



education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES P1

GRADE 12

2026

EASY TO SCORE MARKS

#LEVEL 1-3 MUST FALL

LEARNER GUIDE

TABLE OF CONTENTS

	Page
• HOW TO USE THE DOCUMENT	2
• FORMAT OF THE PAPER	2
• WEIGHTING OF PRESCRIBED CONTENT	2
• EXAMINABLE TOPICS IN GRADE10-11	2
• STRUCTURE OF PAPER	3
• NEWTON'S LAWS	4 - 11
• VERTICAL PROJECTILE MOTION	12 - 14
• MOMENTUM AND IMPULSE	19 - 26
• WORK, ENERGY AND POWER	26 -33
• DOPPLER EFFECT	33 - 36
• ELECTROSTATICS	36 - 41
• ELECTRIC CIRCUITS	41 - 46
• ELECTRODYNAMICS	46 - 53
• PHOTOELECTRIC EFFECT	53 – 61
• DATA SHEETS	61 -62

HOW TO USE THE DOCUMENT

- Identify the possible definitions, laws and principles based on each topic/question and revise them using examination guidelines.
- Know the structure of the paper (main topics and sub-topics).
- Use the document to identify the easy to score marks on any previous question
- Try to answer the attached questions and then practice with different past papers to identify the easy to score marks.

FORMAT OF PAPER 1: PHYSICS

TYPE OF QUESTIONS	DURATION	TOTAL MARKS
10 multiple choice questions (20 marks)	3 hours	150
9 Structured questions (130 marks)		

WEIGHTING OF PRESCRIBED CONTENT

CONTENT	MARKS
MECHANICS • Momentum • Vertical projectile motion • Newton's Laws • Work, energy & power	65
WAVES, SOUND & LIGHT Doppler effect	15
ELECTRICITY & MAGNETISM • Work, energy & power • Electrostatics • Electric circuits • Electrodynamics	55
MATTER & MATERIAL Photoelectric effect	15
TOTAL	150

STRUCTURE OF PAPER 1 (PHYSICS)

QUESTIONS	TOPIC	Estimated marks	
1	Multiple choice(all topics)	20	
2	Newton's Laws	15	
3	Vertical projectile motion	16	
4	Momentum and Impulse	12	
5	Work, Energy And Power	12	
6	Doppler Effect	12	
7	Electrostatics	14	
8	Electric Circuits	21	
9	Electrodynamics	13	
10	Photoelectric Effect	15	
TOTAL MARKS		150	

NEWTON'S LAW

OUTCOME: EASILY OBTAINABLE marks for QUESTION 2 is ± 10 MARKS

NB: PRACTICAL SKILLS:

1. Independent variable/dependent/ control variable (1)
1 mark awarded for each✓
2. Investigation question (1)
2 marks awarded✓✓
3. Hypothesis/conclusion (2)
2 marks awarded✓✓
1. **Possible definitions/ Laws:** (2)
 - Normal Force, frictional force, Static frictional force, Kinetic frictional force, inertia, Newton's 1st /2nd /3rd law of motion and Newton's Law of Universal Gravitation✓✓
2. **Drawing of a free-body diagram.** (2-5)
 - Marks usually represent the number of forces to be drawn.
 - All forces must touch the dot and have an arrow point away from the dot.
 - 1 mark awarded for a weight drawn vertical downwards✓
 - 1 mark for the normal force drawn perpendicular to the surface, if and only if the object is in contact with the surface✓
 - 1 mark for the applied force ✓
 - 1 mark for the frictional force in opposite to the direction of motion ✓
 - 1 mark for the tension if the object is attached to the string/rope/cable✓

Correct formulae		
Formulae		Marking criteria
$f^{\max} = \mu_s N$ / $f_k = \mu_k N$ $F_{\text{net}} = ma$ $W = mg$	$F = \frac{Gm_1 m_2}{r^2}$ $g = \frac{GM}{r^2}$	• Mark is awarded for a correct formula if and only if there is attempt of substitution.

