quad (33,67 - 34,04)$$

OPTION 2/OPSIE 2

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR } f_L = \frac{v}{v - v_s} f_s \checkmark$$

$$\frac{v}{\lambda_L} = \left(\frac{v + 0}{v - v_s} \right) f_s$$

$$\frac{340}{0,5 - 0,05} = \left(\frac{340 + 0}{340 - v_s} \right) 680 \checkmark$$

$$\frac{340}{0,45} = \left(\frac{340 + 0}{340 - v_s} \right) 680$$

$$v_s = 34 \text{ m} \cdot \text{s}^{-1} \checkmark \quad (33,67 - 34,04)$$

OPTION 3/OPSIE 3	OPTION 4/OPSIE 4
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR } f_L = \frac{v}{v - v_s} f_s \checkmark$ $\frac{v}{\lambda_L} = \left(\frac{v+0}{v-v_s} \right) \frac{v}{\lambda_s}$ $\therefore \frac{1}{\lambda_L} = \left(\frac{v+0}{v-v_s} \right) \frac{1}{\lambda_s}$ $\left(\frac{1}{0,5 - 0,05} \right) \checkmark = \left(\frac{340+0}{340-v_s} \right) \frac{1}{0,5} \checkmark$ $\frac{1}{0,45} = \left(\frac{340+0}{340-v_s} \right) \frac{1}{0,5}$ $v_s = 34 \text{ m}\cdot\text{s}^{-1} \checkmark \quad (33,67 - 34,04)$	$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \text{ OR } f_L = \frac{v}{v - v_s} f_s \checkmark$ $v_1 = v_2$ $f_s \lambda_1 = f_L \lambda_2$ $(600)(0,5) = f_L(0,45) \checkmark$ $f_L = 755,56 \text{ Hz}$ $755,56 = \left(\frac{340+0}{340-v_s} \right) 680 \checkmark$ $v_s = 34 \text{ m}\cdot\text{s}^{-1} \checkmark \quad (33,67 - 34,04)$

(5)
[12]

QUESTION 7/VRAAG 7

7.1.1 Added/Toegevoeg $\checkmark$

(1)

7.1.2 **NOTE/LET WEL**

Ignore signs of the charges./ Ignoreer tekens van die ladings.

$$n = \frac{Q}{q_e} \checkmark$$

$$= \frac{-1,95 \times 10^{-6}}{-1,6 \times 10^{-19}} \checkmark$$

$$= 1,22 \times 10^{13} \checkmark \quad (1,21875 \times 10^{13})$$

(3)

7.1.3 **Marking criteria/Nasienkriteria**

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

The (electrostatic) force experienced per unit positive charge placed at that point.

Die (elektrostatiese) krag per eenheid positiewe lading wat by die punt geplaas is.

NOTE/LET WEL (1 mark for:/1 punt vir:)

An electric field is a region of space in which an electric charge experiences a force.

'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind.

(2)

7.1.4

$$E = \frac{kQ}{r^2} \checkmark$$

$$= \frac{(9 \times 10^9)(1,95 \times 10^{-6})}{(0,5)^2} \checkmark$$

$$= 7,02 \times 10^4 \text{ N}\cdot\text{C}^{-1} \checkmark$$

(3)

7.2

OPTION 1/OPSIE 1

Marking criteria/Nasienkriteria:

- Coulomb's Law formula/*Coulomb se formule* ✓
- Correct substitution for F_{q1} **OR** F_{q2} into $\frac{kQ_1Q_2}{r^2}$ ✓
*Korrekte substitusie van F_{q1} **OF** F_{q2} in $\frac{kQ_1Q_2}{r^2}$*
- Correct substitution of 1,38 N for $F_{(net)}$ /*Korrekte substitusie van 1,38 N vir $F_{(net)}$* ✓
- Subtracting (vector addition) electrostatic forces /*Aftrek (vektoraddisie) van elektrostatiese kragte* ✓
- Final answer/*Finale antwoord*: $1,11 \times 10^{-7} \text{ C}$ ✓ ($1,106 \times 10^{-7} \text{ C}$)

$$F_{E(net)} = F_{q2} + F_{q1}$$

$$1,38 \checkmark = \left(+ \frac{kQ_1Q_2}{r^2} \right) + \left(- \frac{kQ_1Q_2}{r^2} \right) \checkmark$$

$$1,38 = \left(+ \frac{(9 \times 10^9)(1,95 \times 10^{-6})q_2}{(0,03)^2} \right) + \left(- \frac{(9 \times 10^9)(1,95 \times 10^{-6})q_2}{(0,05)^2} \right) \checkmark$$

$$q_2 = 1,11 \times 10^{-7} \text{ C} \checkmark (1,106 \times 10^{-7} \text{ C})$$

OPTION 2/OPSIE 2

Marking criteria/Nasienkriteria:

- $E = \frac{kQ}{r^2}$ ✓
- Correct substitution of $7,08 \times 10^5 \text{ N} \cdot \text{C}^{-1}$ /*Korrekte substitusie van $7,08 \times 10^5 \text{ N} \cdot \text{C}^{-1}$* ✓
- Correct substitution for E_{q1} **OR** E_{q2} into $\frac{kQ_2}{r^2}$ ✓
*Korrekte substitusie van E_{q1} **OF** E_{q2} in $\frac{kQ_2}{r^2}$*
- Subtracting electric fields/*Aftrek van elektriese velde* ✓
- Final answer/*Finale antwoord*: $1,11 \times 10^{-7} \text{ C}$ ✓ ($1,106 \times 10^{-7} \text{ C}$)

$$E = \frac{F}{q} = \frac{1,38}{1,95 \times 10^{-6}}$$

$$= 7,08 \times 10^5 \text{ N} \cdot \text{C}^{-1} (707692,30)$$

$$E_{net} = E_{q2} + E_{q1}$$

$$7,08 \times 10^5 \checkmark = \left(+ \frac{kQ_2}{r^2} \right) + \left(- \frac{kQ_1}{r^2} \right) \checkmark$$

$$= \left(+ \frac{(9 \times 10^9)q_2}{(0,03)^2} \right) + \left(- \frac{(9 \times 10^9)q_1}{(0,05)^2} \right) \checkmark$$

$$q_2 = 1,11 \times 10^{-7} \text{ C} \checkmark (1,106 \times 10^{-7} \text{ C})$$

(5)
 [14]

QUESTION 8/VRAAG 8

8.1.1 12 V ✓ (1)

8.1.2 0 (V) ✓ (1)

8.2 **Marking criteria/Nasienkriteria**

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

The rate at which work is done or energy is expended/transferred.
 Die tempo waarteen arbeid verrig word of energie oorgedra word.

(2)

8.3 **OPTION 1/OPSIE 1**

$$P = I^2 R \checkmark$$

$$5,76 = (1,2^2) R \checkmark$$

$$R = 4 \Omega \checkmark$$

OPTION 2/OPSIE 2

$$P = VI$$

$$5,76 = V(1,2)$$

$$V = 4,8 \text{ V}$$

$$P = \frac{V^2}{R} \checkmark$$

$$5,76 = \frac{(4,8)^2}{R} \checkmark$$

$$R = 4 \Omega \checkmark$$

$$V = IR \checkmark$$

$$4,8 = (1,2)R \checkmark$$

$$R = 4 \Omega \checkmark$$

(3)

8.4 **POSITIVE MARKING FROM QUESTION 8.3**
POSITIEWE NASIEN VANAF VRAAG 8.3

OPTION 1/OPSIE 1

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{8,4} \checkmark$$

$$R_p = 3,5 \Omega$$

$$R_T = 3,5 + 4 \checkmark$$

$$= 7,5 \Omega \checkmark$$

OPTION 2/OPSIE 2

$$R_p = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_p = \frac{(6)(8,4)}{6 + 8,4} \checkmark$$

$$R_p = 3,5 \Omega$$

$$R_T = 3,5 + 4 \checkmark$$

$$= 7,5 \Omega \checkmark$$

(3)

8.5

POSITIVE MARKING FROM QUESTION 8.3

POSITIEWE NASIEN VANAF VRAAG 8.3

CALCULATE V_p/BEREKEN V_p Marking criteria/Nasienkriteria - Formula/Formule: $V = IR$ ✓ - Substitution to calculate V_p / <i>Vervanging om V_p te bereken.</i> ✓	CALCULATE V_2/BEREKEN V_2 Marking criteria/Nasienkriteria - Substitution to calculate I_{branch} or ratio of R_{branch} / <i>Vervanging om I_{tak} of verhouding van R_{tak} te bereken.</i> ✓ - Substitution to calculate V_2 / <i>Vervanging om V_2 te bereken.</i> ✓ - Final Answer/Finale antwoord: 3 V ✓
<u>OPTION 1/OPSIE 1</u> $V_p = IR$ $= (1,2)(3,5)$ ✓ $= 4,2 \text{ V}$	$I = \frac{V}{R}$ $= \frac{4,2}{8,4}$ ✓ $= 0,5 \text{ A}$
<u>OPTION 2/OPSIE 2</u> $P_x = VI$ $5,76 = V(1,2)$ $V_x = 4,8 \text{ V}$ $I_{6\Omega} = \frac{8,4}{14,4} \times 1,2$ $= 0,7 \text{ A}$ $V_{6\Omega} = IR$ $= (0,7)(6)$ ✓ $= 4,2 \text{ V}$	$V_2 = IR$ ✓ $= (0,5)(6)$ ✓ $= 3 \text{ V}$ ✓ OR/OF
<u>OPTION 3/OPSIE 3</u> $\varepsilon = I(R + r)$ $12 = 1,2(7,5 + r)$ $r = 2,5 \Omega$ $V_p = 12 - 1,2(2,5 + 4)$ ✓ = 4,2 V	$R_{2,4} : R_6 = 2,4 : 6$ ✓ $= 2 : 5$ $V_{2,4} : V_6 = 1,2 : 3$ ✓ ✓ $V_2 = 3 \text{ V}$ ✓
CALCULATION OF $I_{8,4\Omega}$ AND V_2/BEREKENING VAN $I_{8,4\Omega}$ EN V_2 <u>OPTION 4/OPSIE 4</u> $I_{8,4\Omega} = \left(\frac{6}{14,4}\right)(1,2)$ OR/OF $\left(\frac{3,5}{8,4}\right)(1,2)$ $= 0,5 \text{ A}$ ✓ ✓ $V_2 = IR$ ✓ $= (0,5)(6)$ ✓ $= 3 \text{ V}$ ✓	
<u>OPTION 5/OPSIE 5</u> $V_x = IR$ $= (1,2)(4)$ $= 4,8 \text{ V}$ $V_{\text{ext}} = IR_{\text{ext}}$ $= (1,2)(7,5)$ $= 9 \text{ V}$ $V_p = 9 - 4,8$ ✓ = 4,2 V $V_{8,4\Omega} = IR$ $4,2 = I(8,4)$ ✓ $I = 0,5 \text{ A}$ $V_2 = IR$ ✓ $= (0,5)(6)$ ✓ $= 3 \text{ V}$ ✓	

(5)

8.6 Decreases/*Neem af* ✓

Total resistance decreases. / *Totale weerstand neem af.* ✓

Current increases. / *Stroom neem toe.* ✓

V_{internal} / Internal voltage (“lost volts”) increases. / *Interne potensiaalverskil neem toe.* ✓

V_{external} / external voltage decreases. / *Eksterne potensiaalverskil neem af.*

NOTE/LET WEL

Do not penalise if “total” is omitted. / *Moenie penaliseer indien “totaal” uitgelaat is nie.*

(4)
 [19]

QUESTION 9/VRAAG 9

9.1 Slip rings/*Sleepringe* ✓

ACCEPT/AANVAAR

Split ring/slip ring commutator / *splitring/sleepring kommutator*

(1)

9.2 Y to/na X ✓✓

(2)

9.3 **Marking criteria/Nasienkriteria**

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The AC potential difference which dissipates the same amount of energy as an equivalent DC potential difference.

Die WS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke GS-potensiaalverskil.

ACCEPT/AANVAAR

The DC potential difference which dissipates the same amount of energy as an equivalent AC potential difference.

Die GS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke WS-potensiaalverskil.

(2)

9.4

OPTION 1/OPSIE 1

$$V_{\text{rms/wgk}} = \frac{V_{\text{max/maks}}}{\sqrt{2}}$$

$$= \frac{100}{\sqrt{2}} \checkmark$$

$$= 70,71 \text{ V}$$

$$I_{\text{rms/wgk}} = \frac{V_{\text{rms/wgk}}}{R} \checkmark$$

$$= \frac{70,71}{25} \checkmark$$

$$= 2,83 \text{ A} \checkmark$$

ACCEPT/AANVAAR

If subscripts omitted in

$V = IR$

Indien onderskrifte uitgelaat is in $V = IR$

OPTION 2/OPSIE 2

$$I_{\text{max/maks}} = \frac{V_{\text{max/maks}}}{R}$$

$$= \frac{100}{25} \checkmark$$

$$= 4 \text{ A}$$

$$I_{\text{rms/wgk}} = \frac{I_{\text{max/maks}}}{\sqrt{2}} \checkmark$$

$$= \frac{4}{\sqrt{2}} \checkmark$$

$$= 2,83 \text{ A} \checkmark$$

OPTION 3/OPSIE 3

$$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R}$$

$$= \frac{100^2}{25}$$

$$= \frac{100^2}{25} \checkmark = 200 \text{ W}$$

$$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \checkmark$$

$$200 = \left(\frac{100}{\sqrt{2}} \right) I_{\text{rms}} \checkmark$$

$$I_{\text{rms}} = 2,83 \text{ A} \checkmark$$

(4)

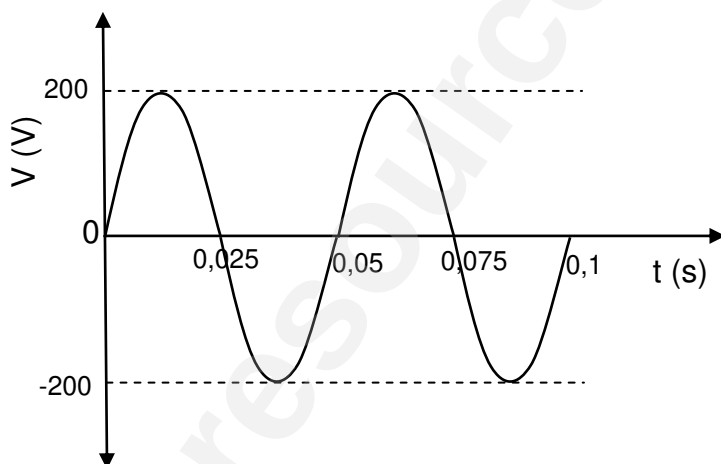
9.5

**POSITIVE MARKING FROM QUESTION 9.4 /
 POSITIEWE NASIEN VANAF VRAAG 9.4**

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2	OPTION 3/OPSIE 3
$P_{ave/gem} = \frac{V_{rms/wgk}^2}{R} \checkmark$ $= \frac{70,71^2}{25} \checkmark$ $= 200,00 \text{ W} \checkmark (200 \text{ W})$	$P_{ave} = V_{rms} I_{rms} \checkmark$ $= (70,71)(2,83) \checkmark$ $= 200,11 \text{ W} \checkmark$	$P_{ave/gem} = I_{rms/wgk}^2 R \checkmark$ $= (2,83)^2 (25) \checkmark$ $= 200,22 \text{ W} \checkmark$
OPTION 4/OPSIE 4 $I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$ $2,83 = \frac{I_{max}}{\sqrt{2}}$ $I_{max/maks} = 4 \text{ A}$ $P_{ave/gem} = \frac{V_{max/maks} I_{max/maks}}{2} \checkmark$ $= \frac{(100)(4)}{2} \checkmark$ $= 200 \text{ W} \checkmark$		

(3)

9.6



Marking criteria/Nasienkriteria

- 2 waves $\checkmark$
 2 golwe
- Period of wave is 0,05 s $\checkmark$
 Periode van golf is 0,05 s
- Amplitude = 200 V $\checkmark$

(3)

[15]

QUESTION 10/VRAAG 10

- 10.1 **Marking criteria/Nasienkriteria**
 If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.
 The minimum frequency of light needed to eject electrons from a metal / surface. ✓✓
Minimum frekwensie van lig benodig om elektrone vanaf 'n metaal / oppervlak vry te stel. (2)
- 10.2 Greater than/Groter as ✓✓ (2)
- 10.3 **OPTION 1/OPSIE 1**
 $E = W_o + E_{k(max)}$ ✓
 $f_x = \left(\frac{1}{6,63 \times 10^{-34}} \right) \checkmark (23,01 \times 10^{-19}) \checkmark + 10,40 \times 10^{14} \checkmark$
 $= 4,51 \times 10^{15} \text{ (Hz)} \checkmark (45,1 \times 10^{14} \text{ Hz})$
- OPTION 2/OPSIE 2**
 $m = \frac{1}{h} \checkmark$
 $\frac{f_x - 10,4 \times 10^{14} \checkmark}{23,01 \times 10^{-19} - 0 \checkmark} = \frac{1}{6,63 \times 10^{-34} \checkmark}$
 $f_x = 4,51 \times 10^{15} \text{ (Hz)} \checkmark (45,1 \times 10^{14} \text{ Hz})$
- OPTION 3/OPSIE 3**
 $E = W_o + E_{k(max)} \checkmark$
 $hf = hf_0 + E_{k(max)}$
 $6,63 \times 10^{-34} f_x \checkmark = (6,63 \times 10^{-34})(10,40 \times 10^{14}) \checkmark + 23,01 \times 10^{-19} \checkmark$
 $f_x = 4,51 \times 10^{15} \text{ (Hz)} \checkmark (45,1 \times 10^{14} \text{ Hz})$ (5)
- 10.4
- 10.4.1 No effect/Geen effek nie ✓ (1)
- 10.4.2 Increases/Verhoog ✓ (1)
- 10.4.3 No effect/Geen effek nie ✓ (1)

[12]

TOTAL/TOTAAL: 150



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN**

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

2022

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 28 pages./
Hierdie nasienriglyne bestaan uit 28 bladsye.**

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | B ✓✓ | (2) |
| 1.2 | B ✓✓ | (2) |
| 1.3 | B ✓✓ | (2) |
| 1.4 | A ✓✓ | (2) |
| 1.5 | D ✓✓ | (2) |
| 1.6 | C ✓✓ | (2) |
| 1.7 | D ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | A ✓✓ | (2) |
| 1.10 | C ✓✓ | (2) |
| | | [20] |

QUESTION 2/VRAAG 2

2.1

Marking criteria/Nasienkriteria:

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
 1 punt per word/frase.

A body will remain in its state of rest or motion at constant velocity unless a (non-zero) resultant/net force/unbalanced force acts on it. ✓✓

'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.

OR/OF

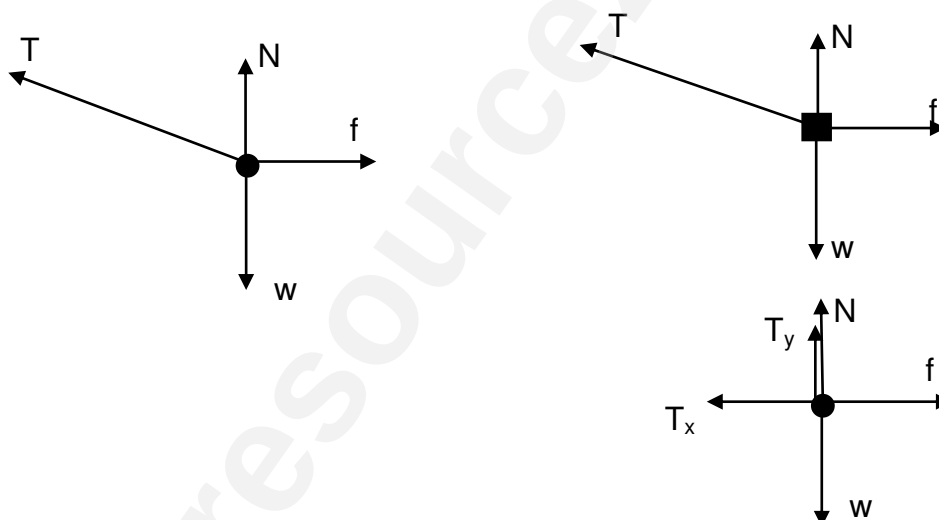
A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net force acts on it. ✓✓

'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto krag daarop inwerk.

(2)

2.2

ACCEPT/AANVAAR



	Accepted symbols/Aanvaarde simbole
N ✓	F_N /Normal/Normal force/Normaal/Normaalkrag/ F_{buoyant}
f ✓	F_f/f_k /frictional force/wrywingskrag/kinetic frictional force/kinetiese wrywingskrag/300 N
w ✓	F_g/mg /Weight/Gewig/ $F_{\text{Earth on man}}/F_{\text{Aarde op man}}/F_w$ /Gravitational force/Gravitasiekring/686 N
T ✓	Tension/Spinning/ $F_{\text{Tension}}/F_{\text{Spanning}}/F_T/F_S$ ACCEPT/ AANVAAR $F/F_{\text{applied}}/F_{\text{toegepas}}$

Notes/Aantekeninge

- Mark is awarded for label and arrow./Punt word toegeken vir byskrif en pyltjie.
- Do not penalise for length of arrows./Moenie vir die lengte van die pyltjies penaliseer nie.
- Deduct 1 mark for any additional force /Trek 1 punt af vir enige addisionele krag
- If T is not shown but T_y and T_x are shown give 1 mark for both.
 Indien T nie aangetoon is nie maar T_y en T_x is getoon, ken 1 punt toe vir beide.

(4)

2.3

OPTION 1/OPSIE 1 $\left. \begin{aligned} F_{\text{net}} &= ma \\ T \cos 50^\circ - F_f &= ma \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{T \cos 50^\circ - 300 = 0} \checkmark \quad \text{OR/OR} \quad \underline{T \cos 50^\circ = 300} \checkmark \checkmark$ $T = 466,72 \text{ N} \checkmark (468,75 \text{ N})$	OR/OR $F_{\text{net}} = 0 \checkmark \checkmark$ $T \cos 50^\circ = F_f \checkmark \checkmark$
OPTION 2/OPSIE 2 $W_{\text{net}} = \Delta E_k \checkmark$ $\underline{T \Delta x \cos 0^\circ + f \Delta x \cos 180^\circ = 0} \checkmark$ $\underline{T \cos 50^\circ - 300 = 0} \checkmark$ $T = 466,72 \text{ N} \checkmark (468,75 \text{ N})$	
NOTE/AANTEKENING Can use $\sin 40^\circ$ instead of $\cos 50^\circ$. <i>Kan ook $\sin 40^\circ$ i.p.v. $\cos 50^\circ$ gebruik.</i>	

(4)

2.4 Increases/Neem toe $\checkmark$

F_{net} increases / F_{net} is not zero / $T_x > f$ / $\underline{T \cos 50^\circ} > f \checkmark$
 F_{net} neem toe / F_{net} is nie nul nie / $T_x > f$ / $\underline{T \cos 50^\circ} > f$

(2)

2.5

Marking criteria Options 1 & 2/Nasienkriteria Opsies 1 & 2 • Substitution to calculate a/Vervanging om a te bereken $\checkmark$ • Formula to calculate $F_{\text{up/water}}$/Formule om $F_{\text{op/water}}$ te bereken $\checkmark$ • Substitution to calculate $F_{\text{up/water}}$/Vervanging om $F_{\text{op/water}}$ te bereken $\checkmark \checkmark$ • Final answer/Finale antwoord: 679,20 N $\checkmark$	
OPTION 1/OPSIE 1 DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF: $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{0 = (16)^2 + 2a(0,8)} \checkmark$ $a = -160 \text{ m} \cdot \text{s}^{-2}$ $\left. \begin{aligned} F_{\text{net}} &= ma \\ F_g - F_{\text{up/op}} &= ma \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{(4)(9,8) - F_{\text{up/op}} = (4)(-160)} \checkmark$ $F_{\text{up/op}} = -679,20 \text{ N}$ $F_{\text{up/op}} = 679,20 \text{ N} \checkmark$	UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{0 = (-16)^2 + 2a(-0,8)} \checkmark$ $a = 160 \text{ m} \cdot \text{s}^{-2}$ $\left. \begin{aligned} F_{\text{net}} &= ma \\ -F_g + F_{\text{up/op}} &= ma \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{-(4)(9,8) + F_{\text{up/op}} = (4)(160)} \checkmark$ $F_{\text{up/op}} = 679,20 \text{ N} \checkmark$

OPTION 2/OPSIE 2

**DOWNWARDS AS POSITIVE/
 AFWAARTS AS POSITIEF**

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$0,8 = \left(\frac{16 + 0}{2} \right) \Delta t$$

$$\Delta t = 0,1 \text{ s}$$

$$v_f = v_i + a\Delta t$$

$$0 = 16 + a(0,1) \checkmark$$

$$a = -160 \text{ m}\cdot\text{s}^{-2}$$

OR/OF

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$0,8 = (16)(0,1) + \frac{1}{2}(a)(0,1)^2 \checkmark$$

$$a = -160 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma$$

$$F_g - F_{\text{up/op}} = ma \checkmark \text{ Any one/Enige een}$$

$$(4)(9,8) - F_{\text{up/op}} \checkmark = (4)(-160) \checkmark$$

$$F_{\text{up/op}} = -679,20 \text{ N}$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

**UPWARDS AS POSITIVE/
 OPWAARTS AS POSITIEF**

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$-0,8 = \left(\frac{-16 + 0}{2} \right) \Delta t$$

$$\Delta t = 0,1 \text{ s}$$

$$v_f = v_i + a\Delta t$$

$$0 = -16 + a(0,1) \checkmark$$

$$a = 160 \text{ m}\cdot\text{s}^{-2}$$

OR/OF

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$-0,8 = (-16)(0,1) + \frac{1}{2}(a)(0,1)^2 \checkmark$$

$$a = 160 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma$$

$$-F_g + F_{\text{up/op}} = ma \checkmark \text{ Any one/Enige een}$$

$$-(4)(9,8) + F_{\text{up/op}} \checkmark = (4)(160) \checkmark$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

USING ENERGY PRINCIPLES/GEbruik VAN ENERGIë BEGINSëLS

Marking criteria OPTIONS 3 to 5/Nasienkriteria OPSIES 3 to 5

- Formula / Formule $\checkmark$
- Substitution / Vervanging $\checkmark \checkmark \checkmark$
- Final answer/Finale antwoord: 679,20 N $\checkmark$

OPTION 3/OPSIE 3

$$W_{\text{net}} = \Delta K$$

$$F_{\text{net}} \Delta x \cos \theta = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \checkmark \text{ Any one/Enige een}$$

$$(4)(9,8)(0,8) \cos 0^\circ \checkmark + F_{\text{up/op}}(0,8) \cos 180^\circ \checkmark = \frac{1}{2}(4)(0 - 16^2) \checkmark$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

OPTION 4/OPSIE 4

$$W_{\text{nc}} = \Delta K + \Delta U$$

$$F_{\text{up/op}} \Delta x \cos \theta = \frac{1}{2} m (v_f^2 - v_i^2) + mg(h_f - h_i) \checkmark \text{ Any one/Enige een}$$

$$F_{\text{up/op}}(0,8) \cos 180^\circ \checkmark = \frac{1}{2}(4)(0 - 16^2) \checkmark + (4)(9,8)(0 - 0,8) \checkmark$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

OPTION 5/OPSIE 5

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$0,8 = \left(\frac{16 + 0}{2} \right) \Delta t$$

$$\Delta t = 0,1 \text{ s}$$

$$F_{\text{net}} \Delta t = \Delta p$$

$$F_{\text{net}} \Delta t = (p_{\text{tube/band}})_f - (p_{\text{tube/band}})_i$$

$$(F_g - F_{\text{up/op}}) \Delta t = m(v_{\text{tube/band}(f)} - v_{\text{tube/band}(i)})$$

$$[(4)(9,8) - F_{\text{up/op}}](0,1) = (4)(0 - 16)$$

$$F_{\text{up/op}} = 679,20 \text{ N}$$

✓ Any one/Enige een

(5)
[17]

QUESTION 3/VRAAG 3

3.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
 1 punt per word/frase.

An object which has been given an initial velocity and then it moves under the influence of the gravitational force only/ is in free fall. ✓✓

'n Voorwerp waaraan 'n beginsnelheid gegee is en wat dan slegs onder die invloed van die gravitasiekrag beweeg/in vryval is.