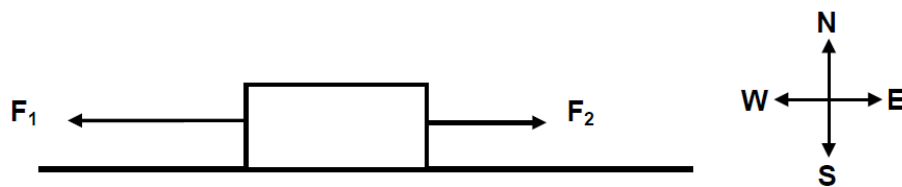
- 1 mark for the correct formula✓
- **NB:** Copy the formula as it is from the formula sheet

- 4 **Correct Substitution(s)** (3)
- From $f^{\max} = \mu_s N / f_k = \mu_k N$: 1 mark for the substitution✓
 - From $F_{\text{net}} = ma$: 2 marks for substitution✓✓
5. **Choosing increase/decrease/remain the same when the angle of inclination is increased/decreased, explain** (2)
- 1 mark for **increase/decrease/remain the same**✓
 - 1 mark for the explanation✓
- EASILY OBTAINABLE marks for QUESTION is [10]

QUESTION 1 : MULTIPLE CHOICE QUESTIONS

- 1.1 Two forces, F_1 and F_2 , are applied on a crate lying on a frictionless, horizontal surface, as shown in the diagram below

The magnitude of force F_1 is greater than that of force F_2 .



The crate will ...

- A accelerate towards the east.
 - B accelerate towards the west.
 - C move at a constant speed towards the east
 - D move at a constant speed towards the west
- (2)
- 1.2 A constant net force acts on a trolley.
- According to Newton's Second Law, the acceleration of the trolley is ... the mass of the trolley.
- A equal to
 - B independent of
 - C directly proportional to
 - D inversely proportional to
- (2)

1.3 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)

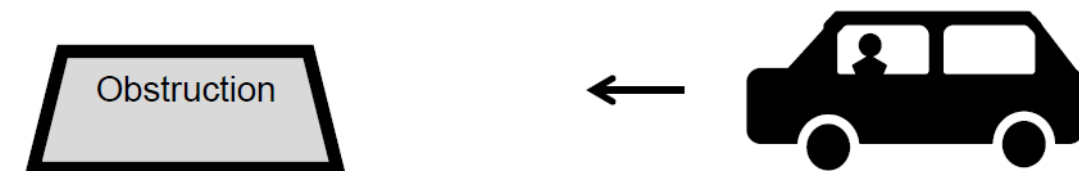
1.4 A car is moving at a **constant velocity**.

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)

1.5 A car is travelling along a road. The driver has his seat belt on. The driver sees an obstruction in the road ahead and suddenly applies the brakes

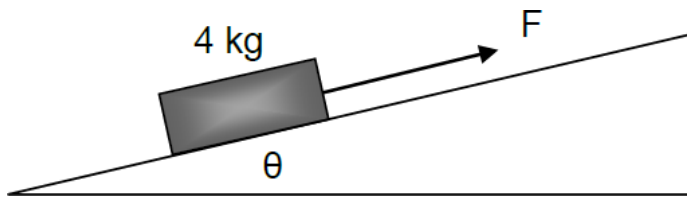


An action-reaction pair is the force of the seat belt on the driver and the force of the ...

- A driver on the seat.
- B wheels on the road.
- C driver on the seat belt.
- D seat belt on the seat.

(2)

- 1.6 A block with a mass of 4 kg is pulled upwards along a frictionless slope, inclined at an angle θ , with a force F , as shown in the sketch below.