(2)

3.2.1

OPTION 1/ OPSIE 1 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $0 = 15 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53 \text{ s}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $0 = -15 + (9,8)\Delta t$ ✓ $\Delta t = 1,53 \text{ s}$ ✓	OPTION 2/ OPSIE 2 Motion from top/Beweging van bo UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $-15 = 0 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53 \text{ s}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $15 = 0 + (9,8)\Delta t$ ✓ $\Delta t = 1,53 \text{ s}$ ✓
OPTION 3/ OPSIE 3 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $-15 = 15 + (-9,8)\Delta t$ ✓ $\Delta t = 3,06 \text{ s}$ $\Delta t_{\text{up}} = 1,53 \text{ s}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $15 = -15 + (9,8)\Delta t$ ✓ $\Delta t = 3,06 \text{ s}$ $\Delta t_{\text{up}} = 1,53 \text{ s}$ ✓	OPTION 4/ OPSIE 4 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (15)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 3,06 \text{ s}$ $\Delta t_{\text{up}} = 1,53 \text{ s}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (-15)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 3,06 \text{ s}$ $\Delta t_{\text{up}} = 1,53 \text{ s}$ ✓

(3)

Marking criteria OPTIONS 5 to 7/Nasienkriteria OPSIES 5 tot 7	
- Any formula relating Δy and Δt/ OR/OF $F_{\text{net}}\Delta t = m\Delta v$ ✓ - Substitution to calculate Δt/ <i>Vervanging om Δt te bereken</i> ✓ - Final answer/<i>finale antwoord</i>: 1,53 s ✓	
OPTION 5/OPSIE 5 $(E_{\text{mech}})_{\text{Top/Bo}} = (E_{\text{mech}})_{30\text{ m}}$ $(E_P + E_K)_{\text{Top/Bo}} = (E_P + E_K)_{30\text{ m}}$ $(mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} = (mgh + \frac{1}{2}mv^2)_{30\text{ m}}$ $(9,8)h + 0 = 0 + \frac{1}{2}(15)^2$ $\Delta h = 11,48\text{ m}$	OPTION A/OPSIE A UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $11,48 = (15)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 1,53\text{ s}$ ✓
OPTION 6/OPSIE 6 $W_{\text{nc}} = \Delta K + \Delta U$ $W_{\text{nc}} = \Delta K + mg(h_f - h_i)$ $0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ $0 = \frac{1}{2}(0 - 15^2) + (9,8)\Delta h$ $\Delta h = 11,48\text{ m}$	DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $11,48 = (-15)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 1,53\text{ s}$ ✓
OPTION 7/OPSIE 7 $W_{\text{net}} = \Delta E_k$ $w\Delta y \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(9,8)\Delta y \cos 180^\circ = 0 - \frac{1}{2}(15)^2$ $\Delta y = 11,48\text{ m}$	OPTION B/OPSIE B $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $11,48 = \left(\frac{15 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 1,53\text{ s}$ ✓
OPTION 8/OPSIE 8 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\frac{15 + 0}{2}\right)\Delta t$ $\Delta y = 7,5\Delta t$ $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (15)^2 + 2(-9,8)(7,5\Delta t)$ ✓ $\Delta t = 1,53\text{ s}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $\Delta y = \left(\frac{-15 + 0}{2}\right)\Delta t$ $\Delta y = -7,5\Delta t$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (-15)^2 + 2(9,8)(-7,5\Delta t)$ ✓ $\Delta t = 1,53\text{ s}$ ✓	OPTION 9/OPSIE 9 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ Any one/ $-(9,8)\Delta t = 0 - 15$ ✓ <i>Enige een</i> $\Delta t = 1,53\text{ s}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } ✓ Any one/ $(9,8)\Delta t = 15 - 0$ ✓ <i>Enige een</i> $\Delta t = 1,53\text{ s}$ ✓

(3)

3.2.2

POSITIVE MARKING FROM QUESTION 3.2.1/ POSITIEWE NASIEN VANAF VRAAG 3.2.1	
Marking criteria/Nasienkriteria - Formula to calculate Δy/Formule om Δy te bereken ✓ - Substitution to calculate Δy/Vervanging om Δy te bereken ✓ - Substitution of/Vervanging van 30 m ✓ - Final answer/Finale antwoord: 41,48 m ✓	
NOTE/AANTEKENING v_f and v_i can be swapped v_f en v_i kan omgeruil word	
OPTION 1/OPSIE 1 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $= \frac{(15)(1,53) + \frac{1}{2}(-9,8)(1,53)^2}{}$ ✓ $= 11,48 \text{ m}$ $\swarrow$ Height/hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $= \frac{(-15)(1,53) + \frac{1}{2}(9,8)(1,53)^2}{}$ ✓ $= -11,48 \text{ m}$ $\swarrow$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓	OPTION 2/OPSIE 2 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (15)^2 + (2)(-9,8)\Delta y$ ✓ $\Delta y = 11,48 \text{ m}$ $\swarrow$ Height/hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (-15)^2 + (2)(9,8)\Delta y$ ✓ $\Delta y = -11,48 \text{ m}$ $\swarrow$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓
OPTION 3/OPSIE 3 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ ✓ $\Delta y = \left(\frac{15 + 0}{2} \right) (1,53)$ ✓ $= 11,48 \text{ m}$ $\swarrow$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ ✓ $\Delta y = \left(\frac{-15 + 0}{2} \right) (1,53)$ ✓ $= -11,48 \text{ m}$ $\swarrow$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓	OPTION 4/OPSIE 4 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (-15)^2 + (2)(-9,8)(-30)$ ✓ $v_f = -28,51 \text{ m} \cdot \text{s}^{-1}$ $\swarrow$ $v_f^2 = v_i^2 + 2a\Delta y$ $(-28,51)^2 = (0)^2 + (2)(-9,8)\Delta y$ ✓ $\Delta y = 41,48 \text{ m}$ Height/Hoogte = 41,48 m ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (15)^2 + (2)(9,8)(30)$ ✓ $v_f = 28,51 \text{ m} \cdot \text{s}^{-1}$ $\swarrow$ $v_f^2 = v_i^2 + 2a\Delta y$ $(28,51)^2 = (0)^2 + (2)(9,8)\Delta y$ ✓ $\Delta y = 41,48 \text{ m}$ Height/Hoogte = 41,48 m ✓

OPTION 5/ OPSIE 5

$$\begin{aligned} (E_{\text{mech}})_{\text{Top/Bo}} &= (E_{\text{mech}})_{30 \text{ m}} \\ (E_P + E_K)_{\text{Top/Bo}} &= (E_P + E_K)_{30 \text{ m}} \\ (mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} &= (mgh + \frac{1}{2}mv^2)_{30 \text{ m}} \end{aligned} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{ Any one/Enige een}$$

$$(9,8)h + 0 = (9,8)(30) + \frac{1}{2}(15)^2 \checkmark$$

$$h = 41,48 \text{ m} \checkmark$$

OPTION 6/OPSIE 6

$$W_{\text{net}} = \Delta E_k$$

$$w\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2) \quad \left. \begin{array}{l} \\ \end{array} \right\} \checkmark \text{ Any one/Enige een}$$

$$(9,8)(\Delta x) \cos 180^\circ = \frac{1}{2}(0 - 15^2) \checkmark$$

$$\Delta x = 11,47 \text{ m}$$

Height above the ground/hoogte bokant grond = $30 + 11,47 = 41,48 \text{ m} \checkmark$

OPTION 7/OPSIE 7

$$W_{\text{nc}} = \Delta E_p + \Delta E_k$$

$$0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2) \quad \left. \begin{array}{l} \\ \end{array} \right\} \checkmark \text{ Any one/Enige een}$$

$$0 = (9,8)(h_f - 0) + \frac{1}{2}(0 - 15^2) \checkmark$$

$$h = 11,47 \text{ m}$$

Height above the ground/hoogte bokant grond = $30 + 11,47 = 41,48 \text{ m} \checkmark$

(4)

3.3

POSITIVE MARKING FROM QUESTION 3.2.2/

POSITIEWE NASIEN VANAF VRAAG 3.2.2

Marking criteria/Nasienkriteria

- Formula/Formule $\checkmark$
- Substitute to calculate Δy_B / Vervang om Δy_B te bereken $\checkmark$
- Substitute to calculate Δy_C / Vervang om Δy_C te bereken $\checkmark$
- Substitute/Vervang $\Delta t + 0,5$ or/of $\Delta t - 0,5$ $\checkmark$
- Equating y_B and y_C $\checkmark$
- Final answer/Finale antwoord: 1,71 s $\checkmark$

OPTION 1/OPSIE 1

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF

Take y_C as height of disc above ground at meeting point / neem hoogte y_C as die hoogte van teiken bokant grond by ontmoetingspunt:

$$\Delta y_C = v_i \Delta t + \frac{1}{2}a \Delta t^2 \checkmark$$

$$y_C - 30 = \frac{15 \Delta t + \frac{1}{2}(-9,8) \Delta t^2}{\checkmark}$$

$$y_C = 15 \Delta t - 4,9 \Delta t^2 + 30 \dots (1)$$

Take y_B as height of ball above ground at meeting point/Neem hoogte y_B as die hoogte van bal bokant grond by ontmoetingspunt:

$$\Delta y_B = v_i \Delta t + \frac{1}{2}a \Delta t^2$$

$$y_B - 0 = \frac{40(\Delta t - 0,5) + \frac{1}{2}(-9,8)(\Delta t - 0,5)^2}{\checkmark}$$

$$y_B = 44,9t - 21,225 - 4,9t^2 \dots (2)$$

At meeting point/By ontmoetingspunt:

$$y_C = y_B$$

$$15 \Delta t - 4,9 \Delta t^2 + 30 = 44,9t - 21,225 - 4,9t^2 \checkmark$$

$$\Delta t = 1,71 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
 AFWAARTS AS POSITIEF**

Take y_C as height of disc above ground at meeting point/*neem hoogte y_C as die hoogte van teiken bokant grond by ontmoetingspunt:*

$$\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$y_C - 30 = \frac{-15 \Delta t + \frac{1}{2} (9,8) \Delta t^2}{\Delta t} \checkmark$$

$$y_C = -15 \Delta t + 4,9 \Delta t^2 + 30 \dots (1)$$

Take y_B as height of ball above ground at meeting point/*neem hoogte y_B as die hoogte van bal bokant grond by ontmoetingspunt:*

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$y_B - 0 = \frac{-40(\Delta t - 0,5) + \frac{1}{2} (9,8)(\Delta t - 0,5)^2}{\Delta t} \checkmark$$

$$y_B = -44,9t + 21,225 + 4,9t^2 \dots (2)$$

At meeting point/*By ontmoetingspunt:*

$$y_C = y_B \therefore \frac{-15 \Delta t + 4,9 \Delta t^2 + 30}{\Delta t} = \frac{-44,9t + 21,225 + 4,9t^2}{\Delta t} \checkmark$$

$$\Delta t = 1,71 \text{ s } \checkmark$$

OPTION 2/OPSIE 2

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

$$\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= \frac{15 \Delta t + \frac{1}{2} (-9,8) \Delta t^2}{\Delta t} \checkmark$$

$$= 15 \Delta t - 4,9 \Delta t^2 \dots (1)$$

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$= \frac{40(\Delta t - 0,5) + \frac{1}{2} (-9,8)(\Delta t - 0,5)^2}{\Delta t} \checkmark$$

Δy_C in terms of/in terme van Δy_B :

$$30 + \Delta y_C = 40(\Delta t - 0,5) + \frac{1}{2} (-9,8)(\Delta t - 0,5)^2$$

$$\Delta y_C = -4,9 \Delta t^2 + 44,9 \Delta t - 51,225 \dots (2)$$

Equate (1) and (2)/*Stel (1) en (2) gelyk:*

$$\frac{15 \Delta t}{\Delta t} = \frac{44,9 \Delta t - 51,225}{\Delta t} \checkmark$$

$$\Delta t = 1,71 \text{ s } \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= \frac{-15 \Delta t + \frac{1}{2} (9,8) \Delta t^2}{\Delta t} \checkmark$$

$$= 4,9 \Delta t^2 - 15 \Delta t \dots (1)$$

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$= \frac{-40(\Delta t - 0,5) + \frac{1}{2} (9,8)(\Delta t - 0,5)^2}{\Delta t} \checkmark$$

Δy_C in terms of/in terme van Δy_B :

$$30 + \Delta y_C = (-40)(t - 0,5) + \frac{1}{2} (9,8)(\Delta t - 0,5)^2$$

$$\Delta y_C = 4,9 \Delta t^2 - 44,9 \Delta t + 51,225 \dots (2)$$

Equate (1) and (2)/*Stel (1) en (2) gelyk:*

$$\frac{-15 \Delta t}{\Delta t} = \frac{-44,9 \Delta t + 51,225}{\Delta t} \checkmark$$

$$\Delta t = 1,71 \text{ s } \checkmark$$

OPTION 3/OPSIE 3

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= \underline{15(\Delta t + 0,5)} + \frac{1}{2}(-9,8)(\Delta t + 0,5)^2 \checkmark \\ &= -4,9t^2 + 10,1\Delta t + 6,275 \dots (1)\end{aligned}$$

$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{40\Delta t + \frac{1}{2}(-9,8)\Delta t^2} \checkmark\end{aligned}$$

Δy_C in terms of/in terme van Δy_B :

$$\begin{aligned}30 + \Delta y &= 40\Delta t + \frac{1}{2}(-9,8)t^2 \\ \Delta y &= -4,9\Delta t^2 + 40t - 30 \dots (2)\end{aligned}$$

Equate (1) and (2)/Stel (1) en (2) gelyk:

$$\begin{aligned}\underline{10,1\Delta t + 6,275 = 40\Delta t - 30} \checkmark \\ \Delta t &= 1,21 \text{ s} \\ \Delta t_{\text{TOT}} &= 1,21 + 0,5 \\ &= 1,71 \text{ s} \checkmark\end{aligned}$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= \underline{-15(\Delta t + 0,5)} + \frac{1}{2}(9,8)(\Delta t + 0,5)^2 \checkmark \\ &= 4,9\Delta t^2 - 10,1\Delta t + 6,275 \dots (1)\end{aligned}$$

$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{-40\Delta t + \frac{1}{2}(9,8)\Delta t^2} \checkmark\end{aligned}$$

Δy_C in terms of/in terme van Δy_B :

$$\begin{aligned}30 + \Delta y &= -40\Delta t + \frac{1}{2}(9,8)t^2 \\ \Delta y &= -4,9\Delta t^2 - 40\Delta t - 30 \dots (2)\end{aligned}$$

Equate (1) and (2)/Stel (1) en (2) gelyk:

$$\begin{aligned}\underline{-10,1\Delta t + 6,275 = -40\Delta t - 30} \checkmark \\ \Delta t &= 1,21 \text{ s}\end{aligned}$$

$$\begin{aligned}\Delta t_{\text{TOT}} &= 1,21 + 0,5 \\ &= 1,71 \text{ s} \checkmark\end{aligned}$$

OPTION 4/OPSIE 4	
Marking criteria: - Formula: $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ - Substitute to calculate Δy_B ✓ - Substitute to calculate Δy_C ✓ - Substitute $\Delta t = 0,5$ ✓ - Adding Δy_B and Δy_C ✓ - Final answer: 1,71 s ✓	Nasienkriteria: - Formule: $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ - Vervang om Δy_B te bereken ✓ - Vervang om Δy_C te bereken ✓ - Vervang $\Delta t = 0,5$ ✓ - Som van Δy_B en Δy_C ✓ - Finale antwoord: 1,71 s ✓
UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF Displacement of C after 0,5 s/ Verplasing van C na 0,5 s $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= 15(0,5) + \frac{1}{2}(-9,8)(0,5)^2$ $\Delta y_C = 6,28 \text{ m}$ Velocity of C after 0,5 s/ Snelheid van C na 0,5 s $v_f = v_i + a \Delta t$ $= 15 + (-9,8)(0,5)$ $= 10,10 \text{ m} \cdot \text{s}^{-1}$ Displacement of C at meeting point/ Verplasing van C by ontmoetingspunt $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= \frac{10,1 \Delta t + \frac{1}{2}(-9,8) \Delta t^2}{1}$ $= 10,1 \Delta t - 4,9 \Delta t^2$ Displacement of B at meeting point/ Verplasing van B by ontmoetingspunt $\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= \frac{40 \Delta t + \frac{1}{2}(-9,8) \Delta t^2}{1}$ $= 40 \Delta t - 4,9 \Delta t^2$ At meeting point/ By ontmoetingspunt: $\Delta y_C + \Delta y_B = -[10,1 \Delta t - 4,9 \Delta t^2] + 40 \Delta t - 4,9 \Delta t^2$ $36,28 = -10,10 \Delta t + 40 \Delta t$ $\Delta t = 1,21 \text{ s}$ $\Delta t_{\text{tot}} = 1,21 + 0,5 = 1,71 \text{ s} \checkmark$	

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

Displacement of C after 0,5 s/ Verplasing van C na 0,5 s

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= -15(0,5) + \frac{1}{2}(9,8)(0,5)^2 \checkmark \\ \Delta y_C &= -6,28 \text{ m}\end{aligned}$$

Velocity of C after 0,5 s/ Snelheid van C na 0,5 s

$$\begin{aligned}v_f &= v_i + a \Delta t \\ &= -15 + (9,8)(0,5) \\ &= -10,10 \text{ m} \cdot \text{s}^{-1}\end{aligned}$$

Displacement of C at meeting point/ Verplasing van C by ontmoetingspunt

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{-10,1 \Delta t + \frac{1}{2}(9,8) \Delta t^2} \checkmark \\ &= -10,1 \Delta t + 4,9 \Delta t^2\end{aligned}$$

Displacement of B at meeting point/ Verplasing van B by ontmoetingspunt

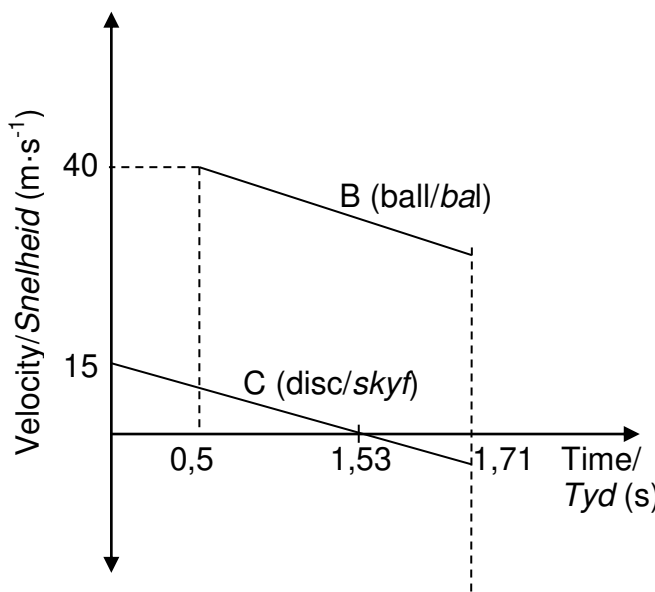
$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{-40 \Delta t + \frac{1}{2}(9,8) \Delta t^2} \checkmark \\ &= -40 \Delta t + 4,9 \Delta t^2\end{aligned}$$

At meeting point/ By ontmoetingspunt:

$$\begin{aligned}\Delta y_C + \Delta y_B &= \underline{-[-10,1 \Delta t + 4,9 \Delta t^2] - 40 \Delta t + 4,9 \Delta t^2} \checkmark \\ -36,28 &= 10,10 \Delta t - 40 \Delta t \\ \Delta t &= 1,21 \text{ s} \\ \Delta t_{\text{tot}} &= 1,21 + 0,5 = 1,71 \text{ s} \checkmark\end{aligned}$$

(6)

3.4 **POSITIVE MARKING FROM QUESTIONS 3.2.1 AND 3.3 /**
POSITIEWE NASIEN VANAF VRAE 3.2.1 EN 3.3.
UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF



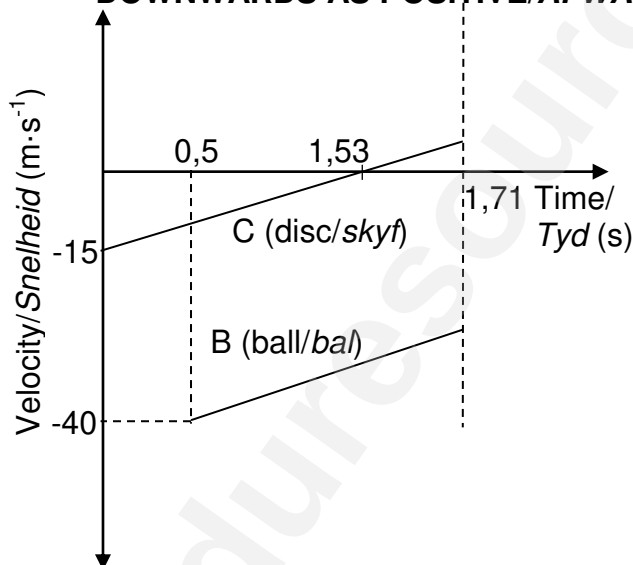
Marking criteria:

- Initial velocities 40 and 15 and straight lines ✓
- B starting at 0,5 s ✓
- Parallel lines with negative gradient ✓
- Time at which disc reaches maximum height (answer from 3.2.1) 1,53 s ✓
- Time at which B hits C (answer from 3.3) 1,71 s ✓

Nasienkriteria:

- Aanvanklike snelhede 40 en 15 en reguitlyne ✓
- B begin by 0,5 s ✓
- Parallele lyne met negatiewe gradiënt ✓
- Tyd wanneer skyf maks hoogte bereik (antwoord van 3.2.1) 1,53 s ✓
- Tyd wanneer B vir C tref (antwoord van 3.3) 1,71s ✓

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF



Marking criteria:

- Initial velocities -40 and -15 and straight lines ✓
- B starting at 0,5 s ✓
- Parallel lines with positive gradient ✓
- Time at which disc reaches maximum height (answer from 3.2.1) 1,53 s ✓
- Time at which B hits C (answer from 3.3) 1,71 s ✓

Nasienkriteria:

- Aanvanklike snelhede -40 en -15 en reguitlyne ✓
- B begin by 0,5 s ✓
- Parallele lyne met positiewe gradiënt ✓
- Tyd wanneer skyf maks hoogte bereik (antwoord van 3.2.1) 1,53 s ✓
- Tyd wanneer B vir C tref (antwoord van 3.3) 1,71s ✓

(5)
 [20]

QUESTION 4 / VRAAG 4

- 4.1 A system on which the resultant/net external force is zero./'n Sisteem waarop die resultante/netto eksterne krag nul is. ✓✓ (2 or/of 0) (2)
- 4.2 1. According to Newton 3rd Law ✓ the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓
OR
 2. The toy cart exerts a force on the rocket to the right ✓ and the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓
OR
 3. The rocket experiences a change in momentum to the right ✓, the toy cart experiences a change in momentum to the left. ✓
OR
 4. $\Delta p_{\text{toy cart}} = -\Delta p_{\text{rocket}}$ ✓✓
OR
 5. Total momentum is conserved / remains constant. ✓
The momentum of the rocket increases. Therefore, the momentum of the toy cart must decrease. ✓
OR
 6. The rocket experiences an impulse to the right ✓ therefore, the toy cart experiences an impulse to the left. ✓
OR
 7. $\text{Impulse}_{\text{rocket}} = -\text{Impulse}_{\text{toy cart}}$ ✓✓
1. Volgens Newton se derde wet ✓ oefen die vuurpyl 'n krag op die speelgoedwaentjie na links uit/ teen die bewegingsrigting. ✓
OF
 2. Die speelgoedwaentjie oefen 'n krag op die vuurpyl na regs ✓ en die vuurpyl oefen 'n krag op die speelgoedwaentjie na links/teen die bewegingsrigting ✓.
OF
 3. Die vuurpyl ondervind 'n verandering in momentum na regs ✓, die speelgoedwaentjie ondervind 'n verandering in momentum na links. ✓
OF
 4. $\Delta p_{\text{speelgoedwaentjie}} = -\Delta p_{\text{vuurpyl}}$
OF
 5. Totale momentum bly behoue. ✓
Die momentum van die vuurpyl neem toe. Dus moet die momentum van die speelgoedwaentjie af neem. ✓
OF
 6. Die vuurpyl ondervind 'n impuls na regs ✓ dus ondervind die speelgoedwaentjie 'n impuls na links. ✓
OF
 7. $\text{Impuls}_{\text{vuurpyl}} = -\text{Impuls}_{\text{speelgoedwaentjie}}$ ✓✓ (2)

4.3

OPTION 1/OPSIE 1 RIGHT AS POSITIVE/REGS AS POSITIEF	
$\left. \begin{aligned} \sum p_i &= \sum p_f \\ (m_1 + m_2)v_i &= m_1v_{1f} + m_2v_{2f} \\ mv_i &= m_1v_{1f} + m_2v_{2f} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$	
$(20 + m_2)2,5 \checkmark = 20(0,6) \checkmark + m_2(30) \checkmark$	
$m_2 = 1,38 \text{ kg} \checkmark$	
LEFT AS POSITIVE/LINKS AS POSITIEF	
$\left. \begin{aligned} \sum p_i &= \sum p_f \\ (m_1 + m_2)v_i &= m_1v_{1f} + m_2v_{2f} \\ mv_i &= m_1v_{1f} + m_2v_{2f} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$	
$(20 + m_2)(-2,5) \checkmark = 20(-0,6) \checkmark + m_2(-30) \checkmark$	
$m_2 = 1,38 \text{ kg} \checkmark$	
OPTION 2/OPSIE 2 RIGHT AS POSITIVE/REGS AS POSITIEF	
$\left. \begin{aligned} \Delta p_{\text{toy cart/speelgoedwaentjie}} &= -\Delta p_{\text{rocket/vuurpyl}} \\ m_1(v_{1(f)} - v_{1(i)}) &= -m_2(v_{2(f)} - v_{2(i)}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$	
$(20) \checkmark (0,6 - 2,5) \checkmark = - (m)(30 - 2,5) \checkmark$	
$m_2 = 1,38 \text{ kg} \checkmark$	
LEFT AS POSITIVE/LINKS AS POSITIEF	
$\left. \begin{aligned} \Delta p_{\text{toy cart/speelgoedwaentjie}} &= -\Delta p_{\text{rocket/vuurpyl}} \\ m_1(v_{1(f)} - v_{1(i)}) &= -m_2(v_{2(f)} - v_{2(i)}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$	
$(20) \checkmark [-0,6 - (-2,5)] \checkmark = - (m)[(-30) - (-2,5)] \checkmark$	
$m_2 = 1,38 \text{ kg} \checkmark$	

(5)
[9]

QUESTION 5/VRAAG 5

5.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 punt per word/frase.

The net/total work done on an object is equal to the change in the object's kinetic energy. ✓✓

Die netto/totale arbeid op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie.

OR/OF

The work done on an object by a net force is equal to the change in the object's kinetic energy.

Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.

(2)

5.2

F_{net} opposite to direction of displacement Δx . ✓ / Both frictional force and gravitational force are in opposite direction of displacement Δx .

F_{net} teenoorgesteld tot rigting van verplasing Δx . / Beide wrywingskrag en gravitasie krag is teenoorgesteld tot die verplasing Δx .

OR/OF

ΔK is negative. / The final K is zero. / E_k decreases.

ΔK is negatief. / Die finale K is nul. / E_k neem af.