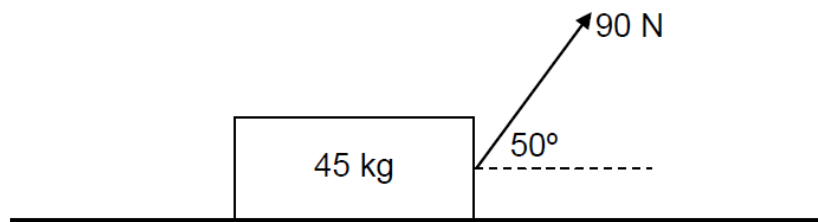
Which ONE of the following equations can be used to calculate the magnitude of the normal force (N)?

- A $N = (4)(9,8)\sin\theta$
- B $N = F - (4)(9,8)\cos\theta$
- C $N = F + (4)(9,8)\cos\theta$
- D $N = (4)(9,8)\cos\theta$

(2)
[12]

QUESTION 2

A box, with a mass of 45 kg, is pulled with a force of 90 N at an angle of 50° to the horizontal. The box moves at a CONSTANT VELOCITY.

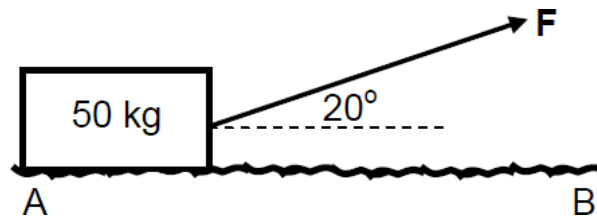


- 2.1 Define the term *kinetic frictional force*. (2)
- 2.2 State *Newton's First Law of Motion* in words. (2)
- 2.3 Calculate the magnitude of the horizontal component of the applied force. (2)
- 2.4 Calculate the magnitude of the normal force. (4)
- 2.5 Calculate the coefficient of kinetic friction. (4)
- 2.6 Will the coefficient of kinetic friction change if the angle of the applied force is decreased? Write only YES or NO and give a reason (2)

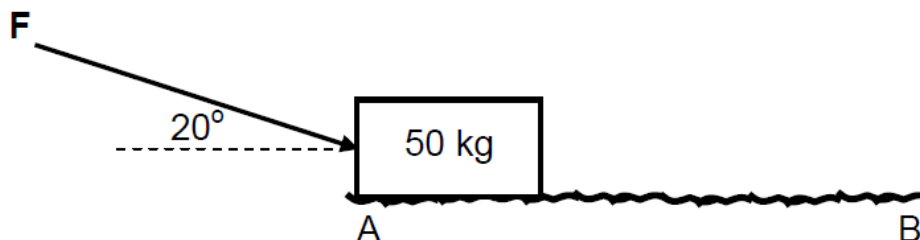
[16]

QUESTION 3

A constant force, F , pulls a 50 kg block at a constant speed over a rough horizontal surface, **AB**, as shown in the diagram below. The coefficient of kinetic friction (μ_k) between the block and the surface is 0,4.



- 3.1 Draw a labelled free-body diagram showing ALL the forces acting on the block. (4)
- 3.2 State Newton's first law of motion in words. (2)
- 3.3 Calculate the magnitude of the:
- 3.3.1 Force F (2)
- 3.3.2 Normal force (2)
- 3.3.3 Frictional force (2)
- 3.4 The same constant force, F , is now applied to the block over the same rough horizontal surface as before, but in the direction shown below.



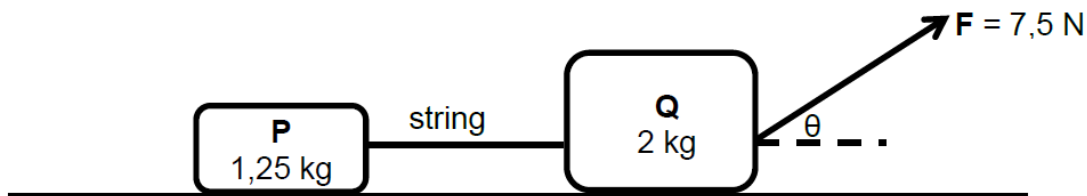
Give a reason why the block will move slower than before.