OR/OF

$W_{\text{net}} = F_{\text{net}} \Delta x \cos \theta$ and/en $\theta = 180^\circ / \cos \theta = -1$

(1)

5.3

OPTION 1/OPSIE 1

$$\left. \begin{aligned} W_{\text{net}} &= \Delta K \\ W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ mgsin\theta\Delta x \cos\theta + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(30\,000)(9,8)\sin 28^\circ \Delta x \cos 180^\circ \checkmark + (31\,000)\Delta x \cos 180^\circ \checkmark$$

$$= \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark$$

$$\Delta x = 96,64 \text{ m} \checkmark$$

OPTION 2/OPSIE 2

$$\left. \begin{aligned} W_{\text{nc}} &= \Delta K + \Delta U \\ W_f &= \Delta K + mg(h_f - h_i) \\ f\Delta x \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$31\,000\Delta x \cos 180^\circ \checkmark = \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark + 30\,000(9,8)(\Delta x \sin 28^\circ - 0) \checkmark$$

$$\Delta x = 96,64 \text{ m} \checkmark$$

OPTION 3/OPSIE 3

$$\left. \begin{aligned} W_{\text{net}} &= \Delta K \\ W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ -\Delta E_p + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ -mg(h_f - h_i) + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$-(30\,000)(9,8)(\Delta x \sin 28^\circ - 0) \checkmark + (31\,000)\Delta x \cos 180^\circ \checkmark = \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark$$

$$\Delta x = 96,64 \text{ m} \checkmark$$

OPTION 4/OPSIE 4

$$\begin{aligned}
 W_{\text{net}} &= \Delta K \\
 W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 mg\Delta x \cos\theta + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2
 \end{aligned}
 \left. \vphantom{\begin{aligned} W_{\text{net}} &= \Delta K \\ W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ mg\Delta x \cos\theta + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned}} \right\} \checkmark \text{ Any one/Enige}$$

$$(30\,000)(9,8)\Delta x \cos 118^\circ + (31\,000)\Delta x \cos 180^\circ = \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark$$

$$\Delta x = 96,64 \text{ m} \checkmark$$

OPTION 5/OPSIE 5

$$\begin{aligned}
 F_{\text{net}} &= ma \\
 F_{\text{net}} &= F_{w//} + f \\
 &= (30\,000)(9,8)\sin 28^\circ + 31\,000 \checkmark \\
 &= 169\,024,64 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 W_{\text{net}} &= \Delta E_k \\
 F_{\text{net}}\Delta x \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2
 \end{aligned}
 \left. \vphantom{\begin{aligned} W_{\text{net}} &= \Delta E_k \\ F_{\text{net}}\Delta x \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned}} \right\} \checkmark \text{ Any one/Enige een}$$

$$169\,024,64\Delta x \cos 180^\circ = \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark$$

$$\Delta x = 96,64 \text{ m} \checkmark$$

(5)

5.4 Ascending/Opgaande $\checkmark$

$$\begin{aligned}
 1. \text{ Ascending/Opgaande: } F_{\text{net(A)}} &= F_{w//} + f \\
 \text{Descending/Afgaande: } F_{\text{net(D)}} &= F_{w//} - f
 \end{aligned}
 \left. \vphantom{\begin{aligned} F_{\text{net(A)}} &= F_{w//} + f \\ F_{\text{net(D)}} &= F_{w//} - f \end{aligned}} \right\} \checkmark$$

$$F_{\text{net(A)}} > F_{\text{net(D)}} \checkmark$$

OR/OF

2. Ascending: $F_{w//}$ and f are both acting in the opposite to direction of displacement. $\checkmark$
 Descending: only f is acting in the opposite direction of displacement. $\checkmark$
 Net force for ascending greater than net force for descending. $\checkmark$

*Opgaande: $F_{w//}$ en f werk beide teen die rigting van verplasing.
 Afgaande: slegs f werk teen die rigting van verplasing.
 Die netto krag opgaande is groter as die netto krag afgaande.*

OR/OF

3. Ascending: F_{net} acts opposite to the direction of motion. $\checkmark$
 Descending: F_{net} acts downwards in the direction of motion. $\checkmark$

*Opgaande: F_{net} werk teen die bewegingsrigting.
 Afgaande: F_{net} werk afwaarts in die bewegingsrigting.*

OR/OF

4. Ascending: $F_{w(//)}$ acts opposite to the direction of motion $\checkmark$
 Descending: $F_{w(//)}$ acts downwards in the direction of motion $\checkmark$
 Net force for ascending greater than net force for descending. $\checkmark$

*Opgaande: $F_{w(//)}$ werk teen die bewegingsrigting.
 Afgaande: $F_{w(//)}$ werk afwaarts in die bewegingsrigting.
 Die netto krag opgaande is groter as die netto krag afgaande.*

(3)

[11]

QUESTION 6/VRAAG 6

6.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.

The (apparent) change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓✓

Die (skynbare) verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/OF

An (apparent) change in observed/detected frequency/pitch as a result of the relative motion between a source and an observer/listener.

'n (Skynbare) verandering in waargenome frekwensie/toonhoogte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/ luisteraar.

(2)

6.2

$$v = f\lambda \quad \checkmark$$

$$340 = (880) \lambda \quad \checkmark$$

$$\lambda = 0,39 \text{ m } (0,386) \quad \checkmark$$

(3)

6.3

OPTION 1/OPSIE 1

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \checkmark \quad \text{OR/OF} \quad f_L = \frac{v + v_L}{v} f_s$$

$$f_L = \frac{340 + 10}{340} 880 \quad \checkmark$$

$$f_L = 905,88 \text{ Hz} \quad \checkmark$$

POSITIVE MARKING FROM QUESTION 6.2/ POSITIEWE NASIEN VANAF VRAAG 6.2

OPTION 2/OPSIE 2

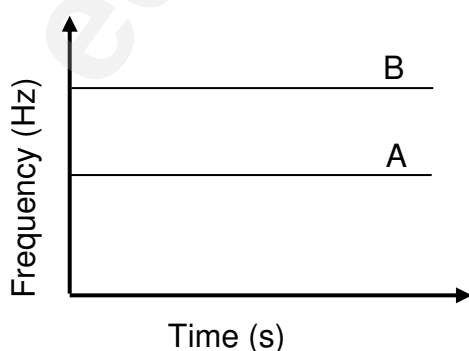
$$v = f\lambda \quad \checkmark$$

$$340 + 10 \quad \checkmark = f_L(0,39) \quad \checkmark$$

$$f_L = 897,44 \text{ Hz} \quad \checkmark$$

(4)

6.4



Marking criteria/Nasienkriteria

B parallel with A and above A. ✓✓

B parallel aan A en bokant A. 2 or/of 0

(2)

[11]

QUESTION 7/VRAAG 7

7.1.1

Marking criteria/Nasienkriteria:

If any of the underlined key words/phrases in the correct context are omitted:

- 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -

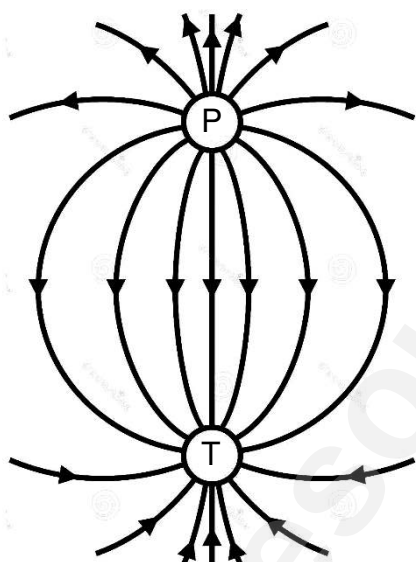
1 punt per word/frase.

The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes) of the charges ✓ and inversely proportional to the square of the distance (r) between them. ✓

Die grootte van die elektrostatische krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

(2)

7.1.2



Criteria for graph/Kriteria vir grafiek:	
Correct shape Korrekte vorm	✓
Correct direction from P to T. Korrekte rigting van P na T.	✓
Lines must not cross and must touch spheres. Lyne mag nie kruis nie en moet die sfere raak.	✓
NOTE/AANTEKENING: If the net electric field pattern is drawn for two like charges: Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is:	0/3

(3)

7.1.3 positive/ positief ✓

(1)

7.1.4

Marking criteria/Nasienkriteria

- Equation for Coulomb's law./Vergelyking vir *Coulomb se wet*. ✓
- Correct substitution into Coulomb's equation for F_{TP} . ✓
Korrekte vervanging in Coulomb se vergelyking vir F_{TP} .
- Correct substitution into Coulomb's equation for F_{TS} . ✓
Korrekte vervanging in Coulomb se vergelyking vir F_{TS} .
- Correct substitution into resultant force equation (Pythagoras equation). ✓
Korrekte vervanging in resultante krag vergelyking (Pythagoras vergelyking).
- Substitute into $Q = ne$. /Vervang in $Q = ne$. ✓
- Final answer/Finale antwoord: $3,05 \times 10^{13}$ ✓

$$F_{\text{net}}^2 = F_{TP}^2 + F_{TS}^2$$

$$= \left(\frac{kQ_1 Q_2}{r^2} \right)^2 + \left(\frac{kQ_1 Q_2}{r^2} \right)^2$$

$$10^2 = \left(\frac{(9 \times 10^9)(3 \times 10^{-6})(3 \times 10^{-6})}{0,1^2} \right)^2 + \left(\frac{(9 \times 10^9)(3 \times 10^{-6})Q_2}{0,15^2} \right)^2$$

$$Q_S = 4,887 \times 10^{-6} \text{ C}$$

$$\downarrow Q_S = ne$$

$$4,887 \times 10^{-6} = n(1,6 \times 10^{-19}) \checkmark$$

$$n = 3,05 \times 10^{13} \checkmark \text{ electrons/elektrone}$$

(6)

7.2.1

E is directly proportional to $\frac{1}{r^2}$. /E is direk eweredig aan $\frac{1}{r^2}$. ✓

OR/OF

$$E \propto \frac{1}{r^2}$$

(1)

7.2.2

Gradient = $\frac{\Delta E}{\Delta \frac{1}{r^2}}$ ✓ $680 \checkmark = \frac{E_A - (0)}{\frac{1}{0,04^2} - (0)} \checkmark$ $E_A = 4,25 \times 10^5 \text{ N} \cdot \text{C}^{-1} \checkmark$	ACCEPT/AANVAAR $E = \frac{kQ}{r^2} \checkmark$ $E_A = \frac{680}{0,04^2} \checkmark$ $= 4,25 \times 10^5 \text{ N} \cdot \text{C}^{-1} \checkmark$ OR/OF $y = mx + c / y = mx \checkmark$ $E_A = 680 \checkmark \left(\frac{1}{0,04^2} \right) \checkmark$ $= 4,25 \times 10^5 \text{ N} \cdot \text{C}^{-1} \checkmark$
---	---

(4)

7.2.3 Greater than / Groter as ✓

The gradient is equal to kQ ./The gradient is proportional to Q . ✓
Graph of sphere B has a steeper gradient than graph of sphere A. ✓
*Die gradiënt is gelyk aan kQ ./Die gradiënt is proporsioneel aan Q .
Grafiek vir sfeer B het 'n steiler gradiënt as die grafiek vir sfeer A.*

OR/OF

For the same $\frac{1}{r^2}$, E is greater for sphere B. ✓✓

Vir dieselfde $\frac{1}{r^2}$, is E groter vir sfeer B.

(3)
[20]

QUESTION 8/VRAAG 8

8.1 A conductor (resistor) which obeys Ohm's law./n Geleier wat Ohm se wet gehoorzaam. ✓✓ (2 or/of 0)

OR/OF

V always directly proportional to I at constant temperature. ✓✓ (2 or/of 0)
 V is altyd direk eweredig aan I by konstante temperatuur.

OR/OF

$\frac{V}{I} = \text{constant} / k / \text{constant at constant temperature}$. ✓✓ (2 or/of 0)

$\frac{V}{I} = \text{konstant} / k / \text{konstant bly by 'n konstante temperatuur}$.

OR/OF

A conductor for which the resistance remains constant at constant temperature when voltage or current change. ✓✓ (2 or/of 0)
'n Geleier waar die weerstand konstant bly by 'n konstante temperatuur wanneer die potensiaalverskil of die stroom verander.

(2)

8.2.1

$$R = \frac{V}{I} \checkmark$$

$$4 = \frac{3,2}{I} \checkmark$$

$$I = 0,8 \text{ A} \checkmark$$

(3)

8.2.2

<u>POSITIVE MARKING FROM QUESTION 8.2.1. /</u> <u>POSITIEWE NASIEN VANAF VRAAG 8.2.1.</u>	
<u>OPTION 1/OPSIE 1</u>	<u>OPTION 2/OPSIE 2</u>
$\epsilon = I(R+r) \checkmark$ $= 0,8 (4 + 8) + 0,5 \checkmark$ $= 10 \text{ V} \checkmark$ OR/OF $\epsilon = I(R+r) \checkmark$ $= 0,8 (4 + 8) + 0,8 \times 0,5 \checkmark$ $= 10 \text{ V} \checkmark$	$V_8 = IR$ $= (0,8)(8)$ $= 6,4 \text{ V}$ $V_{\text{ext}} = \frac{3,2 + 6,4}{} \checkmark$ $= 9,6 \text{ V}$ $V_{\text{int}} = Ir$ $= (0,8)(0,5) \checkmark$ $= 0,4 \text{ V}$ $\epsilon = I(R + r)$ $= V_{\text{ext}} + V_{\text{int}} \checkmark$ $= 9,6 + 0,4 \checkmark$ $= 10 \text{ V} \checkmark$

(4)

8.3.1

<u>POSITIVE MARKING FROM QUESTION 8.2.2./</u> <u>POSITIEWE NASIEN VANAF VRAAG 8.2.2.</u>	
<u>OPTION 1/OPSIE 1</u>	<u>OPTION 2 /OPSIE 2</u>
$V_{\text{int}} = Ir$ $1,2 = I(0,5) \checkmark$ $I = 2,4 \text{ A}$ $R_{\text{ext}} = \frac{V}{I}$ $= \frac{8,8 \checkmark}{2,4 \checkmark}$ $= 3,67 \Omega (3,667)$ $R_p = \frac{12R}{12 + R}$ $3,67 = \frac{12R}{12 + R} \checkmark$ $R = 5,29 \Omega (5,28) \checkmark$ OR/OF $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{3,67} = \frac{1}{R} + \frac{1}{12} \checkmark$ $R = 5,29 \Omega (5,28) \checkmark$	$V_{\text{int}} = 10 - 8,8$ $= 1,2 \text{ V}$ $V_{\text{int}} = Ir$ $1,2 = I(0,5) \checkmark$ $I = 2,4 \text{ A}$ $I_{\text{series branch}} = \frac{V}{R}$ $= \frac{8,8 \checkmark}{8+4}$ $= 0,73 \text{ A} (0,733)$ $I_R = \frac{2,4 - 0,73 \checkmark}{}$ $= 1,67 \text{ A} (1,667)$ $R = \frac{V}{I_R}$ $= \frac{8,8}{1,67 \checkmark}$ $= 5,27 \Omega (5,28) \checkmark$

(5)

8.3.2 There is a short circuit / *Daar is 'n kortsluiting.*

- The resistance of the connected wire is very low. / The total resistance decreases. ✓

Die weerstand van die verbindingsdrade is baie klein. / Die totale weerstand neem af.

- $I \propto \frac{1}{R}$, current delivered by the battery is very high. ✓

$I \propto \frac{1}{R}$, stroom gelewer deur die battery is baie groot.

- Higher current produces more heat. ✓

Hoër stroom produseer meer hitte.

OR/OF

Any one of the following equations can be used to explain the effect of current on heat / *Enig een van die volgende vergelykings kan gebruik word om die effek van stroom op hitte te verduidelik:*

$$W = I^2 R \Delta t / W = \frac{V^2}{R} \Delta t / W = VI \Delta t / P = I^2 R / P = \frac{V^2}{R} / P = VI$$

(3)
[17]

QUESTION 9/VRAAG 9

9.1.1 Electrical to mechanical/kinetic/rotational ✓
Elektries na meganies/kineties/rotasie (1)

9.1.2 DC/GS ✓ (1)

9.1.3 Ensures continuous rotation of the coil. ✓
Verseker aanhoudende rotasie van spoel.

OR/OF

Ensures change in direction of the current in the coil. ✓
Verseker verandering van rigting van stroom in spoel. (1)

9.2 QUESTIONS 9.2.1 AND 9.2.2/VRAE 9.2.1 EN 9.2.2

Only penalise once if subscripts are omitted.

Penaliseer slegs een keer indien onderskrifte uitgelaat is.

9.2.1

Marking criteria/Nasienkriteria:

- Correct formula to calculate resistance. ✓
Korrekte formule om weerstand te bereken.
- Substitute into formula to calculate resistance. ✓
Vervang in formule of weerstand te bereken.
- Final answer/Finale antwoord: 484 to/tot 493,83 Ω ✓

OPTION 1/OPSIE 1

$$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark$$

$$100 = \frac{220^2}{R} \checkmark$$

$$R = 484 \, \Omega \checkmark$$

OPTION 2/OPSIE 2

$$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$$

$$100 = 220 I_{\text{rms}}$$

$$I_{\text{rms}} = 0,45 \, \text{A} \, (0,455)$$

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{R} \checkmark$$

$$0,45 = \frac{220}{R} \checkmark$$

$$R = 488,89 \, \Omega \checkmark$$

OPTION 3/OPSIE 3

$$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$$

$$100 = 220 I_{\text{rms}}$$

$$I_{\text{rms}} = 0,45 \, \text{A} \, (0,455)$$

$$P_{\text{ave}} = I_{\text{rms}}^2 R \checkmark$$

$$100 = (0,45)^2 R \checkmark$$

$$R = 493,83 \, \Omega \checkmark$$

(3)

9.2.2

**POSITIVE MARKING FROM QUESTION 9.2.1/
 POSITIEWE NASIEN VANAF VRAAG 9.2.1.**

Marking criteria:

- Uses power of Y in circuit (80 W) to calculate I_{rms} of the circuit. ✓
- Determines V_{rms} across R_Z in the circuit. ✓
- Uses I_{rms} and V_{rms} across R_Z in the circuit to calculate resistance R_Z . ✓
- Use of any one relevant power equation. ✓
- Uses R_Z and 220 V to calculate X. ✓
- Final answer for X. ✓

Accept range:

846,07 W to 856,03 W

Nasienriglyne:

- Gebruik drywing van Y in stroombaan (80 W) om I_{wgk} te bereken. ✓
- Bepaal V_{wgk} oor R_Z in die stroombaan. ✓
- Gebruik I_{wgk} en V_{wgk} oor R_Z in die stroombaan om weerstand R_Z te bereken. ✓
- Gebruik van enige drywing-formule. ✓
- Gebruik R_Z en 220 V om X te bereken. ✓
- Finale antwoord vir X. ✓

Aanvaar gebied:

846,07 W tot 856,03 W

For resistor Y/Vir resistor Y

$$P_{ave} = I_{rms}^2 R$$

$$80 = I_{rms}^2 (484) \checkmark$$

$$I_{rms} = 0,407 \text{ A}$$

OR/OF

$$P_{ave} = \frac{V_{rms}^2}{R}$$

$$80 = \frac{V_{rms}^2}{484}$$

$$V_{rms} = 196,77 \text{ V}$$

$$I_{rms} = \frac{V_{rms}}{R}$$

$$= \frac{196,77}{484} \checkmark$$

$$= 0,407 \text{ A}$$

For/Vir Z

$$V_{rms} = 220 - 196,77 \checkmark$$

$$= 23,23 \text{ V}$$

$$I_{rms} = \frac{V_{rms}}{R}$$

$$[0,407 = \frac{23,23}{R}] \checkmark$$

$$R = 57,08 \Omega$$

Range/Gebied:

56,66 Ω to/tot 57,13 Ω

X for Z/X vir Z:

$$X = P_{ave} = \frac{V_{rms}^2}{R} \checkmark$$

$$= \frac{220^2}{57,08} \checkmark$$

$$= 847,93 \text{ W} \checkmark$$

OR/OF

$$I_{rms} = \frac{V_{rms}}{R}$$

$$= \frac{220}{57,08}$$

$$= 3,85 \text{ A}$$

$$X = P_{ave} = I_{rms}^2 R \checkmark$$

$$= (3,85)^2 (57,08) \checkmark$$

$$= 846,07 \text{ W} \checkmark$$

OR/OF

$$I_{rms} = \frac{V_{rms}}{R}$$

$$= \frac{220}{57,08}$$

$$= 3,85 \text{ A}$$

$$X = P_{ave} = V_{rms} I_{rms} \checkmark$$

$$= (220)(3,85) \checkmark$$

$$= 847 \text{ W} \checkmark$$

(6)

[12]

QUESTION 10/VRAAG 10

10.1.1

Marking criteria/Nasienkriteria:

If any of the underlined key words/phrases in the correct context are omitted:

- 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
 1 punt per word/frase.

The process whereby electrons are ejected from a (metal) surface when light of suitable frequency is incident on that surface. ✓✓

Die proses waartydens elektrone vrygestel word vanaf 'n (metaal) oppervlak wanneer lig van geskikte frekwensie invallend is op die oppervlak. (2)

10.1.2 For one photon/Vir een foton:

$$E = hf \checkmark$$

$$= (6,63 \times 10^{-34})(1,2 \times 10^{15}) \checkmark$$

$$= 7,96 \times 10^{-19} \text{ J}$$

NOTE/LET WEL

$$W_0 = hf_0 \quad 0/2$$

No of e^- = No of photons/Hoeveelheid fotone

$$= \frac{\text{Total energy of photons}}{\text{Energy of one photon}} / \frac{\text{Totale energie van fotone}}{\text{Energie van een foton}}$$

$$= \frac{1,75 \times 10^{-9}}{7,96 \times 10^{-19}} \checkmark$$

$$= 2,2 \times 10^9 \checkmark (2,198 \times 10^9)$$

(4)

10.1.3

POSITIVE MARKING FOR E ONLY FROM QUESTION 10.1.2/ POSITIEWE NASIEN VIR SLEGS E VANAF VRAAG 10.1.2

$$\left. \begin{aligned} E &= W_0 + K_{\max} \\ hf &= hf_0 + \frac{1}{2}mv_{\max}^2 \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$7,96 \times 10^{-19} \checkmark = (6,63 \times 10^{-34})(9,09 \times 10^{14}) \checkmark + \frac{1}{2}(9,11 \times 10^{-31})v_{\max}^2 \checkmark$$

$$v_{\max} = 6,51 \times 10^5 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(5)

10.2

An atom (electron) in higher (excited) energy state/level returns to a lower energy state/level. ✓

Energy is released as light (photons/frequencies of light are released). ✓

'n Atoom (elektron) in 'n hoër (opgewekte) energie toestand/vlak keer terug na 'n laer energievlak (grondvlak).

Energie word vrygestel as lig (fotone/frekwensies van lig word vrygestel). (2)

[13]

TOTAL/TOTAAL: 150



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2022

MARKS: 150

TIME: 3 hours



This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces in the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.



QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 A bucket is at rest on a table.

Which ONE of the following is the reaction force to the weight of the bucket, as described by Newton's Third Law?

- A Force of the table on Earth
- B Force of the bucket on Earth
- C Force of the bucket on the table
- D Force of the table on the bucket (2)

1.2 A ball is dropped from a small height above the ground.

Ignore air resistance.

The following pairs show physical quantities associated with the ball while it is falling to the ground.

In which ONE of these pairs will BOTH quantities change while the ball is falling?

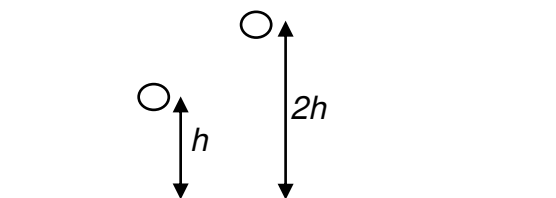
- A Mechanical energy and weight
- B Kinetic energy and momentum
- C Gravitational acceleration and kinetic energy
- D Gravitational potential energy and gravitational force (2)



- 1.3 A ball is dropped from height h and strikes the floor with momentum $\mathbf{p}$.

Ignore air resistance.

The ball is NOW dropped from height $2h$.



Which ONE of the following represents the momentum with which the ball NOW strikes the floor?

A $\mathbf{p}$

B $\sqrt{2} \mathbf{p}$

C $2\sqrt{\mathbf{p}}$

D $2\mathbf{p}$

(2)

- 1.4 Object X exerts a gravitational force $\mathbf{F}$ on object Y when the distance between the centres of the objects is $\mathbf{r}$.

The distance $\mathbf{r}$ is now DOUBLED.

Which ONE of the following represents the gravitational force that X now exerts on Y?

A $\frac{1}{4} \mathbf{F}$

B $\frac{1}{2} \mathbf{F}$

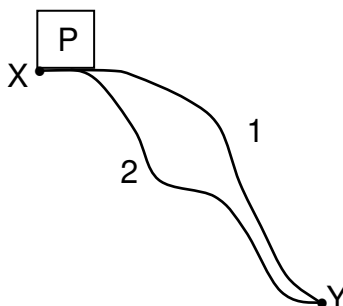
C $2\mathbf{F}$

D $4\mathbf{F}$

(2)



- 1.5 A force $\mathbf{F}$ moves an object P from point X to point Y along two different paths, 1 and 2, as shown below.



The work done by $\mathbf{F}$ in moving the object is the same for both paths. Which ONE of the following can be used to describe force $\mathbf{F}$?

- A Normal force
- B Tension force
- C Frictional force
- D Gravitational force (2)

- 1.6 Which ONE of the following can be explained by the Doppler effect?

- A A stethoscope is used to listen to a person's heartbeat.
- B An echo is heard when sound waves are reflected off a cliff.
- C The spectrum of light from an approaching star is shifted towards shorter wavelengths.
- D Sound intensity decreases when the sound source moves away from a stationary listener. (2)

- 1.7 Two oppositely charged point charges move towards each other.

Which ONE of the following is CORRECT?

The point charges move at ...

- A constant velocity.
- B decreasing velocity.
- C constant acceleration.
- D increasing acceleration. (2)

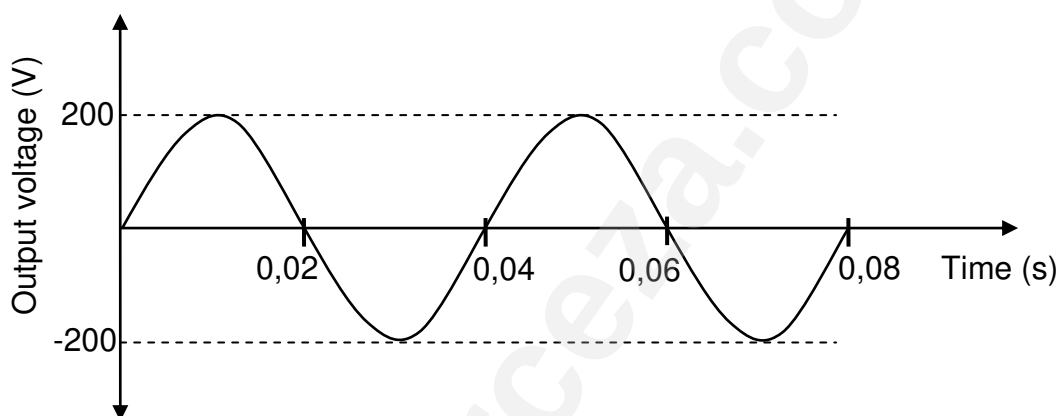


1.8 Which ONE of the following phrases describes the emf of a battery?

- A Energy supplied per unit time
- B Charge transferred per unit time
- C Current supplied per unit charge
- D Maximum energy supplied per unit charge

(2)

1.9 The graph below represents the output voltage versus time for an AC generator.



The speed of rotation of the generator's coil is now DOUBLED.

Which ONE of the combinations below shows the CORRECT new peak output voltage and the time for ONE rotation?

	PEAK OUTPUT VOLTAGE (V)	TIME FOR ONE ROTATION (S)
A	400	0,02
B	200	0,02
C	200	0,04
D	100	0,04

(2)

1.10 A photon of light of energy $2X$ joules is shone onto a metal surface with work function X joules.

Which ONE of the following represents the maximum kinetic energy (in joules) of the electron ejected from the metal by this photon?

- A Zero
- B $\frac{1}{2}X$
- C X
- D $2X$

(2)

[20]

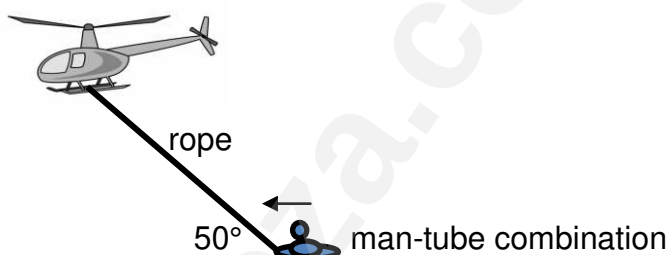


QUESTION 2 (Start on a new page.)

A man faces difficulty while swimming in a dam. During the rescue operation, an inflated tube attached to a helicopter by a rope is dropped from the helicopter.

The man, of mass 70 kg, holds onto the inflated tube of mass 4 kg, while the helicopter is flying horizontally at a **CONSTANT** speed. An average frictional force of 300 N is exerted on the man-tube combination while they are dragged horizontally along the surface of the water by the helicopter. The rope makes an angle of 50° with the surface of the water, as shown in the diagram below.

Assume that the rope is inextensible and massless, and the water of the dam does not flow.



2.1 State Newton's First Law of Motion in words. (2)

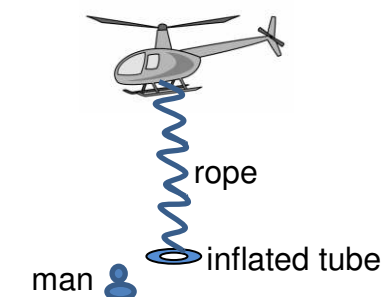
2.2 Draw a free-body diagram of the man-tube combination while they are being dragged. (4)

2.3 Calculate the tension in the rope. (4)

2.4 How will the answer to QUESTION 2.3 change if the helicopter **ACCELERATES** while dragging the man? The frictional force and the angle between the rope and the surface of the water remain the same.

Choose from **INCREASES**, **DECREASES** or **NO CHANGE**. Give a reason for the answer. (2)

In another rescue operation, the inflated tube of mass 4 kg is dropped from the stationary helicopter and it strikes the water at a speed of $16 \text{ m}\cdot\text{s}^{-1}$. The tube sinks vertically downwards into the water to a depth of 0,8 m and then rises to the surface. The rope hangs loosely.