(2)
[14]

QUESTION 4

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 $0 \text{ m}\cdot\text{s}^{-2}$ to the right.



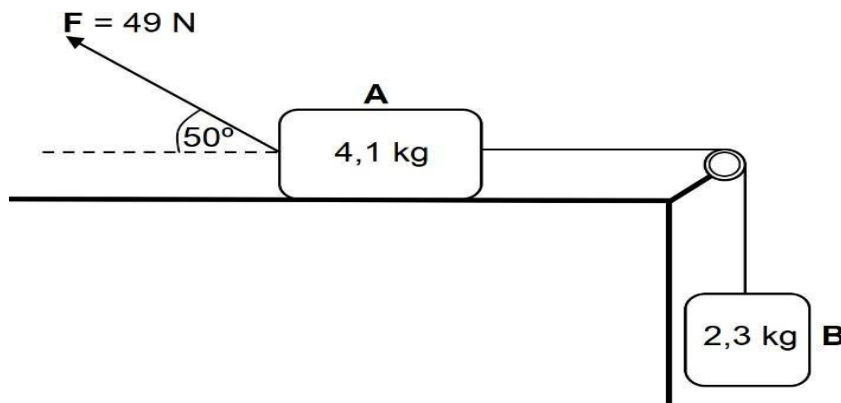
Crate **P** experiences a constant frictional force of 1,8 N and crate **Q** experiences a constant frictional force of 2,2 N.

- 4.1 State Newton's Second Law of Motion in words. (2)
- 4.2 Draw a labelled free-body diagram for crate **P**. (4)
- 4.3 Calculate the magnitude of:
 - 4.3.1 The tension in the string (4)
 - 4.3.2 Angle θ (3)

[13]

QUESTION 5

Block **A** of mass 4,1 kg is connected to block **B** of mass 2,3 kg by a light inextensible string passing over a frictionless pulley. Block **A** is at rest on a rough horizontal table and block **B** hangs vertically, as shown in the diagram. A force **F** of magnitude 49 N is applied on block **A** at an angle of 50° to the horizontal, causing block **A** to accelerate TO THE LEFT from rest along the table. The coefficient of kinetic friction between the surface of the table and block **A** is 0,35



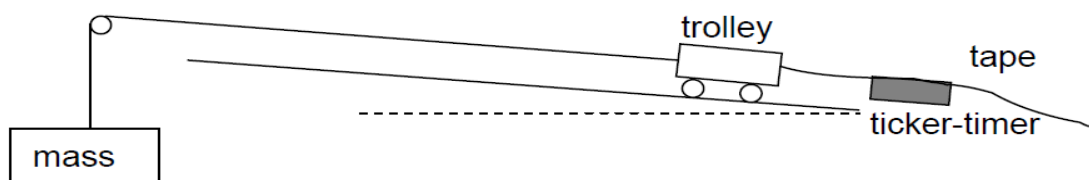
- 5.1 Define normal force. (2)
- 5.2 Draw a labelled free-body diagram showing all the forces acting on block **A** while it accelerates to the left. (5)
- 5.3 Calculate the magnitude of the
- 5.3.1 Kinetic frictional force exerted on block **A** (3)
- 5.3.2 Acceleration of block **A**, by applying Newton's Second Law to each block separately (5)

[15]

QUESTION 6

Learners investigate the relationship between net force and acceleration by pulling a trolley across a surface which is slightly inclined to compensate for friction.

The trolley is connected to different masses by a string of negligible mass. The string passes over a frictionless pulley. Refer to the diagram below.



Ticker-tape attached to the trolley passes through the ticker-timer. The acceleration of the trolley is determined by analyzing the ticker-tape.

The results of the net force produced by the different masses and the acceleration of the trolley were recorded in the table below.