2.5 Calculate the magnitude of the average upward force exerted on the inflated tube while it is sinking. Assume that the average upward force is constant for the motion. (5)

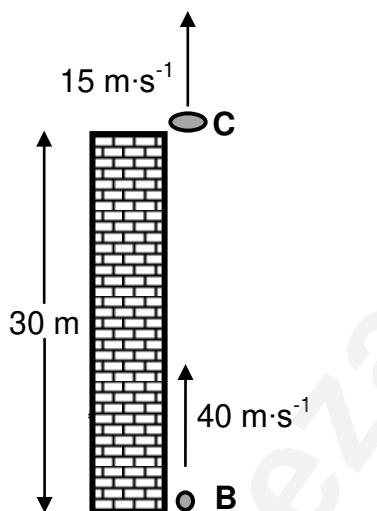
[17]



QUESTION 3 (Start on a new page.)

A small disc, **C**, is thrown vertically upwards at a speed of $15 \text{ m}\cdot\text{s}^{-1}$ from the edge of the roof of a building of height 30 m. AFTER 0,5 s, a small ball **B** is shot vertically upwards from the foot of the building at a speed of $40 \text{ m}\cdot\text{s}^{-1}$ in order to hit disc **C**.

Ignore the effects of air resistance.



3.1 Explain the term *projectile*. (2)

3.2 Calculate the:

3.2.1 Time taken by disc **C** to reach its maximum height (3)

3.2.2 Maximum height above the ground reached by disc **C** (4)

3.3 Calculate the time from the moment that disc **C** was thrown upwards until the time ball **B** hits the disc. (6)

3.4 On the same set of axes, sketch graphs of velocity versus time for disk **C** and ball **B** from the moment that disc **C** was thrown upwards until ball **B** hits disc **C**.

Label the graph for ball **B** as B and the graph for disc **C** as C.

Clearly indicate the following on the graphs:

- The initial velocities of ball **B** and disc **C**
- The time at which ball **B** was shot upward
- The time at which disc **C** reaches its maximum height
- The time at which ball **B** hits disc **C**

(5)
[20]



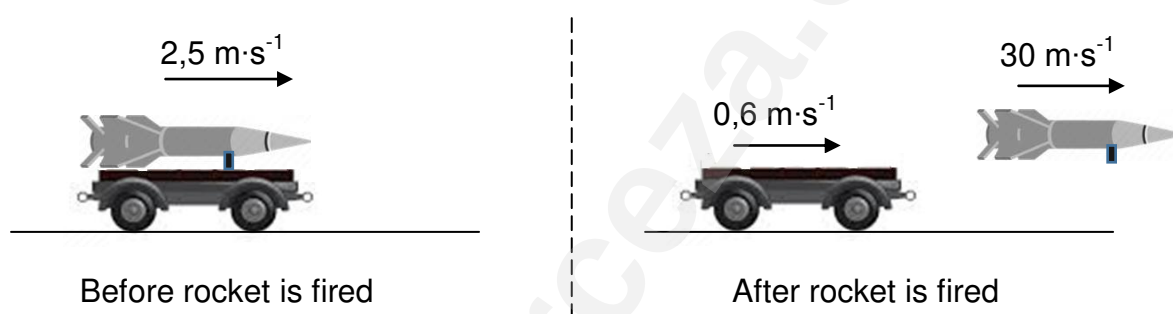
QUESTION 4 (Start on a new page.)

- 4.1 What is meant by an *isolated system* in physics? (2)

During an experiment, a rocket of unknown mass is mounted on a toy cart of mass 20 kg. The cart-rocket combination moves at a constant speed of $2,5 \text{ m}\cdot\text{s}^{-1}$ along a horizontal floor.

At a certain instant, the rocket is fired horizontally in the direction of motion at a speed of $30 \text{ m}\cdot\text{s}^{-1}$. As a result, the cart slows down to a speed of $0,6 \text{ m}\cdot\text{s}^{-1}$, as shown in the diagram below.

Ignore frictional effects.



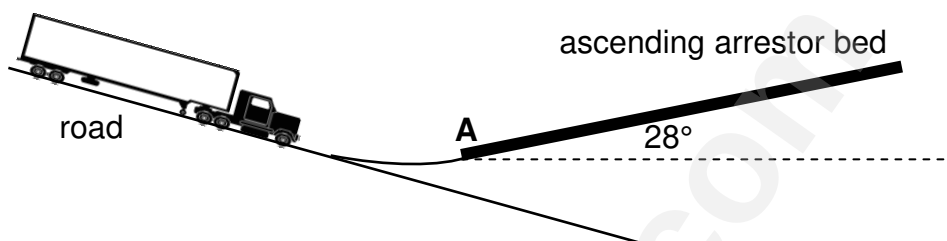
- 4.2 Use relevant physics principles to explain why the firing of the rocket will slow down the cart. (2)
- 4.3 Calculate the mass of the rocket at the instant the rocket was fired from the toy cart. (5)

[9]

QUESTION 5 (Start on a new page.)

Arrestor beds are used to help moving trucks to come to a stop when their brakes fail.

The driver of a 30 000 kg truck driving down a steep road drives onto an ASCENDING arrestor bed inclined at 28° to the horizontal, as shown in the diagram below.



5.1 State the work-energy theorem in words. (2)

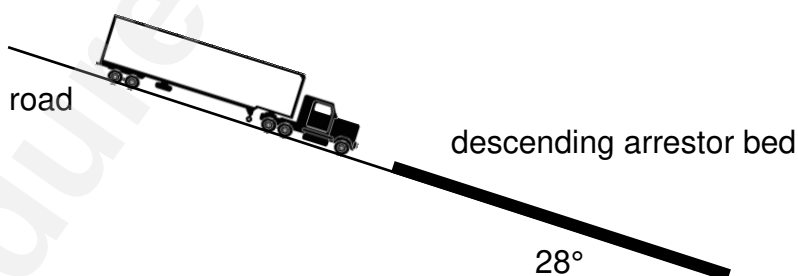
The truck with failed brakes passes point **A** at the beginning of the arrestor bed at a speed of $33 \text{ m}\cdot\text{s}^{-1}$. The average frictional force on the truck is 31 000 N while the truck moves up the arrestor bed.

Ignore the rotational effects of the wheels.

5.2 Give a reason why the net work done on the truck, while moving on the arrestor bed, is negative. (1)

5.3 Use ENERGY PRINCIPLES to calculate the minimum length of the arrestor bed needed to bring the truck to a stop. (5)

The diagram below shows the same truck entering a DESCENDING arrestor bed inclined at 28° to the horizontal. The initial speed of the truck and the average frictional force on the truck are $33 \text{ m}\cdot\text{s}^{-1}$ and 31 000 N respectively.



5.4 Which arrestor bed, ASCENDING or DESCENDING, will be able to stop the truck in a shorter distance?

Explain the answer in terms of the forces acting on the truck.

(3)

[11]



QUESTION 6 (Start on a new page.)

A car moves at a constant speed of $10 \text{ m}\cdot\text{s}^{-1}$ TOWARDS a stationary sound source. The sound source emits sound waves of frequency 880 Hz .

A sound detector **A** is attached to the car and another sound detector **B** is attached to the sound source. Detector **B** detects the sound waves reflected from the car.

The speed of sound in air is $340 \text{ m}\cdot\text{s}^{-1}$.

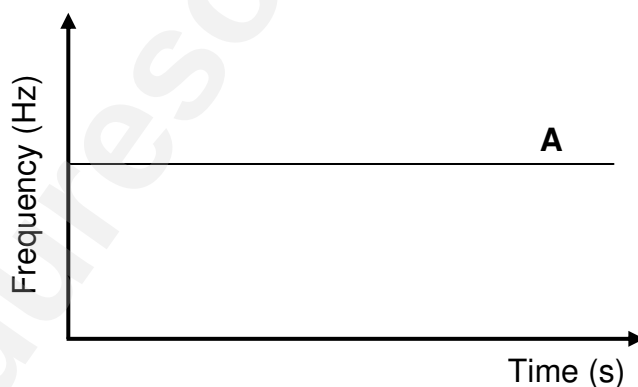


6.1 State the Doppler effect in words. (2)

6.2 Calculate the wavelength of the sound waves emitted by the source. (3)

6.3 Calculate the frequency of the sound waves detected by detector **A**. (4)

The sketch graph below shows the frequency recorded by detector **A**.



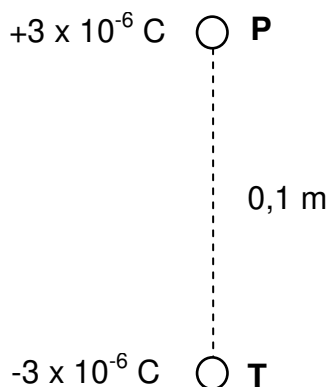
6.4 Redraw the graph above for detector **A** in your ANSWER BOOK. On the same set of axes, sketch the graph of the frequency recorded by detector **B**. Label this graph as B. (2)

[11]



QUESTION 7 (Start on a new page.)

- 7.1 Two small, identical spheres, **P** and **T**, are placed a distance of 0,1 m apart, as shown in the diagram below. **P** carries a charge of $+3 \times 10^{-6} \text{ C}$ and **T** carries a charge of $-3 \times 10^{-6} \text{ C}$.

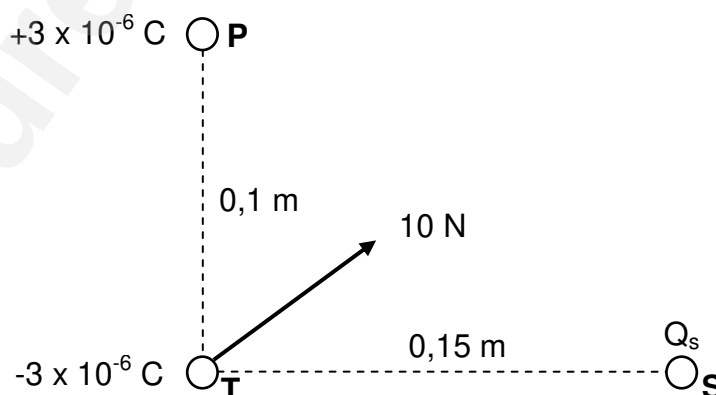


- 7.1.1 State Coulomb's law in words. (2)

- 7.1.2 Draw the resultant electric field pattern due to the charges on **P** and **T**. (3)

A third charged sphere **S** of unknown charge Q_s is placed a distance of 0,15 m from sphere **T** such that the three charged spheres are at the vertices of a right-angled triangle.

The net electrostatic force on sphere **T** due to the other two charged spheres has a magnitude of 10 N, as shown in the diagram below.

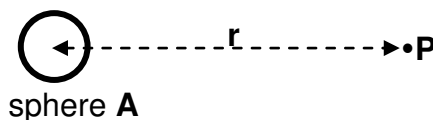


- 7.1.3 Is charge Q_s POSITIVE or NEGATIVE? (1)

- 7.1.4 Calculate the number of electrons added to or removed from sphere **S** to give it a charge of Q_s . (6)



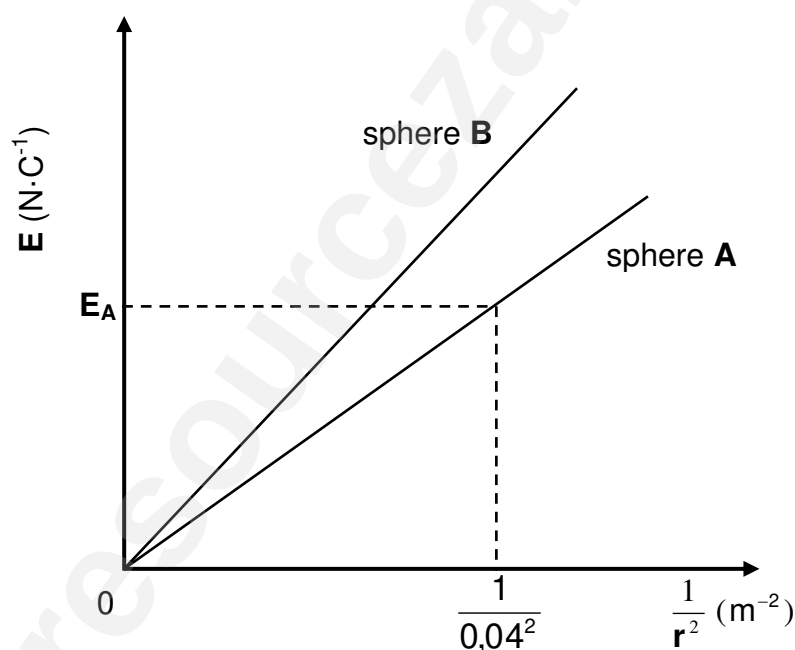
- 7.2 **P** is a variable point in the electric field of charged sphere **A** and **r** is the distance between point **P** and the centre of sphere **A**. See the diagram below.



A learner determines the magnitude of the electric field (**E**) at point **P** for different values of **r**.

Sphere **A** is then replaced by another sphere, **B**, of a different charge. Another set of results are obtained.

The graphs below are obtained from the results for sphere **A** and sphere **B**. **E_A** is the magnitude of the electric field at a distance of 0,04 m from the centre of charged sphere **A**.



Use the graphs to answer the following questions.

- 7.2.1 State the proportionality between the magnitude of electric field **E** at a point and $\frac{1}{r^2}$. (1)
- 7.2.2 Calculate **E_A** if the numerical value of the gradient of the graph for sphere **A** is 680. (4)
- 7.2.3 How does the magnitude of the charge on sphere **B** compare to the magnitude of the charge on sphere **A**?

Choose from GREATER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (3)

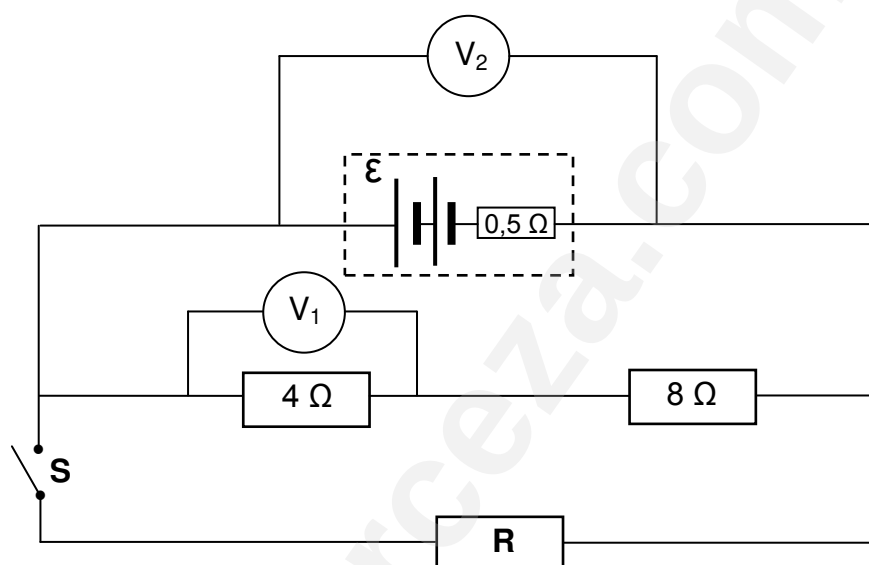
[20]



QUESTION 8 (Start on a new page.)

In the circuit below a battery of UNKNOWN emf and an internal resistance of $0,5 \Omega$ is connected to two resistors of 4Ω and 8Ω each, and a resistor **R** of unknown resistance.

Ignore the resistance of the connecting wires.



8.1 The three external resistors are ohmic conductors.

Explain the meaning of the term *ohmic conductor*.

(2)

8.2 When switch **S** is OPEN, voltmeter V_1 reads 3,2 V.

Calculate the:

8.2.1 Current through the battery

(3)

8.2.2 Emf of the battery

(4)

8.3 When switch **S** is CLOSED, voltmeter V_2 reads 8,8 V.

8.3.1 Calculate the resistance of resistor **R**.

(5)

8.3.2 The battery becomes heated when voltmeter V_2 is replaced by a connecting wire. Explain this observation.

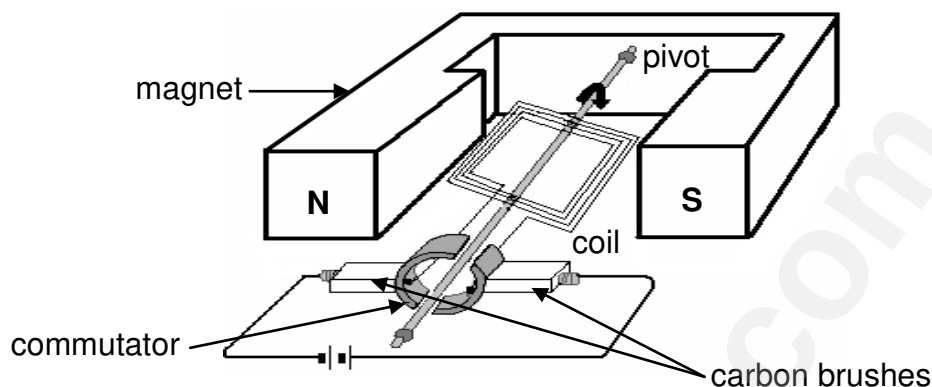
(3)

[17]



QUESTION 9 (Start on a new page.)

9.1 The simplified sketch of an electric motor is shown below.

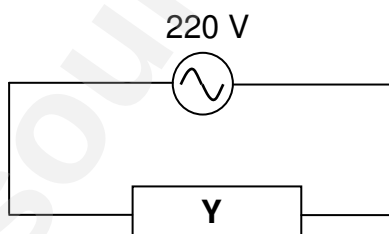


9.1.1 Write down the energy conversion that takes place in this motor. (1)

9.1.2 Is the motor above an AC motor or a DC motor? (1)

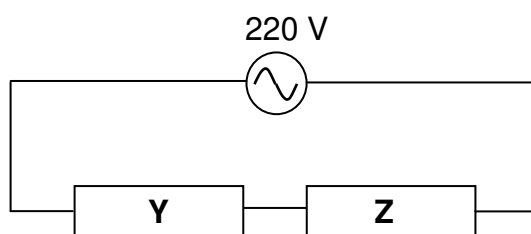
9.1.3 What is the function of the commutator in this motor? (1)

9.2 A resistor **Y** is rated 220 V, 100 W and is connected to a 220 V AC source, as shown in the circuit below.



9.2.1 Calculate the resistance of resistor **Y**. (3)

Another resistor **Z** with a rating 220 V, X W, is now connected in series to resistor **Y** and to the same AC source. See the diagram below.



The power dissipated by resistor **Y** changes to 80 W, while its resistance remains constant.

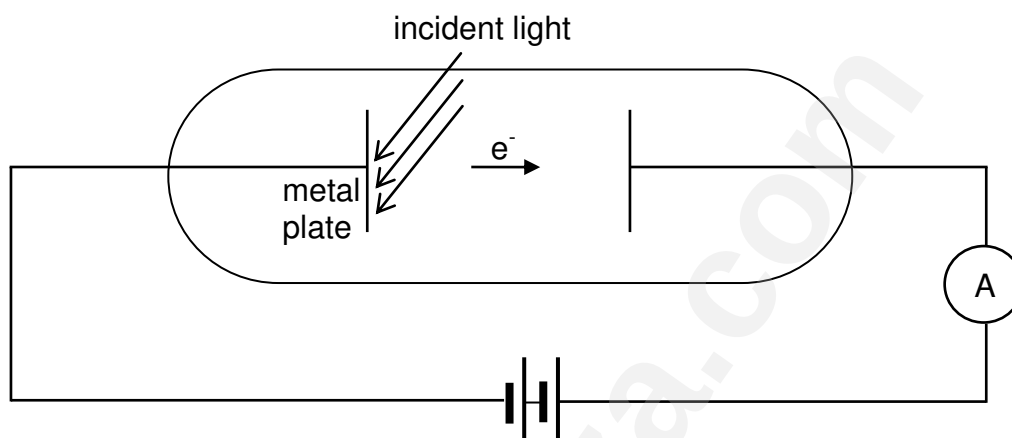
9.2.2 Calculate the power rating X of resistor **Z**, assuming that resistor **Z** has constant resistance. (6)

[12]



QUESTION 10 (Start on a new page.)

- 10.1 The apparatus illustrated in the simplified diagram below is used to demonstrate the photoelectric effect.



- 10.1.1 Define the term *photoelectric effect*. (2)

Incident light of frequency $1,2 \times 10^{15}$ Hz is shone onto the metal plate and electrons are emitted.

Calculate the:

- 10.1.2 Number of photoelectrons emitted in one second if the total energy transferred by the light to the metal plate per second is $1,75 \times 10^{-9}$ J (4)

- 10.1.3 Maximum speed of a photoelectron if the threshold frequency of the metal plate is $9,09 \times 10^{14}$ Hz (5)

- 10.2 Briefly explain how an emission spectrum is formed in terms of energy transitions. (2)
[13]

TOTAL: 150



**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$



TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$ / $P_{\text{gemid}} = F v_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or $E = W_0 + K_{\text{max}}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ / $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	
$E = W_0 + E_{k(\text{maks})}$ of $E = W_0 + K_{\text{maks}}$ waar $E = hf$ en $W_0 = hf_0$ en $E_{k(\text{maks})} = \frac{1}{2} mv_{\text{maks}}^2$ / $K_{\text{maks}} = \frac{1}{2} mv_{\text{maks}}^2$	



ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ε) = $I(R + r)$ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2023

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.



QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

- 1.1 Which ONE of the following quantities is the tendency of an object to resist a change to its state of motion?

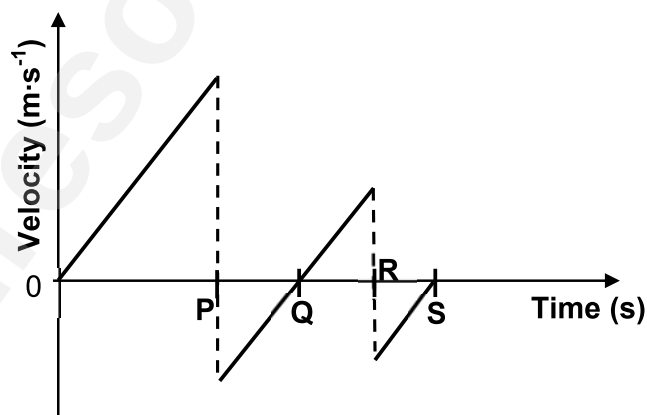
A Inertia
B Impulse
C Momentum
D Acceleration

(2)

- 1.2 A ball is dropped from rest at a height above a concrete floor. The ball strikes the floor and bounces vertically up and down on the same spot on the floor.

The velocity-time graph for the bouncing ball is shown below, with points **P**, **Q**, **R** and **S** representing different times during the motion.

Ignore the effects of air resistance.

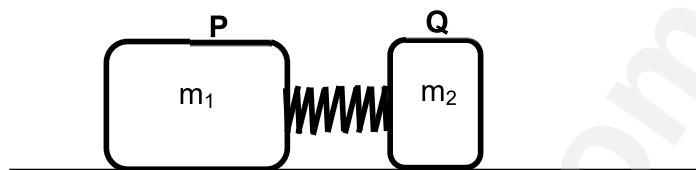


At which time does the ball reach its maximum height after the first upward bounce?

A **P**
B **Q**
C **R**
D **S**

(2)

- 1.3 Two blocks, **P** and **Q**, of masses m_1 and m_2 respectively, are held at rest on a frictionless horizontal floor with a compressed spring between them, as shown below.



When the blocks are released and the spring drops to the floor, block **Q** moves to the right with velocity $\mathbf{v}$.

Which ONE of the following represents the momentum of block **P** after the blocks are released?

- A $m_1\mathbf{v}$ to the right
 - B $m_2\mathbf{v}$ to the right
 - C $m_1\mathbf{v}$ to the left
 - D $m_2\mathbf{v}$ to the left
- (2)

- 1.4 The magnitude of the gravitational force that spheres **X** and **Y** exert on each other is $\mathbf{F}$.

The mass of sphere **X** is now doubled while the mass of sphere **Y** and the distance between the centres of the spheres remain the same.

Which ONE of the following combinations is CORRECT for the magnitude of the forces that the spheres now exert on each other?

	FORCE THAT X EXERTS ON Y	FORCE THAT Y EXERTS ON X
A	$\mathbf{F}$	$\mathbf{F}$
B	$\mathbf{F}$	$2\mathbf{F}$
C	$2\mathbf{F}$	$\mathbf{F}$
D	$2\mathbf{F}$	$2\mathbf{F}$

(2)

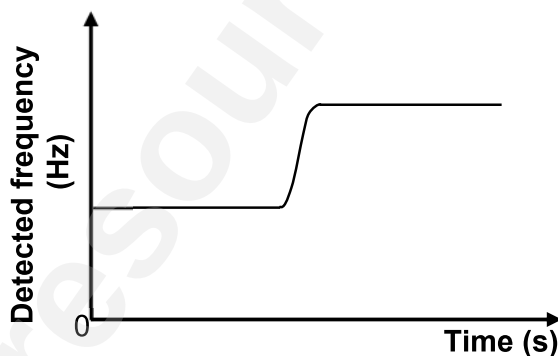
- 1.5 A hot-air balloon is moving vertically downwards at a **CONSTANT SPEED**. Assume that the mass of the hot-air balloon remains constant.

Which **ONE** of the following physical quantities associated with the hot-air balloon changes during the motion?

- A Weight
 - B Momentum
 - C Kinetic energy
 - D Potential energy
- (2)

- 1.6 A learner standing at a roadside records the frequency of sound waves produced by the siren of an ambulance. The ambulance is moving at constant velocity along a straight horizontal road.

The frequency-time graph for the detected sound is shown below.



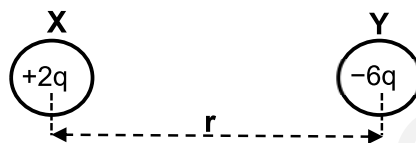
Which **ONE** of the following statements concerning the motion of the ambulance is **CORRECT**?

The ambulance ...

- A approaches the learner and then passes the learner.
 - B moves away from the learner, then turns and approaches the learner.
 - C approaches the learner, then turns and moves away from the learner.
 - D moves away from the learner and then stops.
- (2)

- 1.7 Two identically charged spheres, **X** and **Y**, carry charges of $+2q$ and $-6q$ respectively.

Sphere **X** experiences an electrostatic force **F** to the right when the distance between their centres is **r**.



The spheres are brought into contact and are then returned to their original positions.

Which ONE of the following represents the magnitude of the electrostatic force that sphere **X** experiences now?

A $\frac{1}{4} \mathbf{F}$

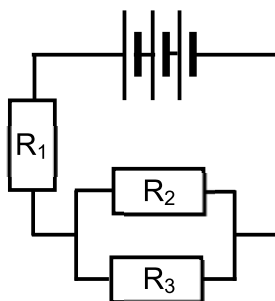
B $\frac{1}{3} \mathbf{F}$

C $4 \mathbf{F}$

D $12 \mathbf{F}$

(2)

- 1.8 In the circuit diagram below, R_1 , R_2 and R_3 are identical resistors. The battery has negligible internal resistance.



The power dissipated by R_1 is **P**.

Which ONE of the following is the power dissipated by R_2 ?

A $\frac{1}{4} \mathbf{P}$

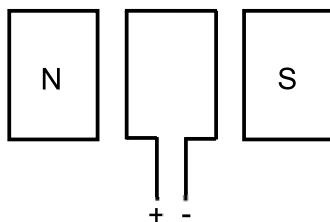
B $\frac{1}{2} \mathbf{P}$

C $2 \mathbf{P}$

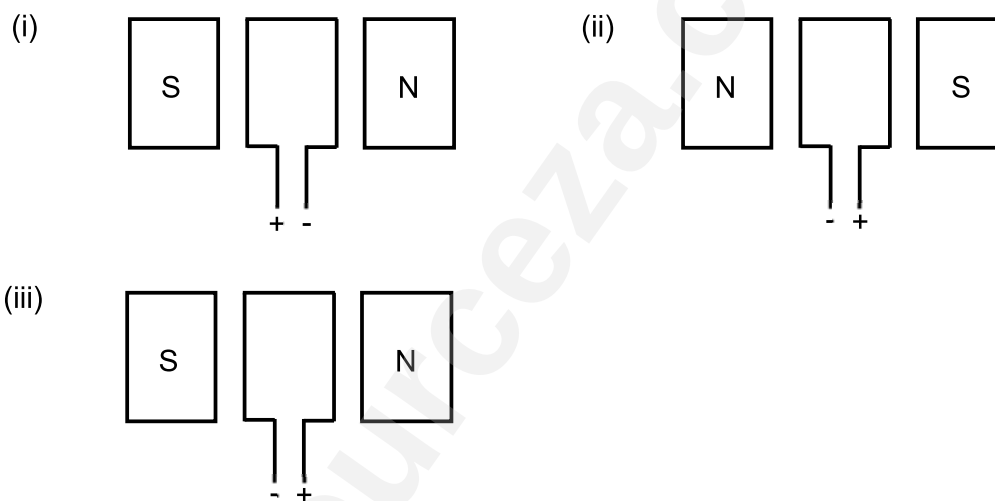
D $4 \mathbf{P}$

(2)

1.9 The simplified diagram below represents a DC motor.



The diagrams below indicate some changes made to the above motor.