NET FORCE (N)	$a \text{ (m} \cdot \text{s}^{-2}\text{)}$
0,3	0,36
0,6	0,73
0,9	1,09
1,2	1,45

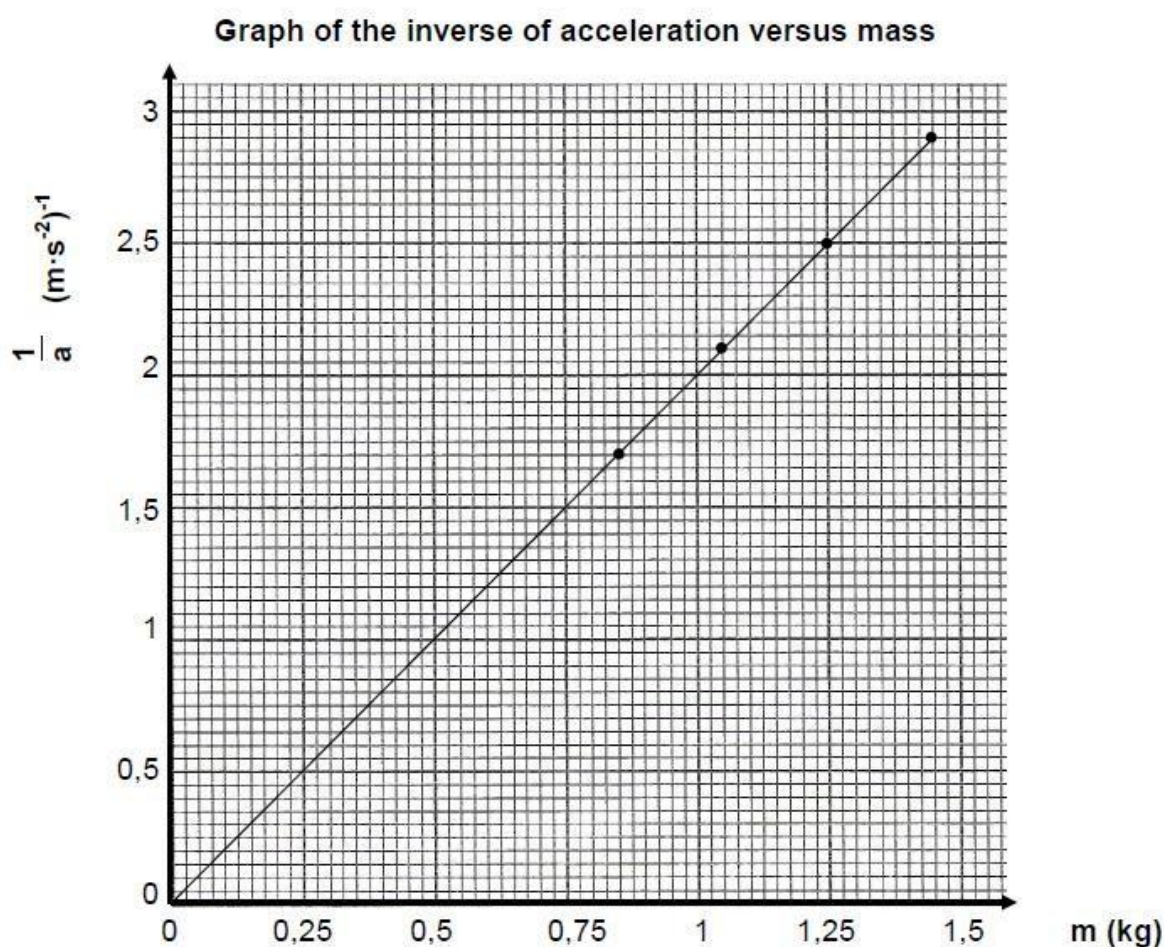
- 6.1 Write down the
- 6.1.1 hypothesis of the experiment (2)
- 6.1.2 independent variable (1)
- 6.1.3 controlled variable (1)

- 6.2 Use the graph paper on the ANSWER SHEET and draw a graph of the acceleration versus net force (2)
- 6.3 Calculate the gradient of the graph (3)
- 6.4 Use the gradient of the graph calculated in QUESTION 3.2 to determine the mass of the trolley. (2)

[11]

QUESTION 7

Learners investigate the relationship between the mass of an object and the acceleration it experiences when a constant net force is applied on the object. They use their results to draw the graph below.