Which of the changes to the motor above will change the original direction of rotation of the coil?

- A (i) and (ii) only
 B (i) and (iii) only
 C (ii) and (iii) only
 D (iii) only

(2)

1.10 An atom has a ground state energy of x . When the atom moves to a higher energy state y , a line spectrum is observed.

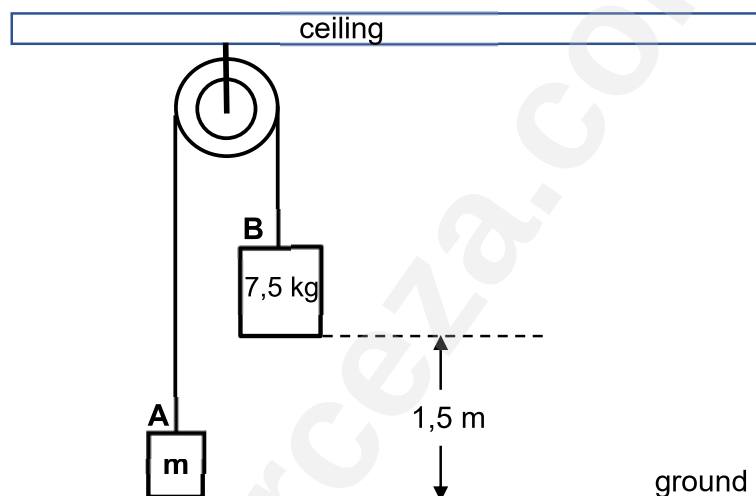
Which ONE of the following combinations is CORRECT for the ENERGY CHANGE of the atom and the TYPE OF LINE SPECTRUM observed during the transition?

	ENERGY CHANGE	TYPE OF LINE SPECTRUM
A	$y - x$	Emission
B	$x - y$	Emission
C	$x - y$	Absorption
D	$y - x$	Absorption

(2)
[20]

QUESTION 2 (Start on a new page.)

Block **A** of mass **m** is connected to block **B** of mass 7,5 kg by a light inextensible rope passing over a frictionless pulley. Block **B** is initially held at a height of 1,5 m above the ground, while block **A** is initially stationary on the ground, as shown in the diagram below.



When block **B** is released, it moves vertically downwards and strikes the ground with a velocity of $3,41 \text{ m}\cdot\text{s}^{-1}$.

Ignore the effects of friction.

- 2.1 Show, by means of a calculation, that the magnitude of the acceleration of block **B** was $3,88 \text{ m}\cdot\text{s}^{-2}$ while the block was moving vertically downwards. (3)
- 2.2 Draw a labelled free-body diagram showing ALL the forces acting on block **B** immediately after it was released. (2)
- 2.3 State Newton's Second Law of Motion in words. (2)
- 2.4 Calculate the value of **m** by applying Newton's Second Law to EACH BLOCK while they are in motion. (5)
- 2.5 Calculate the maximum height above the ground reached by block **A**. (5)

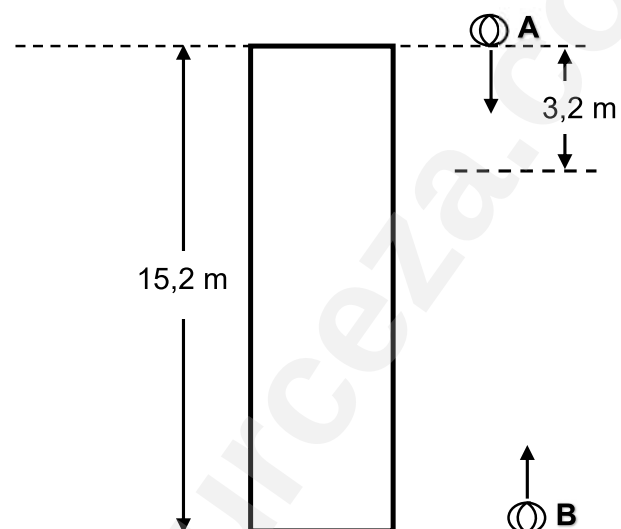
[17]

QUESTION 3 (Start on a new page.)

Ball **A** is dropped from rest from the top of a building 15,2 m high.

After ball **A** has fallen 3,2 m, a second ball **B** is projected vertically upwards from the ground. After a while, the two balls strike the ground at the SAME time.

Ignore the effects of air resistance.



3.1 Define the term *free fall*. (2)

3.2 Calculate the:

3.2.1 Time taken for ball **A** to strike the ground (3)

3.2.2 Magnitude of the velocity with which ball **B** was projected from the ground (5)

3.3 On the same system of axes, draw position-time graphs to show the motions of both ball **A** and ball **B** from the instant ball **A** is dropped until the time it reaches the ground.

Take the ground as the zero position.

Label the graphs **A** and **B**.

Clearly indicate the following on the graphs:

- The starting time for each ball
- The initial position of each ball
- The time when the balls strike the ground

(5)
[15]

QUESTION 4 (Start on a new page.)

Trolley **A** of mass 7,2 kg moves to the right at $0,4 \text{ m}\cdot\text{s}^{-1}$ in a straight line on a horizontal floor. It collides with a stationary trolley **B** of mass 5,3 kg.

After the collision, the trolleys lock together and move to the right, as shown in the diagram below.

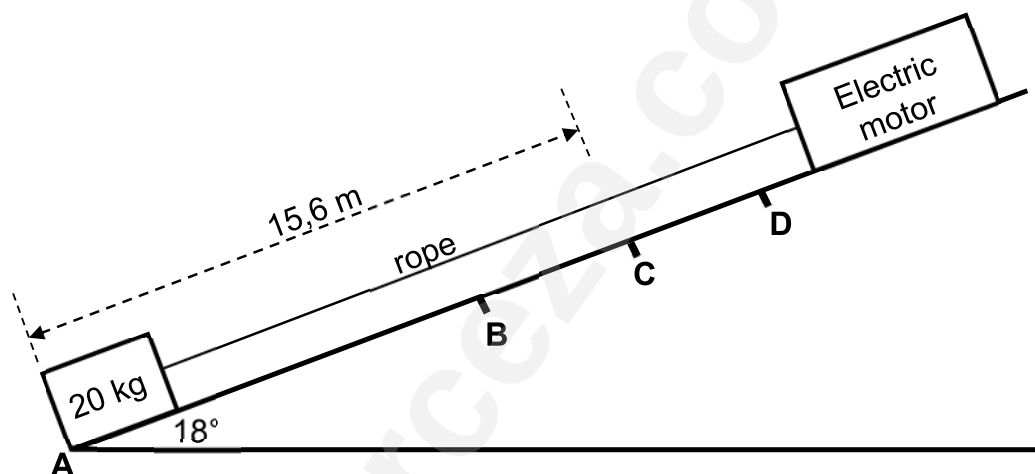
Ignore any frictional effects.



- 4.1 State the *principle of conservation of linear momentum* in words. (2)
- 4.2 Calculate the magnitude of the:
- 4.2.1 Velocity of the trolleys immediately after the collision (3)
- 4.2.2 Average net force exerted by trolley **A** on trolley **B** during the collision, if the collision time is 0,02 s (3)
- [8]**

QUESTION 5 (Start on a new page.)

An electric motor pulls a 20 kg crate from rest at point **A** up an inclined plane by means of a light inextensible rope. The inclined plane makes an angle of 18° with the horizontal. **B**, **C** and **D** are points on the inclined plane and the distance between points **A** and **C** is 15,6 m, as shown in the diagram below.



The motor exerts a constant force of 96,8 N parallel to the inclined plane on the rope.

A constant frictional force of 13,5 N acts on the crate as it is moves on the inclined plane.

- 5.1 Define a *non-conservative force*. (2)
- 5.2 Use ENERGY PRINCIPLES to calculate the speed of the crate when it reaches point **C**. (5)
- 5.3 Calculate the minimum average power dissipated by the electric motor to pull the crate from point **A** to point **C**. (3)

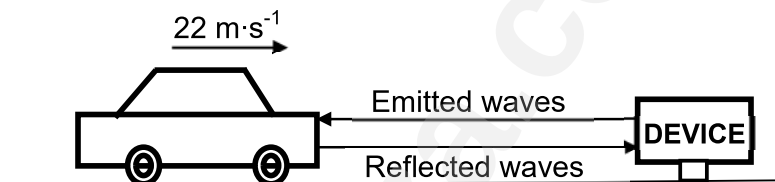
When the crate reaches point **C**, the rope breaks. The crate continues moving up the inclined plane, comes to a stop at point **D**, and then slides down the plane past point **B**.

- 5.4 Draw a labelled free-body diagram for the crate as it slides down the plane past point **B**. (3)
 - 5.5 Draw a velocity-time graph for the entire motion of the crate starting from point **A** until it passes point **B** again on its motion down the inclined plane. (4)
- [17]**

QUESTION 6 (Start on a new page.)

- 6.1 A car moves at a constant velocity of $22 \text{ m}\cdot\text{s}^{-1}$ on a straight horizontal road TOWARDS a stationary device, which can both emit and detect sound waves.

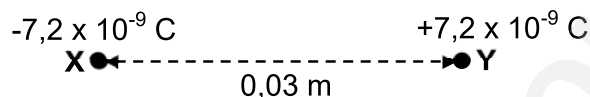
The device emits sound waves with a frequency of $24\,000 \text{ Hz}$. These sound waves are reflected off the car and the reflected sound waves are then detected by the device, as shown in the diagram below.



- 6.1.1 State the *Doppler effect* in words. (2)
- 6.1.2 If the speed of sound in air is $340 \text{ m}\cdot\text{s}^{-1}$, calculate the frequency of the reflected sound waves detected by the device. (6)
- 6.2 The spectral lines observed for a distant star show that the star is moving away from Earth. Explain, by referring to frequency, how one can deduce that the star is moving away from Earth. (2)
- [10]**

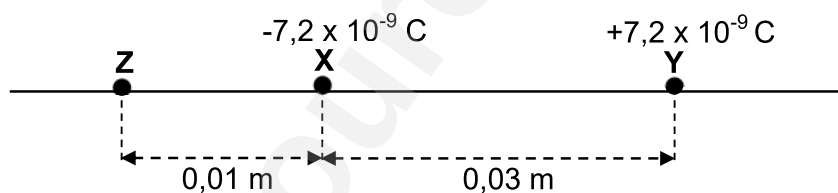
QUESTION 7 (Start on a new page.)

Two point charges, **X** and **Y**, are held 0,03 m apart, as shown in the diagram below. The charge of **X** is $-7,2 \times 10^{-9} \text{ C}$, while the charge of **Y** is $+7,2 \times 10^{-9} \text{ C}$.



- 7.1 State Coulomb's law in words. (2)
- 7.2 Draw the net electric field pattern due to the two point charges. (3)
- 7.3 Calculate the magnitude of the electrostatic force that **Y** exerts on **X**. (3)

A third point charge, **Z**, of unknown positive charge, is positioned 0,01 m to the left of point charge **X** on the line joining point charges **X** and **Y**, as shown in the diagram below.



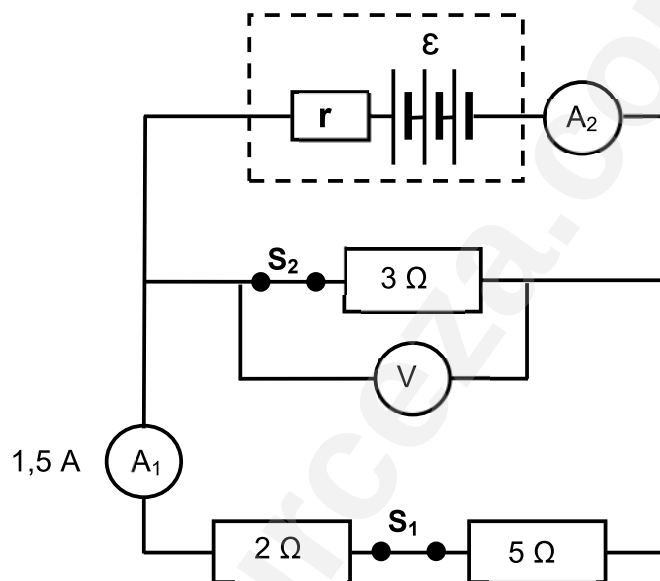
- 7.4 Draw a labelled vector diagram to show the directions of the electric fields at the point where **X** is positioned. (2)
- 7.5 The magnitude of the resultant electric field at the point where **X** is positioned is $4,91 \times 10^5 \text{ N}\cdot\text{C}^{-1}$.

Calculate the magnitude of charge **Z**.

(5)
[15]

QUESTION 8 (Start on a new page.)

A battery with unknown emf ($\mathcal{E}$) and unknown internal resistance (r) is connected to three resistors, a high-resistance voltmeter, two switches and two ammeters of negligible resistance, as shown below.



8.1 State Ohm's law in words. (2)

Both switch S_1 and switch S_2 are CLOSED. The reading on ammeter A_1 is 1,5 A.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

8.2.2 Reading on ammeter A_2 (4)

8.2.3 Power dissipated in the 3Ω resistor (3)

Switch S_1 is now OPENED, while switch S_2 remains CLOSED. The reading on ammeter A_2 is now 3,64 A.

8.3 Calculate the emf of the battery. (5)

Switch S_2 is now OPENED, while switch S_1 is CLOSED.

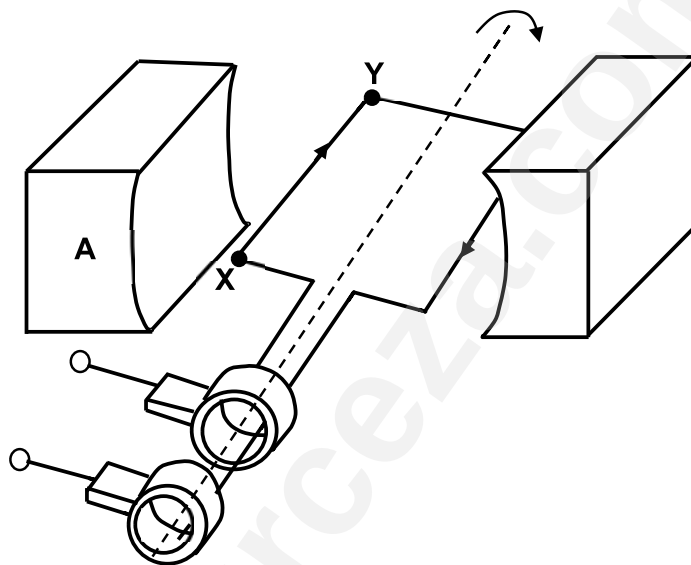
8.4 How does the voltmeter reading change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer.

(4)
[21]

QUESTION 9 (Start on a new page.)

- 9.1 The simplified sketch below represents an AC generator with the coil initially horizontal between the poles of a magnet. **X** and **Y** are two points on the coil, while **A** is one of the poles of the magnet.



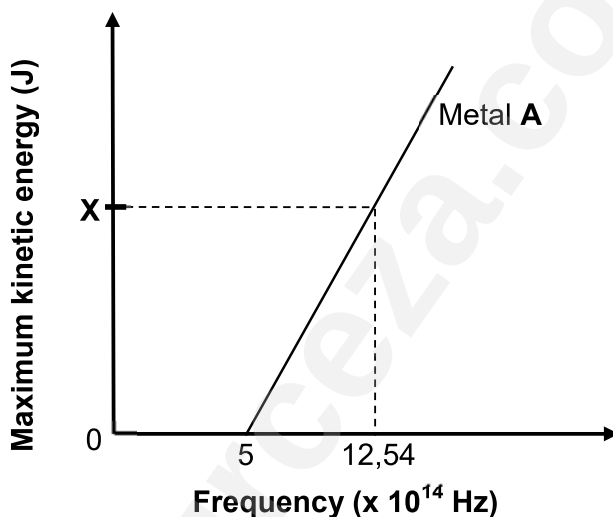
When the coil of the generator rotates clockwise between the two poles of the magnet, the direction of the induced current is from **X** to **Y**, as shown above.

- 9.1.1 Is **A** the NORTH POLE or the SOUTH POLE of the magnet? (1)
- 9.1.2 The coil is now rotated through 180° .
Will the direction of the current be from **X** to **Y** or from **Y** to **X**? (1)
- 9.1.3 Sketch an emf-time graph for TWO complete rotations of the coil, starting from the position of the coil as shown in the diagram above. (3)
- 9.2 An electrical device is connected to an AC generator. The rms potential difference across the device is 200 V and the maximum current passing through the device is 6 A.
- Calculate the:
- 9.2.1 Resistance of the device (4)
- 9.2.2 Energy consumed by the device in two hours (4)
- [13]**

QUESTION 10 (Start on a new page.)

In a photoelectric investigation, light of different frequencies was radiated on each of two metals, **A** and **B**. The graph of maximum kinetic energy of the ejected electrons from metal **A** and the frequency of the incident photons is shown below.

Point **X** on the graph represents an unknown maximum kinetic energy.



10.1 Write down the numerical value of the gradient of the graph. (1)

10.2 Define the term *work function*. (2)

10.3 Calculate the:

10.3.1 Work function of metal **A** (3)

10.3.2 Value of **X** shown on the graph (4)

10.4 How will EACH of the following be affected if light of frequency $12,54 \times 10^{14}$ Hz, but of higher intensity, is used?

Choose from INCREASES, DECREASES or NO EFFECT.

10.4.1 The value of **X** (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

Metal **B** has a larger work function than metal **A**.

10.5 Redraw the graph above in your ANSWER BOOK. (Do NOT include values on the axes.) Label this graph as **A**.

On the SAME set of axes, sketch the graph for metal **B**. Label this graph as **B**.

(2)
[14]

TOTAL: 150



**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$



TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$ / $P_{\text{gemid}} = F v_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or/of $E = W_0 + K_{\text{max}}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ or $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	
$E = W_0 + E_{k(\text{maks})}$ of $E = W_0 + K_{\text{maks}}$ waar $E = hf$ en $W_0 = hf_0$ en $E_{k(\text{maks})} = \frac{1}{2} mv_{\text{maks}}^2$ of $K_{\text{maks}} = \frac{1}{2} mv_{\text{maks}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf ($\mathcal{E}$) = $I(R + r)$ emk ($\mathcal{E}$) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$
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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN**

**PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)**

2023

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 30 pages./
Hierdie nasienriglyne bestaan uit 30 bladsye.**

GENERAL MARKING GUIDELINES PAPER 1
ALGEMENE NASIEN RIGLYNE VRAESTEL 1**1. CALCULATIONS/BEREKENINGE**

- 1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.
Punte sal toegeken word vir: korrekte formule, korrekte substitusie, korrekte antwoord met eenheid.
- 1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.
Geen punte sal toegeken word waar 'n **verkeerde of ontoepaslike formule gebruik word nie**, selfs al is daar relevante simbole en relevante substitusies.
- 1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
*Wanneer 'n fout gedurende **substitusie in 'n korrekte formule** begaan word, sal 'n punt vir die korrekte formule en vir die korrekte substitusies toegeken word, maar **geen verdere punte** sal toegeken word nie.*
- 1.4 If **no formula** is given, but all **substitutions are correct**, a candidate will **forfeit one mark**.
*Indien **geen formule** gegee is nie, **maar al die substitusies is korrek**, **verloor** die kandidaat **een punt**.*
- 1.5 **No penalisation if zero substitutions are omitted** in calculations where **correct formula/principle is given correctly**.
Geen penalisering indien nulwaardes nie getoon word nie in berekeninge waar die **formule/beginsel korrek gegee is nie**
- 1.6 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.
Wiskundige manipulasies en verandering van onderwerp van toepaslike formules tel geen punte nie, maar indien 'n kandidaat met die korrekte formule begin en dan die onderwerp van die formule verkeerd verander, sal punte vir die formule en korrekte substitusies toegeken word. Die punt vir die verkeerde numeriese antwoord word verbeur

- 1.7 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer given.
Punte word slegs vir 'n formule toegeken indien 'n poging tot 'n berekening aangewend is, d.w.s. substitusies is gedoen of 'n numeriese antwoord is gegee.
- 1.8 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
Punte kan slegs toegeken word vir substitusies wanneer waardes in formules ingestel is en nie vir waardes wat voor 'n berekening gelys is nie.
- 1.9 All calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
Alle berekenings, wanneer dit nie in die vraag gespesifiseer word nie, moet tot 'n minimum van TWEE desimale plekke afgerond word.
- 1.10 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
Indien 'n finale antwoord van 'n berekening korrek is, sal volpunte nie outomaties toegeken word nie. Nasieners sal altyd verseker dat die korrekte/toepaslike formule gebruik word en dat bewerkings, insluitende substitusies, korrek is
- 1.11 Questions where a series of calculations do not necessarily always have to follow the same order (as in circuit calculations), full marks will be awarded provided that it is a valid solution to the problem.
Vrae waar 'n reeks berekeninge nie noodwendig altyd in dieselfde volgorde hoef te wees nie (soos in stroombaanberekeninge) sal volpunte toegeken word op voorwaarde dat dit 'n geldige oplossing vir die probleem is.
- 1.12 Any calculation that will not bring the candidate closer to the answer than the original solution, will not count any marks.
Enige berekening wat nie die kandidaat nader aan die antwoord as die oorspronklike oplossing bring nie, sal geen punte tel nie.

2. Units/Eenhede

- 2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
Kandidate sal slegs een keer gepeenaliseer word vir die herhaaldelike gebruik van 'n verkeerde eenheid in 'n vraag.
- 2.2 Units are only required in the final answer to a calculation.
Eenhede word slegs in die finale antwoord op 'n berekening verlang.

- 2.3 Marks are only awarded for an answer, and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:

- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

Punte word slegs vir 'n antwoord en nie vir 'n eenheid op sigself toegeken nie. Kandidate sal dus die punt wat toegeken is vir die antwoord in elk van die volgende gevalle verbeur:

- Korrekte antwoord + verkeerde eenheid
- Verkeerde antwoord + korrekte eenheid
- Korrekte antwoord + geen eenheid

- 2.4 SI units must be used, except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \cdot s^{-1}$ or $km \cdot h^{-1}$ instead of $m \cdot s^{-1}$ where the question warrants this. *SI-eenhede moet gebruik word, behalwe in sekere gevalle, bv. $V \cdot m^{-1}$ in plaas van $N \cdot C^{-1}$, en $cm \cdot s^{-1}$ of $km \cdot h^{-1}$ in plaas van $m \cdot s^{-1}$ waar die vraag dit regverdig.*

3 General/Algemeen

- 3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc. *Indien een antwoord of berekening verlang word, maar twee word deur die kandidaat gegee, sal slegs die eerste een nagesien word, ongeag watter een korrek is. Indien twee antwoorde verlang word, sal slegs die eerste twee nagesien word, ens.*
- 3.2 For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted. *Vir nasiendoeleindes sal alternatiewe simbole (s, u, t, ens.) ook aanvaar word.*
- 3.3 Separate compound units with a multiplication dot, not a full stop, e.g. $m \cdot s^{-1}$. For marking purposes, $m.s^{-1}$ and m/s will also be accepted. *Skei saamgestelde eenhede met 'n vermenigvuldigpunt, nie met 'n punt nie, bv. $m \cdot s^{-1}$. Vir nasiendoeleindes sal $m.s^{-1}$ en m/s ook aanvaar word.*

4. Positive marking/*Positiewe nasien*

Positive marking regarding calculations will be followed in the following cases:

Positiewe nasien met betrekking tot berekenings sal in die volgende gevalle geld:

- 4.1 **Subquestion to subquestion:** When a certain variable is incorrectly calculated in one subquestion (e.g. 3.1) and needs to be substituted into another subquestion (3.2 or 3.3), **full marks** are to be awarded for the subsequent subquestions.

Subvraag na subvraag: Wanneer 'n sekere veranderlike in een subvraag (bv. 3.1) bereken word en dan in 'n ander vervang moet word (3.2 of 3.3), word **volpunte** vir die daaropvolgende subvrae toegeken.

- 4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.
- 'n Vraag met veelvuldige stappe in 'n subvraag:** Indien 'n kandidaat, byvoorbeeld, die stroom verkeerd bereken in die eerste stap as gevolg van 'n substitusiefout, verbeur die kandidaat die punt vir die substitusie sowel as die finale antwoord.

5. Negative marking/*Negatiewe nasien*

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for, for example, QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 should be considered.

'n Verkeerde antwoord, indien dit op 'n konsepsuele fout gebaseer is, kan nie korrek gemotiveer word nie. Indien die kandidaat dus gevra word om in VRAAG 3.2 die antwoord op VRAAG 3.1 te motiveer en VRAAG 3.1 is verkeerd, kan geen punte vir VRAAG 3.2 toegeken word nie. Indien die antwoord op, byvoorbeeld, VRAAG 3.1 egter op 'n berekening gebaseer is, moet die motivering vir die verkeerde antwoord in VRAAG 3.2 oorweeg word.

QUESTION 1/VRAAG 1

- 1.1 A ✓✓ (2)
- 1.2 B ✓✓ (accept Q/aanvaar Q) (2)
- 1.3 D ✓✓ (2)
- 1.4 D ✓✓ (2)
- 1.5 D ✓✓ (2)
- 1.6 B **OR/OF** D ✓✓ (2)
- 1.7 B ✓✓ (2)
- 1.8 A ✓✓ (2)
- 1.9 A ✓✓ (2)
- 1.10 D ✓✓ (2)
- [20]**



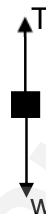
QUESTION 2/VRAAG 2

2.1

Marking criteria/Nasienkriteria • Formula to calculate a./Formule om a te bereken. ✓ • Correct substitution to calculate a./Korrekte vervanging om a te bereken. ✓✓	
OPTION 1/OPSIE 1 DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(3,41)^2 \checkmark = (0)^2 + (2)a(1,5)$ ✓ $a = 3,88 \text{ m}\cdot\text{s}^{-2}$	UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-3,41)^2 \checkmark = (0)^2 + (2)a(-1,5)$ ✓ $a = -3,88$ $a = 3,88 \text{ m}\cdot\text{s}^{-2}$
OPTION 2/OPSIE 2 DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ $1,5 = \left(\frac{0 + 3,41}{2} \right) \Delta t$ $\Delta t = 0,88 \text{ s}$ UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ $-1,5 = \left(\frac{0 - 3,41}{2} \right) \Delta t$ $\Delta t = 0,88 \text{ s}$	$v_f = v_i + a\Delta t$ ✓ $-3,41 \checkmark = (0) + a(0,88)$ ✓ $a = -3,88$ $a = 3,88 \text{ m}\cdot\text{s}^{-2}$ OR/OF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-1,5 \checkmark = (0)(0,88) + \frac{1}{2}a(0,88)^2$ ✓ $a = -3,88$ $a = 3,88 \text{ m}\cdot\text{s}^{-2}$ $v_f = v_i + a\Delta t$ ✓ $3,41 \checkmark = (0) + a(0,88)$ ✓ $a = 3,88 \text{ m}\cdot\text{s}^{-2}$ OR/OF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,5 \checkmark = (0)(0,88) + \frac{1}{2}a(0,88)^2$ ✓ $a = 3,88 \text{ m}\cdot\text{s}^{-2}$

(3)

2.2

**ACCEPT/AANVAAR**

	Accepted symbols/Aanvaarde simbole
W ✓	F_g/F_w /weight/gewig/mg/gravitational force/gravitasiekrag/ $F_{\text{Earth on block}}$ / $F_{\text{Aarde op blok}}$ /73,5N
T ✓	Tension/Spinning/ F_{Tension} / F_{Spanning} / F_{rope} / F_{tou} / F_T / F
Notes/Aantekeninge: - Mark awarded for label <u>and</u> arrow./Punt toegeken vir byskrif <u>en</u> pyltjie. - Do not penalise for length of arrows since drawing is not to scale./Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie. - Any other additional force(s)/Enige ander addisionele krag(te): Max/Maks $\frac{1}{2}$	

(2)

2.3

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. ✓✓

Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp is.

OR/OF

The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force.

Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum van die voorwerp in dieselfde rigting as die resulterende/netto krag.

(2)

2.4

Marking criteria/Nasienkriteria - Any correct formula./Enige korrekte formule. ✓ - Correct substitution to calculate tension./Korrekte vervanging om spanning te bereken. ✓✓ - Correct substitution to calculate mass of block A./Korrekte vervanging om massa van blok A te bereken. ✓ - Correct final answer/Korrekte finale antwoord: 3,25 kg ✓	
Calculation of tension (Block B) 3 marks: Berekening van spanning (Blok B) 3 punte:	Calculation of mass (Block A) 2 marks: Berekening van massa (Blok A) 2 punte:
DOWNWARDS POSITIVE/AFWAARTS POSITIEF $\left. \begin{array}{l} F_{\text{net}} = ma \\ F_g + T = ma \\ mg - T = ma \end{array} \right\} \begin{array}{l} \checkmark \text{Any one/} \\ \text{Enige een} \end{array}$ $\underline{7,5(9,8) - T} \checkmark = \underline{7,5(3,88)} \checkmark$ $T = 44,40 \text{ N}$ UPWARDS POSITIVE/OPWAARTS POSITIEF $\left. \begin{array}{l} F_{\text{net}} = ma \\ T - F_g = ma \\ T - mg = ma \end{array} \right\} \begin{array}{l} \checkmark \text{Any one/} \\ \text{Enige een} \end{array}$ $\underline{T - 7,5(9,8)} \checkmark = \underline{7,5(-3,88)} \checkmark$ $T = 44,40 \text{ N}$	UPWARDS POSITIVE/OPWAARTS POSITIEF $\left. \begin{array}{l} F_{\text{net}} = ma \\ T - F_g = ma \\ T - mg = ma \end{array} \right\} \begin{array}{l} \checkmark \text{Any one/} \\ \text{Enige een} \end{array}$ $\underline{44,40 - m(9,8)} \checkmark = \underline{m(3,88)} \checkmark$ $m = 3,25 \text{ kg} \checkmark$ DOWN POSITIVE/AF POSITIEF $\left. \begin{array}{l} F_{\text{net}} = ma \\ F_g - T = ma \\ mg - T = ma \end{array} \right\} \begin{array}{l} \checkmark \text{Any one/} \\ \text{Enige een} \end{array}$ $\underline{m(9,8) - 44,40} \checkmark = \underline{m(-3,88)} \checkmark$ $m = 3,25 \text{ kg} \checkmark$

(5)

2.5

Marking criteria/Nasienkriteria

- Any correct formula./Enige korrekte formule. ✓
- Correct substitution of v_i and v_f ./Korrekte vervanging van v_i en v_f . ✓
- Correct substitution of $9,8 \text{ m} \cdot \text{s}^{-2}$./Korrekte vervanging van $9,8 \text{ m} \cdot \text{s}^{-2}$. ✓
- Adding 1,5 m to calculated Δy . /Tel 1,5 m by berekende Δy . ✓
- Correct final answer/Korrekte finale antwoord: 2,09 m ✓

OPTION 1/OPSIE 1**UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$(0^2) = (3,41)^2 \checkmark + (2)(-9,8)\Delta y \quad \checkmark$$

$$\Delta y = 0,59 \text{ m}$$

$$\text{Maximum height} = 0,59 + 1,5 \quad \checkmark$$

$$= 2,09 \text{ m} \quad \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$(0^2) = (-3,41)^2 \checkmark + (2)(9,8)\Delta y \quad \checkmark$$

$$\Delta y = -0,59$$

$$\Delta y = 0,59 \text{ m}$$

$$\text{Maximum height} = 0,59 + 1,5 \quad \checkmark$$

$$= 2,09 \text{ m} \quad \checkmark$$

OPTION 2/OPSIE 2**UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t$$

$$0 = 3,41 + (-9,8)\Delta t$$

$$\Delta t = 0,35 \text{ s}$$

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \checkmark$$

$$= (3,41)(0,35) \checkmark + \frac{1}{2}(-9,8)(0,35)^2 \quad \checkmark$$

$$= 0,59 \text{ m}$$

$$\text{Maximum height} = 0,59 + 1,5 \quad \checkmark$$

$$= 2,09 \text{ m} \quad \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

$$v_f = v_i + a\Delta t$$

$$0 = -3,41 + (9,8)\Delta t$$

$$\Delta t = 0,35 \text{ s}$$

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \checkmark$$

$$= (-3,41)(0,35) \checkmark + \frac{1}{2}(9,8)(0,35)^2 \quad \checkmark$$

$$= -0,59$$

$$\Delta y = 0,59 \text{ m}$$

$$\text{Maximum height} = 0,59 + 1,5 \quad \checkmark$$

$$= 2,09 \text{ m} \quad \checkmark$$

OPTION 3/OPSIE 3 UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ $0 = 3,41 + (-9,8)\Delta t$ $\Delta t = 0,35 \text{ s}$ $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$ $\Delta y = \left(\frac{3,41 + 0}{2} \right) \checkmark (0,35) \checkmark$ $= 0,59 \text{ m}$ Maximum height = $0,59 + 1,5 \checkmark$ $= 2,09 \text{ m} \checkmark$	DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ $0 = -3,41 + (9,8)\Delta t$ $\Delta t = 0,35 \text{ s}$ $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$ $\Delta y = \left(\frac{-3,41 + 0}{2} \right) \checkmark (0,35) \checkmark$ $= -0,59 \text{ m}$ Maximum height = $0,59 + 1,5 \checkmark$ $= 2,09 \text{ m} \checkmark$
Note/Aantekening: OPTION 4 TO 5/OPSIE 4 TOT 5 Substitution of incorrect mass/Vervanging van verkeerde massa: max/maks: $\frac{3}{5}$	
OPTION 4/OPSIE 4 $\left. \begin{aligned} (E_{\text{mech}})_{\text{top}} &= (E_{\text{mech}})_{\text{bottom}} \\ (E_p + E_k)_{\text{top}} &= (E_p + E_k)_{\text{bottom}} \\ (mgh + \frac{1}{2}mv_i^2)_{\text{top}} &= (mgh + \frac{1}{2}mv_f^2)_{\text{bottom}} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{(9,8)(h) + (0)} \checkmark = \underline{(0) + \frac{1}{2}(3,41)^2} \checkmark$ $h = 0,59 \text{ m}$ Maximum height = $0,59 + 1,5 \checkmark$ $= 2,09 \text{ m} \checkmark$	
OPTION 5/OPSIE 5 $\left. \begin{aligned} W_{\text{nc}} &= \Delta K + \Delta U \\ W_{\text{nc}} &= \Delta K + mg(h_f - h_i) \\ 0 &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{(0) = (0) - \frac{1}{2}(3,41)^2} \checkmark + \underline{(9,8)(h)} \checkmark$ $h = 0,59 \text{ m}$ Maximum height = $0,59 + 1,5 \checkmark$ $= 2,09 \text{ m} \checkmark$	
OPTION 6/OPSIE 6 $\left. \begin{aligned} W_{\text{net}} &= \Delta E_k \\ w\Delta y \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{(9,8)(\Delta y) \cos 180^\circ} \checkmark = \underline{0 - \frac{1}{2}(3,41)^2} \checkmark$ $\Delta y = 0,59 \text{ m}$ Maximum height = $0,59 + 1,5 \checkmark$ $= 2,09 \text{ m} \checkmark$	

(5)
[17]

QUESTION 3/VRAAG 3

- 3.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓
 Beweging slegs onder die invloed van gravitasie/gewig/gravitasiekrag.

(2 or/of 0)

OR/OFMotion in which the only force acting is the gravitational force.Beweging waar die enigste krag wat inwerk gravitasiekrag is.

(2)

3.2.1

Marking criteria/Nasienkriteria

- Formula to calculate Δt ./Formule om Δt te bereken. ✓
- Correct substitution to calculate Δt ./Korrekte vervanging om Δt te bereken. ✓
- Final answer/Finale antwoord: 1,76 s ✓

OPTION 1/OPSIE 1**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$-15,2 = (0) + \frac{1}{2}(-9,8) \Delta t^2 \checkmark$$

$$\Delta t = 1,76 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$15,2 = (0) + \frac{1}{2}(9,8) \Delta t^2 \checkmark$$

$$\Delta t = 1,76 \text{ s} \checkmark$$

OPTION 2/OPSIE 2**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = (0)^2 + (2)(-9,8)(-15,2)$$

$$v_f = -17,26 \text{ m} \cdot \text{s}^{-1}$$

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$-17,26 = (0) + (-9,8) \Delta t \checkmark$$

$$\Delta t = 1,76 \text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = (0)^2 + (2)(9,8)(15,2)$$

$$v_f = 17,26 \text{ m} \cdot \text{s}^{-1}$$

OR/OF

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$-15,2 = \left(\frac{0 - 17,26}{2} \right) \Delta t \checkmark$$

$$\Delta t = 1,76 \text{ s} \checkmark$$

OPTION 3/OPSIE 3

$$(E_{\text{mech}})_{\text{top}} = (E_{\text{mech}})_{\text{bottom}}$$

$$(E_p + E_k)_{\text{top}} = (E_p + E_k)_{\text{bottom}}$$

$$(mgh + \frac{1}{2}mv_i^2)_{\text{top}} = (mgh + \frac{1}{2}mv_f^2)_{\text{bottom}}$$

$$(9,8)(15,2) + 0 = 0 + (\frac{1}{2})(v_f)^2$$

$$v_f = 17,26 \text{ m} \cdot \text{s}^{-1}$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f = v_i + a\Delta t \checkmark$$

$$17,26 = (0) + (9,8) \Delta t \checkmark$$

$$\Delta t = 1,76 \text{ s} \checkmark$$

OPTION 4/OPSIE 4

$$W_{\text{nc}} = \Delta K + \Delta U$$

$$W_{\text{nc}} = \Delta K + mg(h_f - h_i)$$

$$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$$

$$0 = \frac{1}{2}(v_f^2 - 0) + (9,8)(15,2)$$

$$v_f = 17,26 \text{ m} \cdot \text{s}^{-1}$$

OR/OF

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$15,2 = \left(\frac{0 + 17,26}{2} \right) \Delta t \checkmark$$

$$\Delta t = 1,76 \text{ s} \checkmark$$

OPTION 5/OPSIE 5

$$W_{\text{net}} = \Delta E_k$$

$$W \Delta y \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$(9,8)(15,2) \cos 180^\circ = 0 - \frac{1}{2}(v_f)^2$$

$$v_f = 17,26 \text{ m} \cdot \text{s}^{-1}$$

OPTION 6/OPSIE 6 UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF $F_{\text{net}}\Delta t = \Delta p = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ $\frac{-9,8\Delta t = -17,26 - (0)}{\Delta t = 1,76 \text{ s}} \checkmark$	DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF $F_{\text{net}}\Delta t = \Delta p = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ $\frac{9,8\Delta t = 17,26 - (0)}{\Delta t = 1,76 \text{ s}} \checkmark$
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(3)

3.2.2 POSITIVE MARKING FROM QUESTION 3.2.1.

POSITIEWE NASIEN VANAF VRAAG 3.2.1.**Marking criteria/Nasienkriteria**

- Correct substitution to calculate Δt for ball A./Korrekte vervanging om Δt te bereken vir bal A. $\checkmark$
- Subtraction $1,76 - 0,81$./Aftrekking $1,76 - 0,81$. $\checkmark$
- Correct formula to calculate v_i for ball B./Korrekte formule om v_i te bereken vir bal B. $\checkmark$
- Correct substitution to calculate v_i for ball B./Korrekte vervanging om v_i te bereken vir bal B. $\checkmark$
- Final answer/Finale antwoord: $4,66 \text{ m}\cdot\text{s}^{-1}$ $\checkmark$ (4,66 to/tot 4,7)

OPTION 1/OPSIE 1**UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$\frac{-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2 \checkmark}{\Delta t = 0,81 \text{ s}}$$

$$\Delta t(B) = \frac{1,76 - 0,81}{\Delta t(B) = 0,95 \text{ s}}$$

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$\frac{(0) = v_i(0,95) + \frac{1}{2}(-9,8)(0,95)^2 \checkmark}{v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark}$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$\frac{3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2 \checkmark}{\Delta t = 0,81 \text{ s}}$$

$$\Delta t(B) = \frac{1,76 - 0,81}{\Delta t(B) = 0,95 \text{ s}}$$

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$\frac{0 = -v_i(0,95) + \frac{1}{2}(9,8)(0,95)^2 \checkmark}{v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark}$$

OPTION 2/OPSIE 2**UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$\frac{-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2 \checkmark}{\Delta t = 0,81 \text{ s}}$$

$$\Delta t(B) = \frac{1,76 - 0,81}{\Delta t(B) = 0,95 \text{ s}}$$

$$v_f = v_i + a\Delta t$$

$$\frac{-v_i = v_i + (-9,8)(0,95) \checkmark}{v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark}$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$\frac{3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2 \checkmark}{\Delta t = 0,81 \text{ s}}$$

$$\Delta t(B) = \frac{1,76 - 0,81}{\Delta t(B) = 0,95 \text{ s}}$$

$$v_f = v_i + a\Delta t$$

$$\frac{v_i = -v_i + (9,8)(0,95) \checkmark}{v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark}$$

Calculate/Bereken: $v_f = 7,92 \text{ m}\cdot\text{s}^{-1}$ OPTION 3/OPSIE 3 UPWARDS +/ OPWAARTS + $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (0)^2 + (2)(-9,8)(-3,2)$ $v_f = -7,92 \text{ m}\cdot\text{s}^{-1}$ DOWNWARDS +/ AFWAARTS + $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (0)^2 + (2)(9,8)(3,2)$ $v_f = 7,92 \text{ m}\cdot\text{s}^{-1}$ OPTION 4/OPSIE 4 $(E_{\text{mech}})_{\text{top}} = (E_{\text{mech}})_{\text{bot}}$ $(E_p + E_k)_{\text{top}} = (E_p + E_k)_{\text{bot}}$ $(mgh + \frac{1}{2}mv_i^2)_{\text{top}} = (mgh + \frac{1}{2}mv_f^2)_{\text{bot}}$ $(9,8)(3,2) + 0 = 0 + (\frac{1}{2})(v_f)^2$ $v_f = 7,92 \text{ m}\cdot\text{s}^{-1}$ OPTION 5/OPSIE 5 $W_{\text{nc}} = \Delta K + \Delta U$ $W_{\text{nc}} = \Delta K + mg(h_f - h_i)$ $0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ $0 = \frac{1}{2}(v_f^2 - 0) + (9,8)(3,2)$ $v_f = 7,92 \text{ m}\cdot\text{s}^{-1}$ OPTION 6/OPSIE 6 $W_{\text{net}} = \Delta E_k$ $w\Delta y \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(9,8)(3,2)\cos 0^\circ = \frac{1}{2}v_f^2 - 0$ $v_f = 7,92 \text{ m}\cdot\text{s}^{-1}$	Calculate/Bereken: $\Delta t(B) = 0,95 \text{ s}$ UPWARDS +/ OPWAARTS + $v_f = v_i + a\Delta t$ $-7,92 = (0) + (-9,8)\Delta t \checkmark$ $\Delta t = 0,81 \text{ s}$ $\Delta t(B) = \frac{1,76 - 0,81}{\checkmark}$ $\Delta t(B) = 0,95 \text{ s}$ OR/OF $\Delta y = \left(\frac{v_i + v_f}{2}\right) \Delta t$ $-3,2 = \left(\frac{0 - 7,92}{2}\right) \Delta t \checkmark$ $\Delta t = 0,81 \text{ s}$ $\Delta t(B) = \frac{1,76 - 0,81}{\checkmark}$ $\Delta t(B) = 0,95 \text{ s}$ OR/OF $\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2$ $-12 \checkmark = -7,92\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$ $\Delta t = 0,95 \text{ s}$ DOWNWARDS +/ AFWAARTS + $v_f = v_i + a\Delta t$ $7,92 = (0) + (9,8)\Delta t \checkmark$ $\Delta t = 0,81 \text{ s}$ $\Delta t(B) = \frac{1,76 - 0,81}{\checkmark}$ $\Delta t(B) = 0,95 \text{ s}$ OR/OF $\Delta y = \left(\frac{v_i + v_f}{2}\right) \Delta t$ $3,2 = \left(\frac{0 + 7,92}{2}\right) \Delta t \checkmark$ $\Delta t = 0,81 \text{ s}$ $\Delta t(B) = \frac{1,76 - 0,81}{\checkmark}$ $\Delta t(B) = 0,95 \text{ s}$ OR/OF $\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2$ $12 \checkmark = 7,92\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$ $\Delta t = 0,95 \text{ s}$	Calculate/Bereken: $v_i = 4,66 \text{ m}\cdot\text{s}^{-1}$ UPWARDS +/ OPWAARTS + $(\Delta t_{\text{up and down}} = 0,95 \text{ s})$ $v_f = v_i + a\Delta t \checkmark$ $-v_i = v_i + (-9,8)(0,95) \checkmark$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark$ OR/OF $(\Delta t_{\text{up}} = 0,475 \text{ s})$ $v_f = v_i + a\Delta t \checkmark$ $0 = v_i + (-9,8)(0,475) \checkmark$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark$ OR/OF $\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $0 = v_i(0,95) + \frac{1}{2}(-9,8)(0,95)^2 \checkmark$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark$ DOWNWARDS +/ AFWAARTS + $v_f = v_i + a\Delta t \checkmark$ $v_i = v_i + (9,8)(0,95) \checkmark$ $= -4,66$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark$ OR/OF $(\Delta t_{\text{up}} = 0,475 \text{ s})$ $v_f = v_i + a\Delta t \checkmark$ $0 = v_i + (9,8)(0,475) \checkmark$ $= -4,66$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark$ OR/OF $\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $0 = -v_i(0,95) + \frac{1}{2}(9,8)(0,95)^2 \checkmark$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark$
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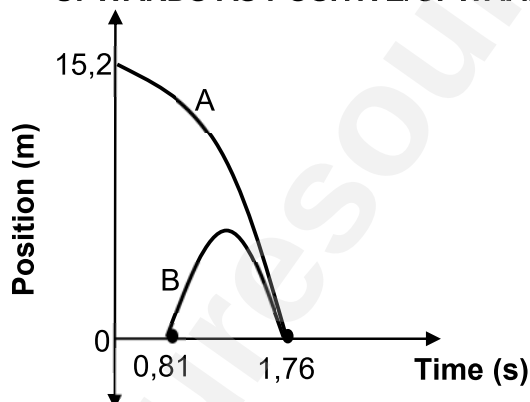
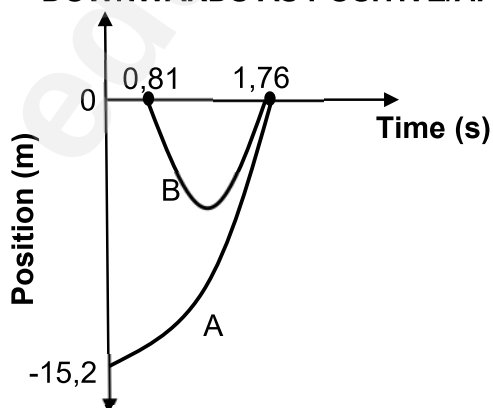
OPTION 7/OPSIE 7 UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF $\left. \begin{aligned} F_{\text{net}}\Delta t &= \Delta p \\ &= m(v_f - v_i) \end{aligned} \right\} \begin{array}{l} \checkmark \text{Any one} \\ \text{/Enige een} \end{array}$ $(-9,8)(0,95) \checkmark = -2v_i \checkmark \checkmark$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} \checkmark (4,655 \text{ m}\cdot\text{s}^{-1})$	DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF $\left. \begin{aligned} F_{\text{net}}\Delta t &= \Delta p \\ &= m(v_f - v_i) \end{aligned} \right\} \begin{array}{l} \checkmark \text{Any one} \\ \text{/Enige een} \end{array}$ $(9,8)(0,95) \checkmark = 2v_i \checkmark \checkmark$ $v_i = 4,66 \text{ m}\cdot\text{s}^{-1} (4,655 \text{ m}\cdot\text{s}^{-1}) \checkmark$
---	--

(5)

3.3

POSITIVE MARKING FROM QUESTION 3.2.1/**POSITIEWE NASIEN VANAF VRAAG 3.2.1****Marking criteria/Nasienkriteria:**

- Initial position of ball A = 15,2 m and B = 0 m./Oorspronklike posisie van A = 15,2 m en B = 0 m. ✓
- Starting times for A = 0 s and B = 0,81 s./Begintye van A = 0 s en B = 0,81 s. ✓
- Both balls strike the ground at t = 1,76 s./Albei balle tref die grond op t = 1,76 s. ✓
- Shape of graph for ball A./Vorm van grafiek vir bal A. ✓
- Shape of graph for ball B./Vorm van grafiek vir bal B. ✓
- If graphs are drawn on separate axis/Indien grafieke op aparte asse geteken word:
max/maks: 4/5

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF (CHANGED GRAPH)**DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:**

(5)

[15]

QUESTION 4 /VRAAG 4

4.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

In an isolated system the total (linear) momentum is conserved/remains constant. ✓✓ (accept closed system)

In 'n geïsoleerde sisteem bly die totale (lineêre) momentum behoue/konstant. ✓✓ (aanvaar geslote sisteem)

ACCEPT FOR 1 MARK/AANVAAR VIR 1 PUNT

The total (linear) momentum before collision is equal to the total (linear) momentum after collision provided the system is isolated/the net external force on the system is zero.

Die totale (lineêre) momentum voor 'n botsing is gelyk aan die totale (lineêre) momentum na botsing mits die stelsel geïsoleer is/die netto eksterne krag op die stelsel is nul.

(2)

4.2.1

OPTION 1/OPSIE 1**RIGHT AS POSITIVE/REGS AS POSITIEF:**

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ m_A v_{Ai} + m_B v_{Bi} &= m_A v_{Af} + m_B v_{Bf} \\ m_A v_{Ai} + m_B v_{Bi} &= (m_A + m_B) v_f \\ (7,2)(0,4) + (0) &= (7,2 + 5,3) v_f \quad \checkmark \\ v_f &= 0,23 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

LEFT AS POSITIVE/LINKS AS POSITIEF:

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ m_A v_{Ai} + m_B v_{Bi} &= m_A v_{Af} + m_B v_{Bf} \\ m_A v_{Ai} + m_B v_{Bi} &= (m_A + m_B) v_f \\ (7,2)(-0,4) + (0) &= (7,2 + 5,3) v_f \quad \checkmark \\ v_f &= -0,23 \\ \therefore v_f &= 0,23 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

OPTION 2/OPSIE 2**RIGHT AS POSITIVE/REGS AS POSITIEF**

$$\left. \begin{aligned} \Delta p_{\text{trolley A}} &= -\Delta p_{\text{trolley B}} \\ m_A(v_{Af} - v_{Ai}) &= -m_B(v_{Bf} - v_{Bi}) \\ (7,2)(v_f - 0,4) &= -(5,3)(v_f - 0) \quad \checkmark \\ v_f &= 0,23 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

LEFT AS POSITIVE/LINKS AS POSITIEF

$$\left. \begin{aligned} \Delta p_{\text{trolley A}} &= -\Delta p_{\text{trolley B}} \\ m_A(v_{Af} - v_{Ai}) &= -m_B(v_{Bf} - v_{Bi}) \\ (7,2)(v_f + 0,4) &= -(5,3)(v_f - 0) \quad \checkmark \\ v_f &= -0,23 \\ \therefore v_f &= 0,23 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

(3)

4.2.2

POSITIVE MARKING FROM QUESTIONS 4.2.1.**POSITIEWE NASIEN VANAF VRAAG 4.2.1.**

OPTION 1/OPSIE 1 RIGHT AS POSITIVE/ REGS AS POSITIEF: Force of B on A/Krag van B op A: $F_{\text{net}}\Delta t = \Delta p$ } ✓ Any one/ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } Enige een $F_{\text{net}}(0,02) = 7,2(0,23 - 0,4)$ ✓ $F_{\text{net}} = -61,2$ $\therefore F_{\text{net}} = 61,2 \text{ N}$ ✓ (60,95 N to/tot 61,2 N)	LEFT AS POSITIVE/ LINKS AS NEGATIEF: Force of B on A/Krag van B op A: $F_{\text{net}}\Delta t = \Delta p$ } ✓ Any one/ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } Enige een $F_{\text{net}}(0,02) = 7,2(-0,23 + 0,4)$ ✓ $F_{\text{net}} = 61,2 \text{ N}$ ✓ (60,95 N to/tot 61,2 N)
OPTION 2/OPSIE 2 RIGHT AS POSITIVE/ REGS AS POSITIEF: Force of A on B/Krag van A op B: $F_{\text{net}}\Delta t = \Delta p$ } ✓ Any one/ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } Enige een $F_{\text{net}}(0,02) = 5,3(0,23 - 0)$ ✓ $F_{\text{net}} = 60,95 \text{ N}$ ✓ (60,95 N to/tot 61,2 N)	LEFT AS POSITIVE/ LINKS AS POSITIEF: Force of A on B/Krag van A op B: $F_{\text{net}}\Delta t = \Delta p$ } ✓ Any one/ $F_{\text{net}}\Delta t = m(v_f - v_i)$ } Enige een $F_{\text{net}}(0,02) = 5,3(-0,23 - 0)$ ✓ $F_{\text{net}} = -60,95$ $\therefore F_{\text{net}} = 60,95 \text{ N}$ ✓ (60,95 N to/tot 61,2 N)
OPTION 3/OPSIE 3 RIGHT AS POSITIVE/REGS AS POSITIEF A: $v_f = v_i + a\Delta t$ $0,23 = 0,4 + a(0,02)$ $a = -8,5 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= (7,2)(-8,5)$ ✓ $= -61,20$ $F_{\text{net}} = 61,20 \text{ N}$ ✓	LEFT AS POSITIVE/LINKS AS POSITIEF A: $v_f = v_i + a\Delta t$ $-0,23 = -0,4 + a(0,02)$ $a = 8,5 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= (7,2)(8,5)$ ✓ $= 61,20 \text{ N}$ $F_{\text{net}} = 61,20 \text{ N}$ ✓
OPTION 4/OPSIE 4 RIGHT AS POSITIVE/REGS AS POSITIEF B: $v_f = v_i + a\Delta t$ $0,23 = 0 + a(0,02)$ $a = 11,5 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= (5,3)(11,5)$ ✓ $= 60,95 \text{ N}$ $F_{\text{net}} = 60,95 \text{ N}$ ✓	LEFT AS POSITIVE/LINKS AS POSITIEF B: $v_f = v_i + a\Delta t$ $-0,23 = 0 + a(0,02)$ $a = -11,5 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ ✓ $= (5,3)(-11,5)$ ✓ $= -60,95 \text{ N}$ $F_{\text{net}} = 60,95 \text{ N}$ ✓

(3)
[8]

QUESTION 5/VRAAG 5

5.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

A force is non-conservative if the work it does/done on an object which is moving between two points depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig/doen op 'n voorwerp wat tussen twee punte beweeg afhanklik is van die pad gevolg.

OR/OF

A force is non-conservative if the work it does/done in moving an object around a closed path is non-zero. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig/doen om 'n voorwerp op 'n geslote pad te beweeg, nie nul is nie.

(2)

Note/Aantekening:

If the word 'work' is omitted, 0/2.

Indien die woord 'arbeid' weggelaat is, 0/2.