- 7.1 State *Newton's Second Law of Motion* in words. (2)
- 7.2 Calculate the gradient of the gradient (3)
- 7.3 Hence, determine the net force applied on the object during the experiment. (2)
- 7.4 Write down a conclusion for this experiment (2)

[9]

VERTICAL PROJECTILE

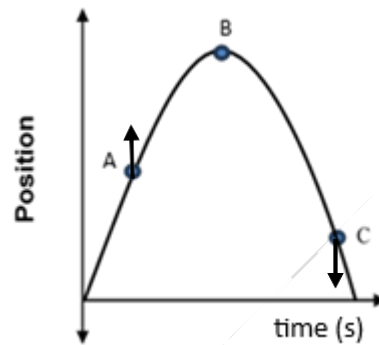
OUTCOME: EASILY OBTAINABLE marks for QUESTION 3 is ± 15 MARKS

1. Possible definitions/ Laws: (2)

Projectile and Free fall ✓✓

2. Magnitude and direction of acceleration. (2)

- At any given point (A/B/C) acceleration is $9.8 \text{ m}\cdot\text{s}^{-2}$, downwards ✓✓



3. Correct formulae. (3)

- 3×1 mark awarded for correct formulae i✓✓✓
- NB:** Copy the formulae as they are from the formula sheet

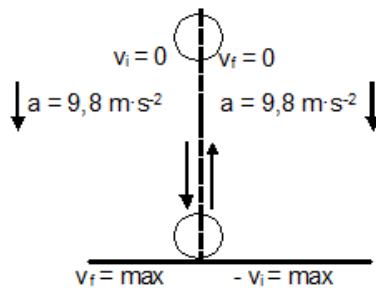
4. Correct Substitution(s) (3)

- 3-4 marks awarded for correct substitution of the given physical quantities. ✓✓✓

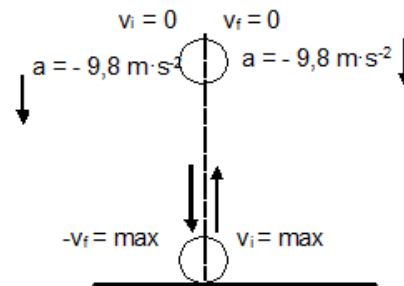
Bouncing ball

A HARD tennis ball is dropped vertically downwards to the ground and then bounces back.

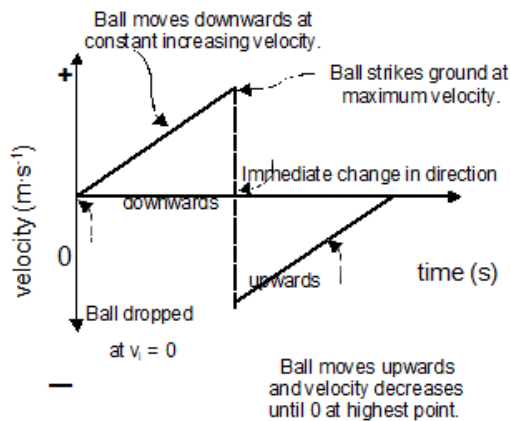
Downwards positive



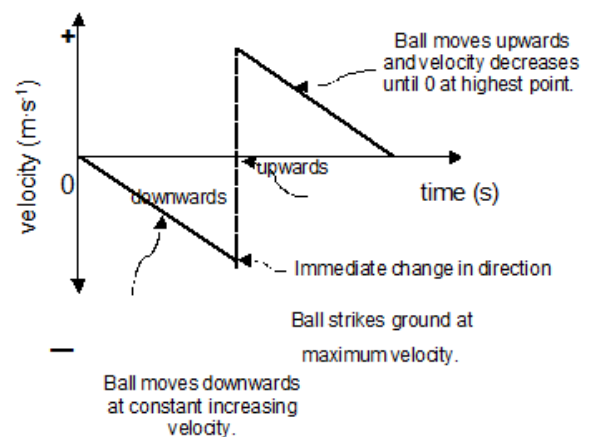
Downwards negative



Velocity-time graph

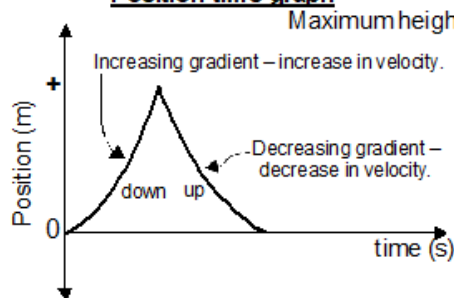


Velocity-time graph

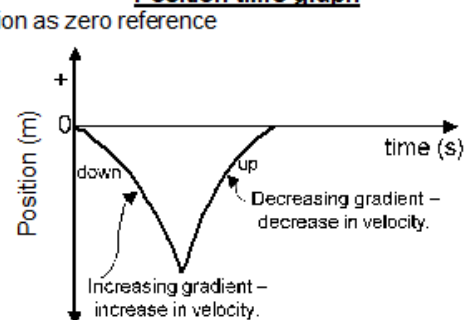


Gradient of the graphs: Constant acceleration of $9,8 \text{ m}\cdot\text{s}^{-2}$ downwards represented by parallel lines