5.2

Marking criteria/Nasienkriteria

- Any one of the correct equations./Enige een van die korrekte vergelykings. ✓
- Correct substitution for work done by gravity or ΔU . ✓
Korrekte vervanging vir arbeid verrig deur gravitasie of ΔU .
- Correct substitution for work done by motor and friction./Korrekte vervanging aan van arbeid verrig deur motor en wrywing. ✓
- Correct substitution for ΔK ./Korrekte vervanging vir ΔK . ✓
- Correct final answer./Korrekte finale antwoord: $5,96 \text{ m}\cdot\text{s}^{-1}$ ✓

OPTION 1/OPSIE 1

$$\left. \begin{aligned} W_{\text{net}} &= \Delta K \\ W_w + W_f + W_F &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ mgsin\theta\Delta x\cos\theta + W_f + W_F &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(20)(9,8)(\sin 18^\circ)(15,6)\cos 180^\circ + (13,5)(15,6)\cos 180^\circ + (96,8)(15,6)\cos 0^\circ = \frac{1}{2}(20)(v_f^2 - 0^2) \checkmark$$

$$v_f = 5,96 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 2/OPSIE 2

$$\left. \begin{aligned} W_{\text{nc}} &= \Delta K + \Delta U \\ W_f + W_F &= \Delta K + mg(h_f - h_i) \\ f\Delta x\cos\theta + F\Delta x\cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$13,5(15,6)\cos 180^\circ + 96,8(15,6)\cos 0^\circ = \frac{1}{2}(20)(v_f^2 - 0^2) + (20)(9,8)(15,6 \sin 18^\circ - 0) \checkmark$$

$$v_f = 5,96 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 3/OPSIE 3

$$\left. \begin{aligned} W_{\text{net}} &= \Delta K \\ W_w + W_f + W_F &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ -\Delta E_p + W_f + W_F &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$-(20)(9,8)(15,6 \sin 18^\circ) + (13,5)(15,6)\cos 180^\circ + (96,8)(15,6)\cos 0^\circ = \frac{1}{2}(20)(v_f^2 - 0^2) \checkmark$$

$$v_f = 5,96 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 4/OPSIE 4

$$\begin{aligned}
 W_{\text{net}} &= \Delta K \\
 W_w + W_f + W_F &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{ Any one/Enige} \\
 mg\Delta x \cos \theta + W_f + W_F &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 (20)(9,8)(15,6)\cos 108^\circ + (13,5)(15,6)\cos 180^\circ + (96,8)(15,6)\cos 0^\circ &= \frac{1}{2}(20)(v_f^2 - 0^2) \checkmark \\
 v_f &= 5,96 \text{ m}\cdot\text{s}^{-1} \checkmark
 \end{aligned}$$

OPTION 5/OPSIE 5

$$\begin{aligned}
 F_{\text{net}} &= ma \\
 F_{\text{net}} &= F - F_{w//} - f \\
 &= 96,8 - (20)(9,8)\sin 18^\circ \checkmark - 13,5 \\
 &= 22,73 \text{ N} \\
 W_{\text{net}} &= \Delta K \\
 F_{\text{net}}\Delta x \cos \theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{ Any one/Enige} \\
 22,73(15,6)\cos 0^\circ &= \frac{1}{2}(20)(v_f^2 - 0^2) \checkmark \\
 v_f &= 5,96 \text{ m}\cdot\text{s}^{-1} \checkmark
 \end{aligned}$$

(5)

5.3

POSITIVE MARKING FROM QUESTION 5.2.**POSITIEWE NASIEN VANAF VRAAG 5.2.****Marking criteria/Nasienkriteria**

- Correct equation for power/Korrekte vergelyking vir drywing. ✓
- Correct substitution into power equation./ ✓
Korrekte vervanging in drywingvergeliking.
- Correct final answer/Korrekte finale antwoord: 288,46 W ✓
Range: 286,46 W to/na 288,73 W

OPTION 1/OPSIE 1

$$\begin{aligned}
 P_{\text{ave}} &= Fv_{\text{ave}} \checkmark \\
 &= 96,8 \left(\frac{(0) + 5,96}{2} \right) \checkmark \\
 &= 288,46 \text{ W} \checkmark
 \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}
 \Delta x &= \left(\frac{v_i + v_f}{2} \right) \Delta t \\
 15,6 &= \left(\frac{(0) + 5,96}{2} \right) \Delta t \\
 \Delta t &= 5,23 \text{ s} \quad (5,24) \longrightarrow
 \end{aligned}$$

$$\begin{aligned}
 P &= \frac{W}{\Delta t} \\
 P &= \frac{F\Delta x \cos \theta}{\Delta t} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{ Any one/Enige een} \\
 P &= \frac{96,8(15,6) \cos 0^\circ}{5,23} \checkmark \\
 P &= 288,73 \text{ W} \checkmark
 \end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}
 v_f^2 &= v_i^2 + 2a\Delta x \\
 (5,96)^2 &= 0^2 + 2a(15,6) \\
 a &= 1,14 \text{ m}\cdot\text{s}^{-2} \quad (1,13) \\
 v_f &= v_i + a\Delta t \\
 5,96 &= 0 + (1,14)\Delta t \\
 \Delta t &= 5,23 \text{ s} \quad (5,27) \longrightarrow
 \end{aligned}$$

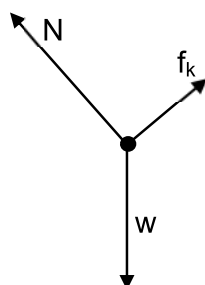
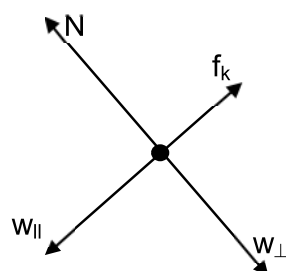
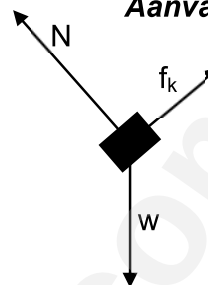
OR/OF

$$\begin{aligned}
 v_{\text{ave}} &= \frac{\Delta x}{\Delta t} \\
 &= \frac{15,6 - 0}{5,23 - 0} \\
 &= 2,98 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

$$\begin{aligned}
 P_{\text{ave}} &= Fv_{\text{ave}} \checkmark \\
 &= 96,8(2,98) \checkmark \\
 &= 288,46 \text{ W} \checkmark
 \end{aligned}$$

(3)

5.4

**Accept/Aanvaar:****Accept force diagram/
Aanvaar kragte-diagram:**

	Accepted symbols/Aanvaarde simbole
N ✓	F_N /196N/Normal/Normaal/ F_{normal} / F_{normaal}
f ✓	(kinetic) friction/(kineties) wrywing/ F_f / F_w / f_k / f_r
w ✓	F_g / F_w /weight/gewig/mg/gravitational force/gravitasiekrag/ $F_{\text{Earth on crate}}$ / $F_{\text{Aarde op krat}}$
Notes/Aantekeninge: - Accept correct numerical values for the forces./Aanvaar korrekte numeriese waardes vir die kragte. - Mark awarded for label <u>and</u> arrow./Punt toegeken vir benoeming <u>en</u> pyltjie. - Do not penalise for length of arrows since drawing is not to scale./Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie. - Any other additional force(s)/Enige ander addisionele krag(te): Max/Maks $2/3$ - If everything correct, but no arrows/Indien alles korrek, maar geen pyltjies: Max/Maks $2/3$	

(3)

5.5

POSITIVE MARKING FROM QUESTION 5.2.**POSITIEWE NASIEN VANAF VRAAG 5.2.****Marking criteria/Nasienkriteria:**

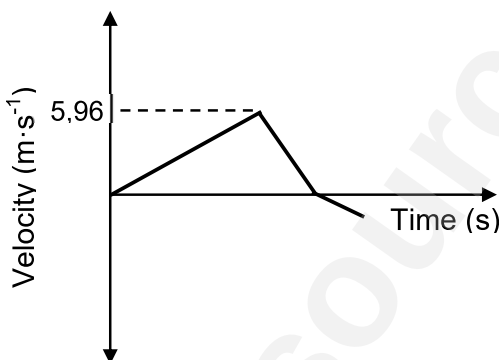
- First straight line starting at zero with positive gradient, reaching a maximum velocity./Eerste reguit lyn met 'n positiewe gradiënt begin by nul en bereik maksimum snelheid. ✓
- Second straight line with negative gradient from maximum velocity to zero./Tweede reguit lyn met negatiewe gradiënt vanaf maksimum snelheid na zero. ✓
- Third straight line continuing from second line at zero and extending below the x-axis./Derde reguit lyn wat aangaan vanaf tweede lyn vanaf nul en verleng onder die x-as. ✓
- Third line has a smaller negative gradient than the second line./Derde reguit lyn het 'n kleiner negatiewe gradiënt as die tweede lyn ✓

Note/Aantekening:

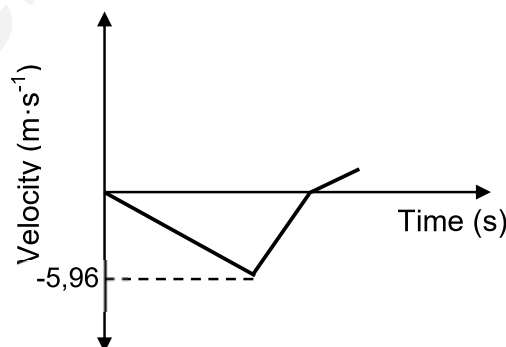
Direction of gradients opposite for graph 2./Rigting van hellings teenoorgesteld vir grafiek 2.

No marks given for values of velocities./Geen punte toegeken vir waardes van snelhede nie.

UPWARDS AS POSITIVE
OPWAARTS AS POSITIEF:



DOWNWARDS AS POSITIVE
AFWAARTS AS POSITIEF:



(4)
[17]

QUESTION 6/VRAAG 6

6.1.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

The (apparent) change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓✓

Die (skynbare) verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/OF

An (apparent) change in observed/detected frequency/pitch as a result of the relative motion between a source and an observer/listener.

'n (Skynbare) verandering in waargenome frekwensie/toonhoogte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar.

(2)

6.1.2

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \checkmark \quad \text{OR/OF} \quad f_L = \frac{v + v_L}{v} f_s$$

$$f_L = \frac{340 + 22}{340} 24\,000 \quad \checkmark$$

$$f_L = 25\,552,94 \text{ Hz}$$

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v}{v - v_s} f_s$$

$$f_L = \frac{340}{340 - 22} 25\,552,94 \quad \checkmark$$

$$f_L = 27\,320,75 \text{ Hz} \quad \checkmark$$

(6)

6.2

The frequencies of the spectral lines would have decreased. / Die frekwensies van die spektrale lyne sou verminder het. ✓✓

OR/OF

The spectral lines from the distant star are shifted towards lower frequency end of the spectrum. / Die spektrale lyne van die ver af ster sou verskuif na 'n laer frekwensie op die spektrum.

(2)
[10]**QUESTION 7/VRAAG 7**

7.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. / Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

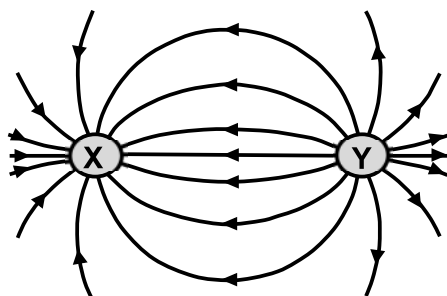
If any reference is made to mass / Indien enige verwysing gemaak is na massa: 0/2

The magnitude of the electrostatic force exerted by one (stationary) point charge (Q_1) on another (stationary) point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them. ✓✓

Die grootte van die elektrostatiese krag uitgeoefen deur een (stilstaande) puntlading (Q_1) op 'n ander puntlading (Q_2) is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

(2)

7.2



Criteria for graph/Kriteria vir grafiek:	
Correct shape/ Korrekte vorm	✓
Correct direction from Y to X. /Korrekte rigting van Y na X.	✓
Lines must not cross and must touch charges./ Lyne mag nie kruis nie en moet die ladinge raak.	✓

Note/Aantekening:

- If the net electric field pattern is drawn for two like charges: $0/3$
Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is: $0/3$
- Ignore labels for point charges/ Ignoreer byskrifte vir puntladings.

(3)

7.3

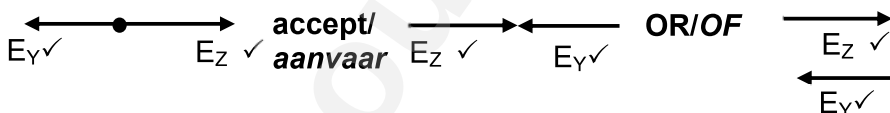
$$F = \frac{kQ_Y Q_X}{r^2} \checkmark$$

$$F = \frac{(9 \times 10^9)(7,2 \times 10^{-9})(7,2 \times 10^{-9})}{(0,03)^2} \checkmark$$

$$= 5,18 \times 10^{-4} \text{ N} \checkmark \quad (0,000518 \text{ N})$$

(3)

7.4

**Notes/Aantekeninge:**

- 1 Mark for arrows in opposite directions./1 Punt vir pyle in teenoorgestelde rigtings.
- 1 Mark for correct labels./1 Punt vir korrekte benoemings.
- Do not penalise for length of arrow since drawing is not to scale./Moenie penaliseer vir die lengte van die pyltjie nie aangesien tekening nie volgens skaal is nie.
- Accept Y and Z as labels./Aanvaar Y en Z as benoeming.

(2)

7.5

OPTION 1/OPSIE 1**Marking criteria/Nasienkriteria**

- Formula for electric field./Formule vir elektriese veld. ✓
- Substitution of E_{net} ./Vervanging van E_{net} . ✓
- Correct substitution into $\frac{kQ}{r^2}$ equation for charge Z or charge Y ✓
Korrekte vervanging in $\frac{kQ}{r^2}$. vergelyking vir lading Z of lading Y
- Subtraction of electric fields ($E_z + E_y$)/Aftrek van elektriese velde ($E_z + E_y$) ✓
- Correct final answer/Korrekte finale antwoord: $6,25 \times 10^{-9} \text{C}$
Range/Gebied: $6,25 \times 10^{-9} \text{C}$ to/na $6,26 \times 10^{-9} \text{C}$

OPTION 1/OPSIE 1

$$E_{\text{net}} = E_z + E_y$$

$$= E_z - E_y$$

$$E_{\text{net}} = \frac{kQ_z}{r^2} + \frac{kQ_y}{r^2}$$

$$4,91 \times 10^5 \checkmark = \left(\frac{(9 \times 10^9)(Q_z)}{0,01^2} \right) \checkmark - \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})}{0,03^2} \right) \checkmark$$

$$Q_z = 6,25 \times 10^{-9} \text{C} \checkmark$$

OPTION 2/OPSIE 2**POSITIVE MARKING FROM QUESTION 7.3/****POSITIEWE NASIEN VANAF VRAAG 7.3****Marking criteria/Nasienkriteria**

- Correct formula for electric field./Korrekte formule vir elektriese veld. ✓
- Substitution of F_{net} ./Vervanging van F_{net} . ✓
- Correct substitution into $\left(\frac{kQ_z Q_x}{r^2} \right)$ for charge Z. ✓
Korrekte vervanging in $\left(\frac{kQ_z Q_x}{r^2} \right)$ vir lading Z
- Subtraction of forces ✓./Aftrek van kragte.
- Correct final answer/Korrekte finale antwoord: $6,26 \times 10^{-9} \text{C}$ ✓
Range/Gebied: $6,25 \times 10^{-9} \text{C}$ to/na $6,26 \times 10^{-9} \text{C}$

$$E = \frac{F}{Q} \checkmark$$

$$4,91 \times 10^5 = \frac{F}{7,2 \times 10^{-9}}$$

$$F_{\text{net}} = 3,54 \times 10^{-3} \text{N}$$

$$F_{\text{net}} = F_{Z \text{ on } X} + F_{Y \text{ on } X}$$

$$F_{\text{net}} = \left(\frac{kQ_z Q_x}{r^2} \right) + \left(\frac{kQ_y Q_x}{r^2} \right)$$

$$(3,54 \times 10^{-3}) \checkmark = \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})Q_z}{(0,01)^2} \right) \checkmark - (5,18 \times 10^{-4})$$

$$Q_z = 6,26 \times 10^{-9} \text{C} \checkmark$$

(5)
[15]

QUESTION 8/VRAAG 8

8.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided all other physical conditions remain constant). ✓✓

Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits alle ander fisiese toestande konstant bly).

OR/OF

The ratio of potential difference to current is constant at constant temperature.

Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/OF

The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided all other physical conditions remain constant).

Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits alle fisiese toestande konstant bly).

(2)

8.2.1

OPTION 1/OPSIE 1

$$R = \frac{V}{I} \checkmark$$

$$7 = \frac{V}{1,5} \checkmark$$

$$V = 10,5 \text{ V} \checkmark$$

OPTION 2/OPSIE 2

$$R = \frac{V}{I} \checkmark$$

$$2 = \frac{V}{1,5}$$

$$V = 3 \text{ V}$$

$$V_T = V_1 + V_2$$

$$= 3 + 7,5 \quad (\text{addition of calculated values/optel van berekende waardes})$$

$$= 10,5 \text{ V} \checkmark$$

$$5 = \frac{V}{1,5}$$

$$V = 7,5 \text{ V}$$

OPTION 3/OPSIE 3

Ratio of R:

$$3 : 7$$

Ratio of I:

$$7 : 3$$

$$I = 1,5 \times \frac{7}{3} = 3,5 \text{ A}$$

$$V = IR \checkmark$$

$$= (3,5)(3) \checkmark$$

$$= 10,5 \text{ V} \checkmark$$

(3)

8.2.2 POSITIVE MARKING FROM QUESTION 8.2.1.**POSITIEWE NASIEN VANAF VRAAG 8.2.1.****OPTION 1/OPSIE 1**

$$R = \frac{V}{I_3} \checkmark$$

$$3 = \frac{10,5}{I_3} \checkmark$$

$$I_3 = 3,5 \text{ A}$$

$$I_T = 1,5 + 3,5 \quad (\text{addition of calculated values/optel van berekende waardes})$$

$$= 5 \text{ A} \checkmark$$

OPTION 2/OPSIE 2

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

OR/OF

$$\frac{1}{R_p} = \frac{1}{7} + \frac{1}{3} \checkmark$$

$$R_p = 2,1 \Omega$$

$$R = \frac{V}{I_T} \checkmark$$

$$2,1 = \frac{10,5}{I_T} \checkmark$$

$$I_T = 5 \text{ A} \checkmark$$

$$R_p = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_p = \frac{(7)(3)}{7 + 3} \checkmark$$

$$= 2,1 \Omega$$

OPTION 3/OPSIE 3

$$I_{3\Omega} = \frac{7}{3} \times 1,5 \checkmark$$

$$= 3,5 \text{ A} \checkmark$$

$$I_{\text{total}} = 3,5 + 1,5$$

$$= 5 \text{ A} \checkmark$$

OPTION 4/OPSIE 4

$$I_s = \left(\frac{R_{3\Omega}}{R_{3\Omega} + R_S} \right) \times I_{\text{total}} \checkmark$$

$$1,5 \checkmark = \frac{3}{3+7} \checkmark \times I_{\text{total}}$$

$$I_{\text{total}} = 5 \text{ A} \checkmark$$

(4)

8.2.3 **POSITIVE MARKING FROM QUESTION 8.2.1 AND/OR QUESTION 8.2.2.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1 EN/OF VRAAG 8.2.2.

OPTION 1/OPSIE 1 $P = \frac{V^2}{R} \checkmark$ $= \frac{10,5^2}{3} \checkmark$ $= 36,75 \text{ W} \checkmark$	OPTION 2/OPSIE 2 $P = I^2 R \checkmark$ $= (3,5)^2 (3) \checkmark$ $= 36,75 \text{ W} \checkmark$
OPTION 3/OPSIE 3 $P = VI \checkmark$ $= (10,5)(3,5) \checkmark$ $= 36,75 \text{ W} \checkmark$	

(3)

8.3 **POSITIVE MARKING IF OPTION 2 IS USED IN QUESTION 8.2.2./**
POSITIEWE NASIEN INDIEN OPSIE 2 GEBRUIK IS IN VRAAG 8.2.2.

Marking criteria/Nasienkriteria - Correct equation for emf./Korrekte vergelyking vir emk. ✓ - Correct substitution for S_2 closed./Korrekte vervanging vir S_2 gesluit. ✓ - Correct substitution for S_2 open./Korrekte vervanging vir S_2 oop. ✓ - Equating emf or internal resistance equations. ✓ Gelykstelling van emk of interne weerstand vergelykings. - Correct final answer/Korrekte finale antwoord: 12,05 V ✓ Range/Gebied: 12,04 V to/tot 12,05 V	
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{R_p} = \frac{1}{7} + \frac{1}{3}$ $R_p = 2,1 \Omega$	
For S_1 and S_2 closed: $\begin{aligned} \mathcal{E} &= I(R + r) \\ \mathcal{E} &= IR + Ir \\ \mathcal{E} &= V_{\text{int}} + V_{\text{ext}} \end{aligned}$	For S_2 open: $\mathcal{E} = I(R + r)$
$= 5(2,1 + r) \checkmark \dots (1)$	$= 3,64(3 + r) \checkmark \dots (2)$
$\begin{aligned} (1) &= (2) \\ 5(2,1 + r) &= 3,64(3 + r) \\ r &= 0,31 \Omega \end{aligned}$ $\begin{aligned} \mathcal{E} &= 5(2,1 + 0,31) \\ &= 12,05 \text{ V} \checkmark \quad (12,04) \end{aligned}$ OR/OF $\begin{aligned} \mathcal{E} &= 3,64(3 + 0,31) \\ &= 12,05 \text{ V} \checkmark \quad (12,04) \end{aligned}$	$\begin{aligned} (1) &= (2): \\ \frac{\mathcal{E} - 10,5}{5} &= \frac{\mathcal{E} - 10,92}{3,64} \\ \mathcal{E} &= 12,05 \text{ V} \checkmark \quad (12,04) \end{aligned}$

(5)

8.4 Increases/*Toeneem* ✓(Total) resistance increases./(*Totale*) weerstand neem toe. ✓Current decreases./*Stroom neem af.* ✓ V_{internal} /Internal volts decreases./ V_{intern} /Interne volts neem af. ✓

(4)

Note/Aantekening:

Award marks if learner proved the statement using calculated numerical values./

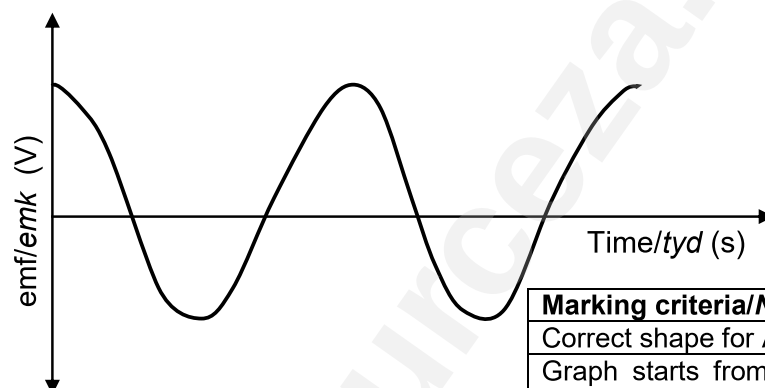
*Ken punte toe indien leerder die stelling bewys deur berekende waardes te gebruik.***[21]****QUESTION 9/VRAAG 9**9.1.1 North pole/*Noord-pool* ✓

(1)

9.1.2 Y to X/*Y na X* ✓

(1)

9.1.3

**Marking criteria/Nasienkriteria**Correct shape for AC./*Korrekte vorm vir WS.* ✓Graph starts from maximum value./*Grafiek begin by maksimum waarde.* ✓Two complete waves/
Twee volledige golwe ✓**Note/Aantekening:**Accept graph starting at negative max./*Aanvaar grafiek wat by negatiewe maks begin.*

(3)

9.2.1

Marking criteria/Nasienkriteria:

- Formula to calculate V_{max} or I_{rms} ./*Formule om V_{maks} of I_{wgk} te bereken.* ✓
- Correct substitution of V_{rms} or I_{max} ./*Korrekte vervanging van V_{wgk} of I_{maks} .* ✓
- Correct substitution to calculate R./*Korrekte vervanging om R te bereken.* ✓
- Correct final answer/*Korrekte finale antwoord: 47,14 Ω to/tot 47,2 Ω* ✓

OPTION 1/OPSIE 1

$$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad \checkmark$$

$$200 = \frac{V_{\text{max}}}{\sqrt{2}} \quad \checkmark$$

$$V_{\text{max}} = 282,84 \text{ V}$$

$$R = \frac{V}{I} \quad \checkmark$$

$$= \frac{282,84}{6} \quad \checkmark$$

$$R = 47,14 \Omega \quad \checkmark$$

OPTION 2/OPSIE 2

$$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad \checkmark$$

$$I_{\text{rms}} = \frac{6}{\sqrt{2}} \quad \checkmark$$

$$I_{\text{rms}} = 4,24 \text{ A}$$

$$R = \frac{V}{I} \quad \checkmark$$

$$= \frac{200}{4,24} \quad \checkmark$$

$$R = 47,17 \Omega \quad \checkmark$$

OPTION 3/OPSIE 3 $I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \checkmark$ $I_{\text{rms}} = \frac{6}{\sqrt{2}} \checkmark$ $I_{\text{rms}} = 4,24 \text{ A}$ $P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$ $= (200)(4,24)$ $= 848 \text{ W (848,53)}$	$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R}$ $848 = \frac{(200)^2}{R} \checkmark$ $R = 47,17 \Omega \checkmark$ OR/OF $P_{\text{ave}} = I_{\text{rms}}^2 R$ $848 = (4,24)^2 R \checkmark$ $R = 47,17 \Omega \checkmark$
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(4)

9.2.2 POSITIVE MARKING FROM QUESTION 9.2.1.

POSITIEWE NASIEN VANAF VRAAG 9.2.1.

OPTION 1/OPSIE 1 $W = I^2 R \Delta t \checkmark$ $= (4,24)^2 (47,17) \checkmark (7200) \checkmark$ $= 6,11 \times 10^6 \text{ J} \checkmark (6,10 \times 10^6)$	OPTION 2/OPSIE 2 $W = VI \Delta t \checkmark$ $= (200)(4,24) \checkmark (7200) \checkmark$ $= 6,11 \times 10^6 \text{ J} \checkmark$
OPTION 3/OPSIE 3 $W = \frac{V^2 \Delta t}{R} \checkmark$ $= \frac{(200^2)}{47,27} (7200) \checkmark$ $= 6,11 \times 10^6 \text{ J} \checkmark (6,10 \times 10^6)$	OPTION 4/OPSIE 4 $P = \frac{W}{\Delta t} \checkmark$ $848 = \frac{W}{7200} \checkmark$ $= 6,11 \times 10^6 \text{ J} \checkmark$

(4)
[13]

QUESTION 10/VRAAG 10

10.1 $6,63 \times 10^{-34} \checkmark$

(1)

10.2 **Marking criteria/Nasienkriteria**

If any of the underlined key words/phrases in the **correct context** is omitted or extra incorrect words added, deduct 1 mark./Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat of inkorrekte woorde bygevoeg is, trek 1 punt af.

The minimum energy needed to eject an electron from a (metal) surface. $\checkmark \checkmark$
Die minimum energie benodig om 'n elektron uit 'n (metaal)oppervlak vry te stel.

(2)

10.3.1 $W_0 = hf_0 \checkmark$

$$= (6,63 \times 10^{-34})(5 \times 10^{14}) \checkmark$$

$$= 3,32 \times 10^{-19} \text{ J} \checkmark$$

(3)

10.3.2 **POSITIVE MARKING FROM QUESTION 10.3.1./ POSITIEWE NASIEN VANAF VRAAG 10.3.1.****OPTION 1/OPSIE 1**

$$\text{Gradient} = \frac{\Delta E_k}{\Delta f} \checkmark$$

$$6,63 \times 10^{-34} \checkmark = \frac{(X - 0)}{(12,54 \times 10^{14} - 5 \times 10^{14})} \checkmark$$

$$X = 5 \times 10^{-19} \text{ (J)} \checkmark$$

OPTION 2/OPSIE 2

$$\left. \begin{aligned} E &= W_o + E_{k(\max)} \\ hf &= hf_o + \frac{1}{2}mv_{\max}^2 \\ h\frac{c}{\lambda} &= h\frac{c}{\lambda_o} + E_{k(\max)} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(6,63 \times 10^{-34})(12,54 \times 10^{14}) \checkmark = 3,32 \times 10^{-19} + E_{k(\max)} \checkmark$$

$$E_{k(\max)} = 5 \times 10^{-19} \text{ J} \checkmark$$

$$X = 5 \times 10^{-19} \text{ (J)}$$

Note/Aantekkening:

Do not penalise learner again in 10.3.2 if $(x \times 10^{14})$ is omitted in 10.3.1/Moenie leerder weer penaliseer in 10.3.2 indien $(x \times 10^{14})$ uitgelaat is in 10.3.1 nie.

(4)

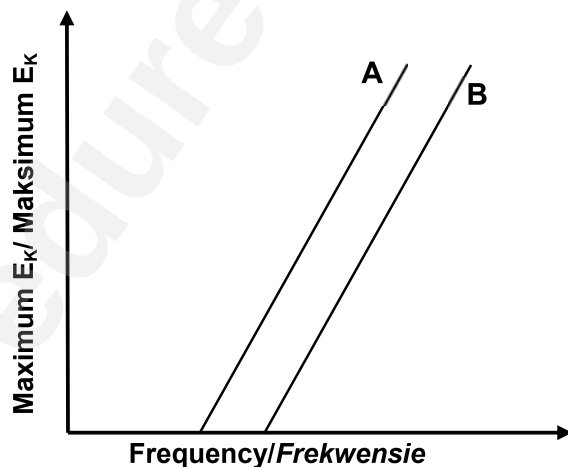
10.4.1 No effect/Geen effek $\checkmark$

(1)

10.4.2 Increases/Toeneem $\checkmark$

(1)

10.5

**Marking criteria/Nasienkriteria**

Graph B to the right of graph A./Grafiek B aan regterkant van grafiek A.	$\checkmark$
Lines are parallel./Lyne is parallel.	$\checkmark$
If both graphs are not labelled/Indien beide grafieke nie benoem is nie: $0/2$	
If two separate graphs are drawn/Indien twee aparte grafieke geteken is: $0/2$	

(2)

[14]**TOTAL/TOTAAL: 150**



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES - PHYSICS (P1)

NOVEMBER 2023

MARKS: 150

TIME: 3 hours

This question paper consists of 19 pages and 3 data sheets.



INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.



QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

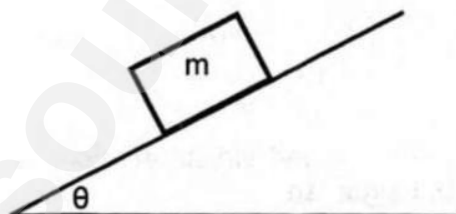
- 1.1 A constant net force is applied to a block. Which ONE of the following statements is CORRECT?

The block will move with a ...

- A constant velocity.
- B constant acceleration.
- C constantly increasing acceleration.
- D constantly decreasing acceleration.

(2)

- 1.2 A crate of mass m is stationary on a plane inclined at an angle θ with the horizontal.



Which ONE of the following statements regarding the magnitude of the frictional force acting on the crate is CORRECT?

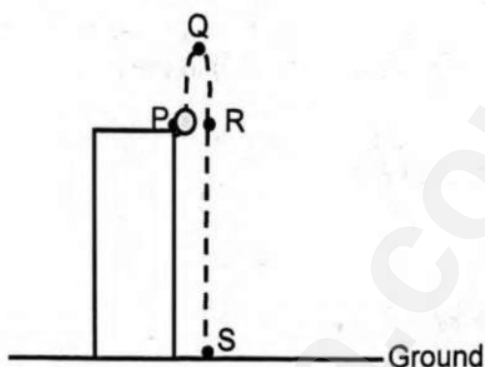
The magnitude of the frictional force acting on the crate is ...

- A equal to the component of the weight of the crate which is parallel to the plane.
- B larger than the component of the weight of the crate which is parallel to the plane.
- C equal to the component of the weight of the crate which is perpendicular to the plane.
- D larger than the component of the weight of the crate which is perpendicular to the plane.

(2)



- 1.3 A ball is projected vertically upwards from the top edge of a building. Points P, Q, R and S represent different positions during the motion of the ball, as shown in the diagram below.



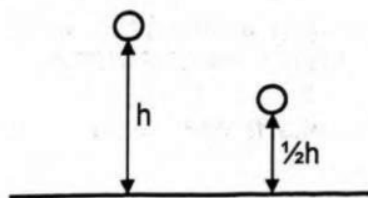
Ignore the effects of air friction.

Between which two points will the ball undergo the greatest change in kinetic energy?

- A P and S
- B P and R
- C R and S
- D Q and S

(2)

- 1.4 A ball is dropped from height h and strikes the floor with momentum p . The ball is then dropped from height $\frac{1}{2}h$.



Ignore the effects of air friction.

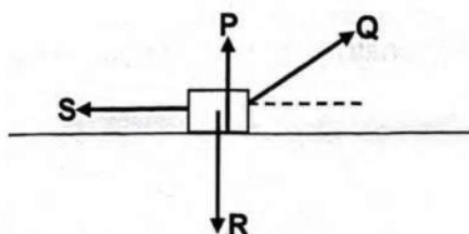
Which ONE of the following represents the momentum of the ball when it strikes the floor after being dropped from height $\frac{1}{2}h$?

- A p
- B $\frac{1}{\sqrt{2}}p$
- C $\frac{1}{2}p$
- D $2p$

(2)



- 1.5 A box moves on a horizontal surface. The diagram below shows all the forces acting on the box.



Which ONE of the following combinations of forces do work on the box?

- A **P** and **R** only
- B **Q** and **S** only
- C **Q**, **R** and **S** only
- D **P**, **Q**, **R** and **S** (2)

- 1.6 A train moving at a constant velocity towards a stationary listener emits sound waves of constant frequency.

Which ONE the following statements about the sound waves observed by the listener is CORRECT?

The observed ...

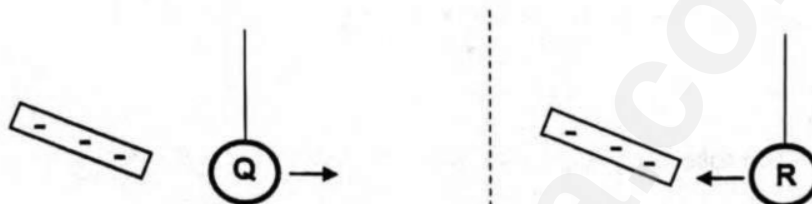
- A frequency is higher than the emitted frequency.
- B wavelength is longer than the emitted wavelength.
- C frequency is lower than the emitted frequency.
- D wavelength is equal to the emitted wavelength. (2)



1.7 Refer to the diagram below.

Q and **R** are small spheres suspended by light insulated strings.

When a negatively charged rod is brought close to sphere **Q**, sphere **Q** is repelled. When the negatively charged rod is brought close to sphere **R**, sphere **R** is attracted.

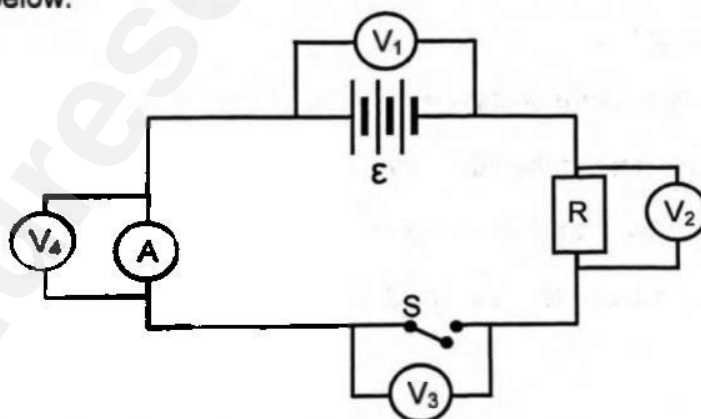


Which ONE of the combinations below can be possible for the nature of the charges on spheres **Q** and **R**?

	NATURE OF CHARGE ON SPHERE Q	NATURE OF CHARGE ON SPHERE R
A	Negative	Negative
B	Positive	Neutral
C	Neutral	Positive
D	Negative	Neutral

(2)

1.8 Four voltmeters, V_1 , V_2 , V_3 and V_4 , are connected in a circuit, as shown in the diagram below.



Which voltmeter(s) will have the same reading as voltmeter V_1 when the switch is open?

- A V_2 only
- B V_3 only
- C V_4 only
- D V_2 and V_4

(2)

- 1.9 A split-ring commutator connects the coil of a generator to an external circuit.

Which ONE of the combinations below is CORRECT for the magnitude and direction of the induced current in the external circuit?

	MAGNITUDE OF INDUCED CURRENT	DIRECTION OF INDUCED CURRENT
A	Constant	Constant
B	Constant	Changes
C	Changes	Constant
D	Changes	Changes

(2)

- 1.10 Light of a suitable frequency is shone on the surface of a metal and electrons are ejected from the metal.

Which ONE of the following is equal to the ratio of the work function to the threshold frequency of the metal?

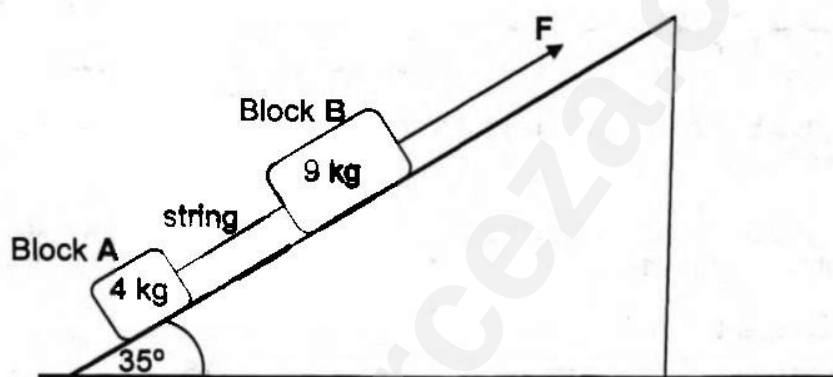
- A Planck's constant
- B The inverse of Planck's constant
- C The energy of the incident photons
- D The maximum kinetic energy of the ejected electrons

(2)
[20]

QUESTION 2 (Start on a new page.)

Two blocks, **A**, of mass 4 kg, and **B**, of mass 9 kg, are connected by a light inextensible string. The blocks are held at rest on a plane which is inclined at an angle of 35° with the horizontal.

A constant force, **F**, acting parallel to the plane, is applied to block **B**, as shown in the diagram below. The blocks now accelerate up the plane at $2 \text{ m} \cdot \text{s}^{-2}$.



- 2.1 State Newton's Second Law of Motion in words. (2)

The kinetic frictional forces acting on blocks **A** and **B** are 5,88 N and 13,23 N respectively.

- 2.2 Draw a labelled free-body diagram showing all the forces acting on block **A**. (4)

- 2.3 Calculate the magnitude of:

- 2.3.1 The tension in the string (4)

- 2.3.2 Force **F** (3)

- 2.4 The angle that the plane makes with the horizontal is now decreased.

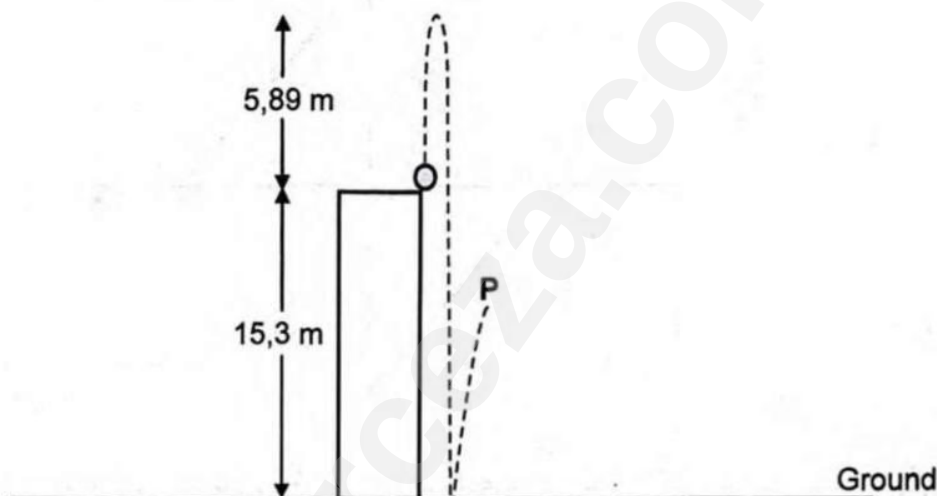
- 2.4.1 How will this change the kinetic frictional force acting on block **A**? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

- 2.4.2 Explain the answer to QUESTION 2.4.1. (2)

[16]

QUESTION 3 (Start on a new page.)

A ball of mass $0,5 \text{ kg}$ is thrown vertically upwards from the top edge of a building which is $15,3 \text{ m}$ high. The ball reaches a maximum height of $5,89 \text{ m}$ above the top of the building. The ball strikes the ground and bounces vertically upwards, reaching a maximum height at point P, as shown in the diagram below.

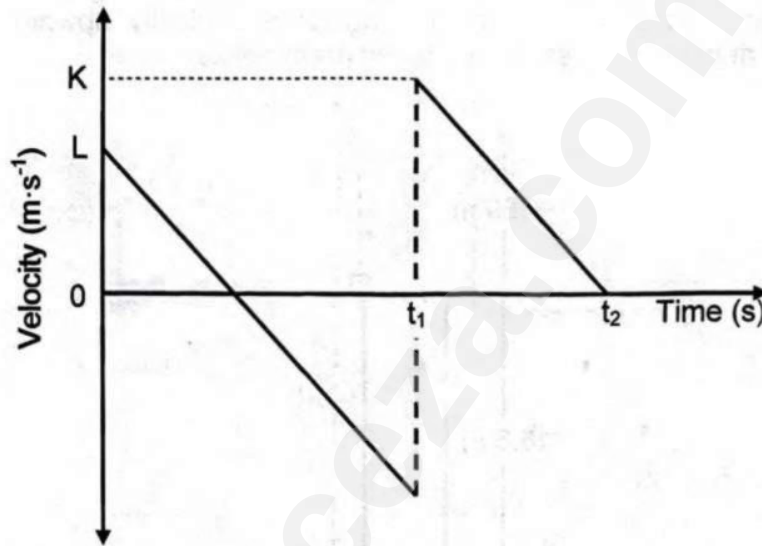


Ignore the effects of air friction.

- 3.1 Define the term *free fall*. (2)
- 3.2 Using only EQUATIONS OF MOTION, calculate the speed at which the ball was projected upwards. (3)
- 3.3 After the collision with the ground, the ball leaves the ground with a speed of $11,92 \text{ m}\cdot\text{s}^{-1}$.
Calculate the:
 - 3.3.1 Amount of kinetic energy lost by the ball during the collision with the ground (5)
 - 3.3.2 Time taken for the ball to reach point P after leaving the ground (3)



- 3.4 The velocity-time graph for the motion of the ball from the instant it is projected upwards from the top edge of the building until the time it reaches point P is shown below.



Write down the numerical values indicated by EACH of the following:

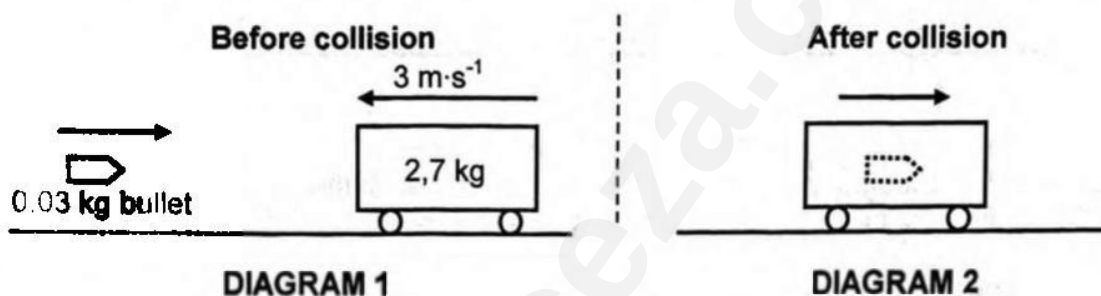
- | | | |
|-------|-------------|-------------|
| 3.4.1 | K | (1) |
| 3.4.2 | L | (1) |
| 3.4.3 | $t_2 - t_1$ | (1) |
| | | [16] |



QUESTION 4 (Start on a new page.)

A wooden trolley of mass $2,7 \text{ kg}$ moves to the left with a constant velocity of $3 \text{ m}\cdot\text{s}^{-1}$. A bullet of mass $0,03 \text{ kg}$ is fired horizontally from the left towards the trolley. (See DIAGRAM 1.)

The bullet strikes the trolley and comes to rest inside the trolley in $0,02 \text{ s}$. The average net force exerted by the trolley on the bullet during this time is 591 N . The bullet-trolley combination now moves to the right. (See DIAGRAM 2.)



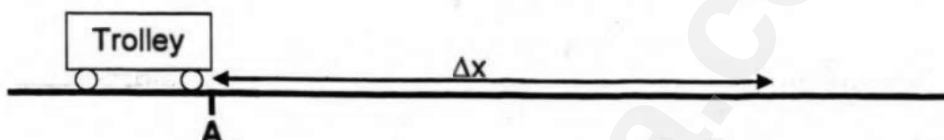
Ignore all frictional and rotational effects.

- 4.1 Write down the magnitude and direction of the average net force that the bullet exerts on the trolley. (1)
- 4.2 Calculate the magnitude of the velocity with which the bullet strikes the trolley. (4)
- 4.3 State the principle of conservation of linear momentum in words. (2)
- 4.4 Calculate the magnitude of the velocity of the bullet-trolley combination after the collision. (4)
- [11]**



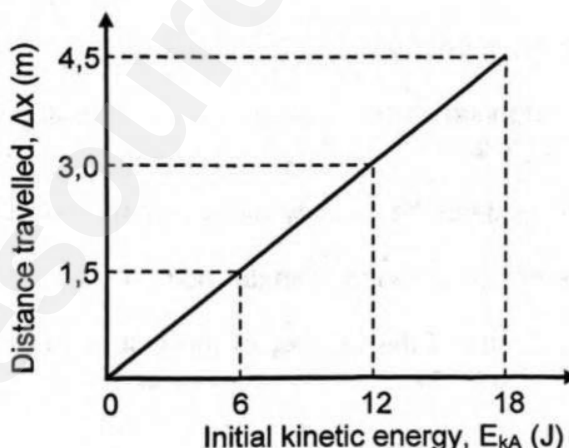
QUESTION 5 (Start on a new page.)

Learners conduct an experiment to determine how the initial kinetic energy given to a trolley affects the distance the trolley moves on a rough horizontal surface. A learner pushes a trolley of unknown mass until it reaches point A with kinetic energy E_{kA} . The horizontal distance (Δx) travelled by the trolley before it comes to rest is then measured. See the diagram below.



The experiment is repeated with the trolley moving on the same rough horizontal surface but with different initial kinetic energies at point A.

The results obtained are shown in the graph below.



Ignore the rotational effects of the wheels of the trolley.

- 5.1 Draw a labelled free-body diagram showing all the forces acting on the trolley during its motion after passing point A. (3)
 - 5.2 Name the independent variable in this experiment. (1)
 - 5.3 State the work-energy theorem in words. (2)
 - 5.4 Calculate the mass of the trolley if the coefficient of kinetic friction between the wheels of the trolley and the rough horizontal surface is 0,18. (6)
- [12]**

QUESTION 6 (Start on a new page.)

- 6.1 An ambulance is moving away from a stationary listener with a constant velocity of $25 \text{ m}\cdot\text{s}^{-1}$. The siren of the ambulance emits sound waves at a frequency of 550 Hz. The listener detects the frequency of these sound waves to be 512,64 Hz.

Ignore the effects of wind.

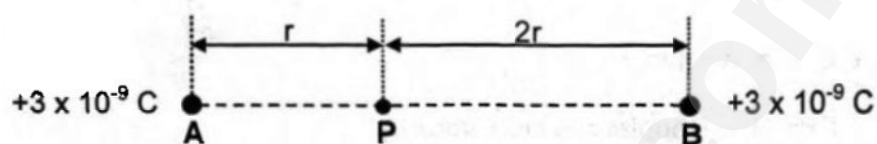
- 6.1.1 State the Doppler effect in words. (2)
- 6.1.2 Use the given information to calculate the speed of sound in air. (5)
- 6.1.3 If the ambulance moves away from the stationary listener with a constant velocity which is greater than $25 \text{ m}\cdot\text{s}^{-1}$, how will EACH of the following change? Choose from INCREASES, DECREASES or REMAINS THE SAME.
- (a) The speed of sound in air (1)
 - (b) The frequency of the sound waves emitted by the siren (1)
 - (c) The frequency of the sound waves detected by the listener (1)
- 6.2 The spectrum of a distant star when viewed from the Earth is red shifted.
- 6.2.1 Is the star moving AWAY FROM or TOWARDS the Earth? (1)
- 6.2.2 Use the Doppler effect to explain the answer to QUESTION 6.2.1. (2)

[13]



QUESTION 7 (Start on a new page.)

Two point charges, **A** and **B**, each with a charge of $+3 \times 10^{-9} \text{ C}$, are stationary on a horizontal surface. Point **P** is r metres from charge **A** and $2r$ metres from charge **B**, as shown in the diagram below.



7.1 Describe an *electric field*. (2)

7.2 Draw the resultant electric field pattern due to charges **A** and **B**. (3)

The magnitude of the net electric field at point **P** is $27 \text{ N}\cdot\text{C}^{-1}$.

7.3 Calculate the value of r . (5)

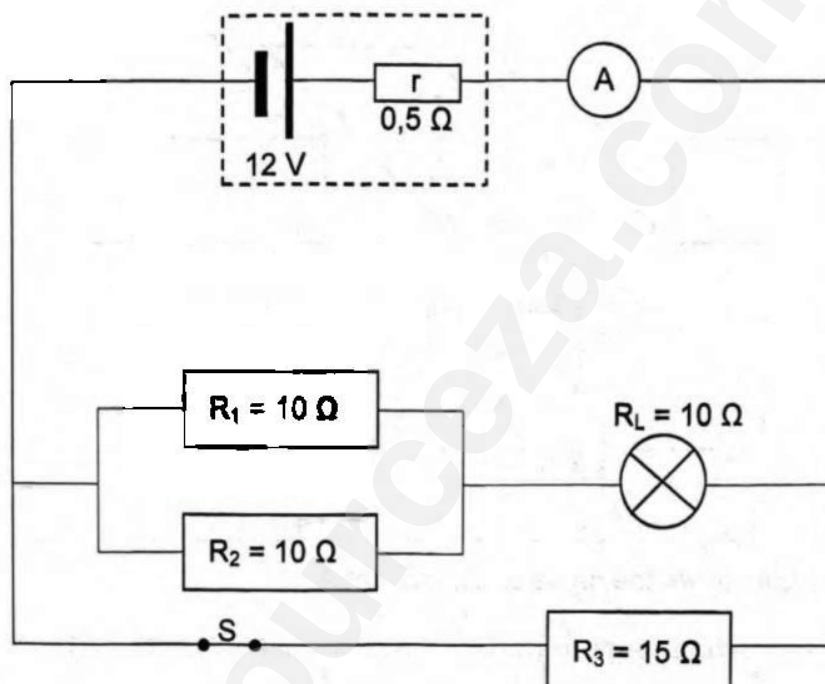
7.4 Calculate the magnitude of the net electrostatic force that an electron would experience if placed at point **P**. (3)

[13]



QUESTION 8 (Start on a new page.)

The circuit diagram below shows a battery with an emf of 12 V and an internal resistance of $0,5 \Omega$ connected to three resistors, a light bulb, a switch, an ammeter and connecting wires. The ammeter and connecting wires have negligible resistance.



8.1 State Ohm's law in words. (2)

Switch S is initially CLOSED.

8.2 Calculate the:

8.2.1 Total external resistance of the circuit (5)

8.2.2 Reading on the ammeter (3)

8.2.3 Power dissipated by resistor R_3 (4)

8.3 Switch S is now OPENED.

8.3.1 If the resistance of the light bulb remains constant, how will the brightness of the light bulb be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

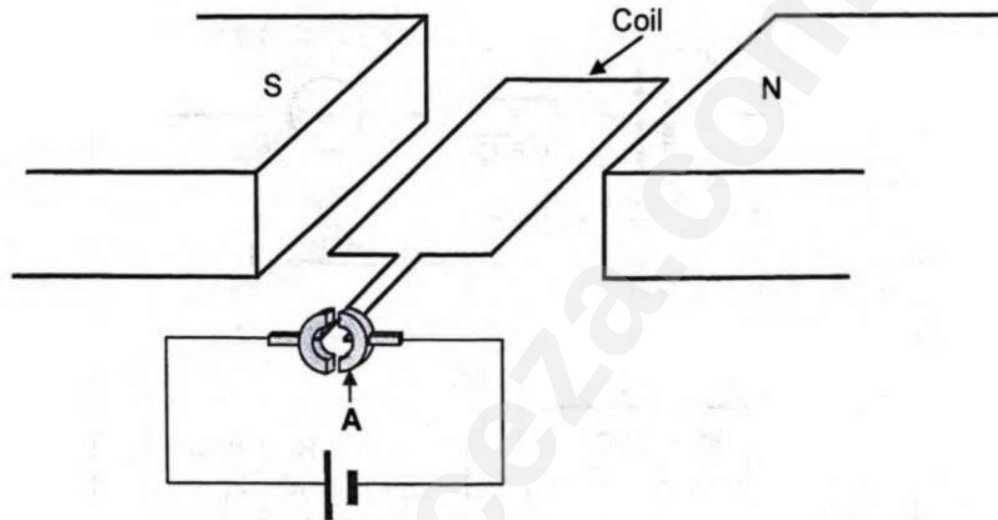
8.3.2 Explain the answer to QUESTION 8.3.1. (3)

[18]



QUESTION 9 (Start on a new page.)

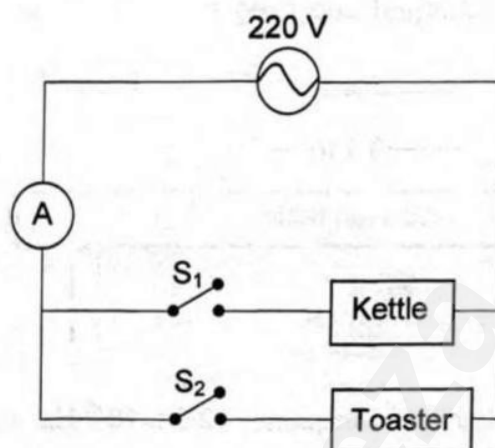
9.1 A simplified diagram of a DC electric motor is shown below.



- 9.1.1 Write down the name of component A. (1)
- 9.1.2 State the energy conversion that takes place in the motor. (1)
- 9.1.3 In which direction will the coil rotate? Choose from CLOCKWISE or ANTICLOCKWISE. (2)
- 9.1.4 State TWO changes that can be made to the motor for the coil to rotate faster. (2)



- 9.2 The circuit diagram below shows an electric kettle and a toaster connected to an AC source with an rms voltage of 220 V. The ammeter, connecting wires and switches S_1 and S_2 have negligible resistance.

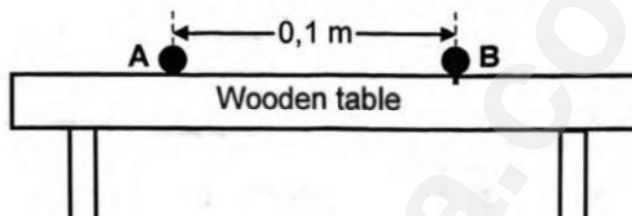


- 9.2.1 Define the term *root mean square current*. (2)
- 9.2.2 When switch S_1 is CLOSED and switch S_2 is OPEN, the maximum current through the circuit is 3,6 A.
Calculate the root mean square current in the circuit. (3)
- 9.2.3 When switch S_1 is OPEN and switch S_2 is CLOSED, the root mean square current in the circuit is 2,62 A.
Calculate the energy consumed by the toaster in two minutes. (3)

[14]

QUESTION 10 (Start on a new page.)

- 10.1 Two small spheres, **A** and **B**, made of pure zinc are at rest 0,1 m apart on a wooden table. Sphere **A** is negatively charged and is free to move on the table, while sphere **B** is uncharged and fixed to the table, as shown in the diagram below.



High-intensity ultraviolet light of frequency $2,8 \times 10^{16}$ Hz is now shone continuously onto sphere **B**.

The work function of zinc is $6,63 \times 10^{-19}$ J.

- 10.1.1 Define the term *work function* of a metal. (2)
- 10.1.2 Explain, using a suitable calculation, why the ultraviolet light shone on sphere **B** will eject electrons from its surface. (4)
- 10.1.3 Sphere **A** carries a charge of $-5,4 \times 10^{-6}$ C and requires a minimum force of 0,027 N to move from rest.

Calculate the minimum number of photons of ultraviolet light that must strike sphere **B** which will cause sphere **A** to move from its rest position. (6)

10.2 A beam of white light is shone through a cold gas. The emerging light is dispersed and a line spectrum is observed on a screen.

10.2.1 Name the type of line spectrum observed. (1)

10.2.2 Describe the spectrum referred to in QUESTION 10.2.1. (2)

10.2.3 The diagrams below indicate some possible energy transitions made by atoms.

Which ONE of the diagrams could result in the type of spectrum observed in QUESTION 10.2.1? Choose from DIAGRAM A or DIAGRAM B.

DIAGRAM A

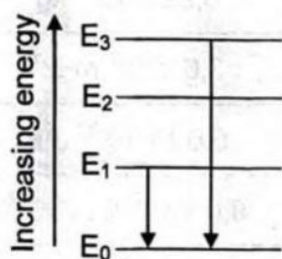
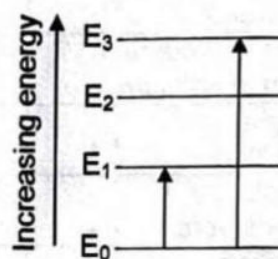


DIAGRAM B



(2)
[17]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstante</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$



TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a \Delta x$ or/of $v_f^2 = v_i^2 + 2a \Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$ / $P_{\text{gemid}} = F v_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ / $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(\text{max})}$ or/of $E = W_o + K_{\text{max}}$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ or/of $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	$\text{emf } (\varepsilon) = I(R + r)$ $\text{emk } (\varepsilon) = I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemid}} = V_{\text{wgk}} I_{\text{wgk}}$
$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemid}} = I_{\text{wgk}}^2 R$
	$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemid}} = \frac{V_{\text{wgk}}^2}{R}$