Position-time graph

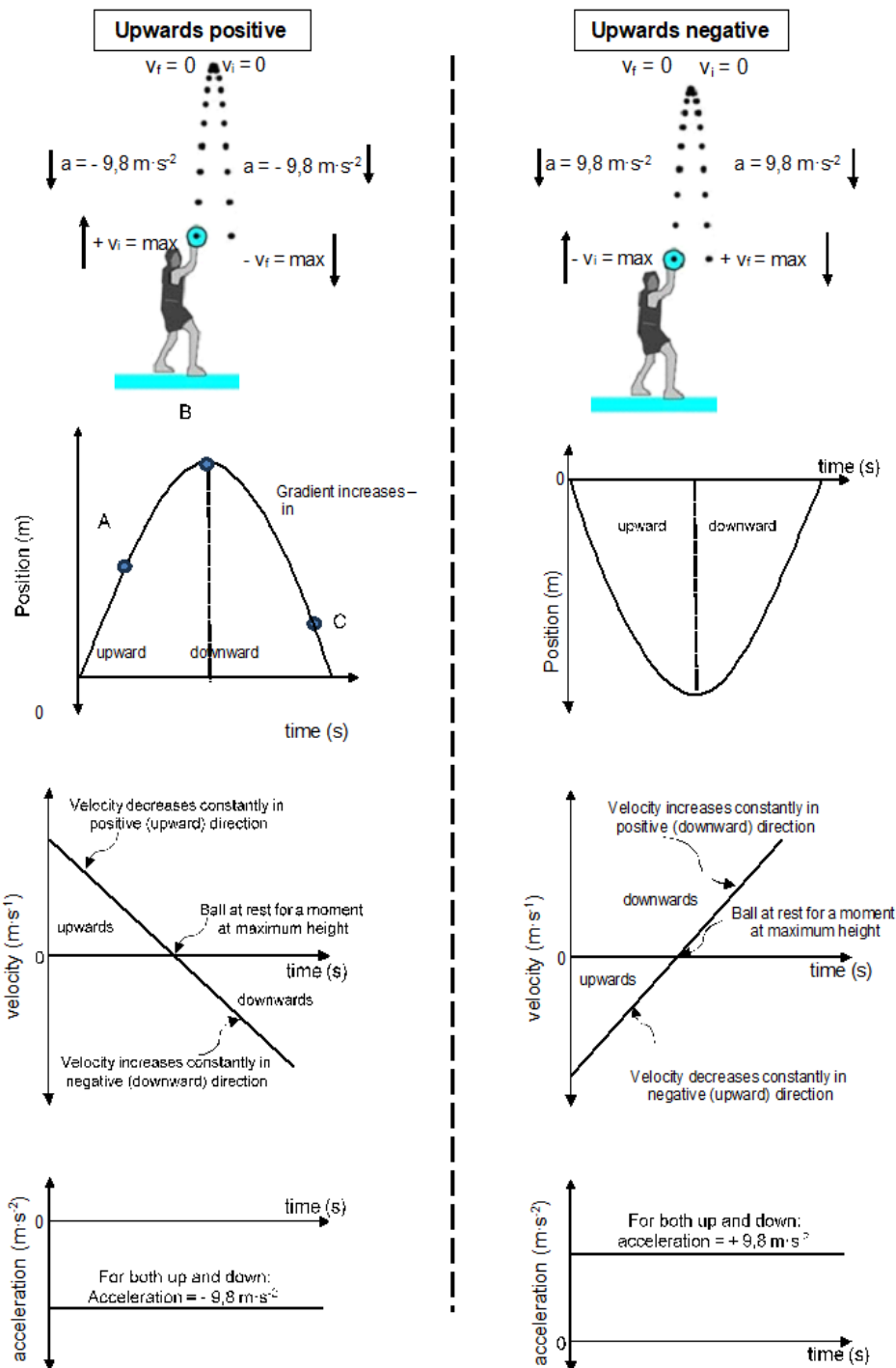


Position-time graph



Vertical Motion represented by graphs

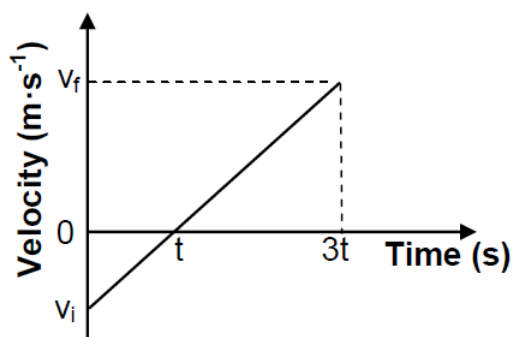
A ball is thrown vertically upwards and returns to the same position from where it was thrown.



- +/- 2 Marks awarded for the calculated physical quantities indicated in the graph ✓✓ (2-6)
 - 1 mark awarded for the line of best fit✓
 - 1 mark awarded for correct shape of the graph✓
- EASILY OBTAINABLE marks for QUESTION is [± 15]

QUESTION 1: MULTIPLE CHOICE QUESTIONS

- 1.1 The velocity versus time sketch graph below represents the motion of a ball which was in free fall. The ball struck the ground after $3t$ seconds.



Which ONE of the following statements is CORRECT?

The ball was ...

- A dropped from a height above the ground.
- B thrown vertically upwards from the ground.
- C thrown vertically upwards from a height above the ground
- D thrown vertically downwards from a height above the ground. (2)

- 1.2 A body is dropped from a certain height above the ground. Disregard ALL frictional forces. Which ONE of the following physical quantities increases as the body falls freely?

- A Acceleration
- B Kinetic energy
- C Resultant force
- D Gravitational potential energy (2)

1.3 An object falls freely in a vacuum near the surface of the Earth.

Which ONE of the following statements regarding the motion of the object is CORRECT?

- A The velocity of the object will remain constant.
- B The velocity of the object will decrease uniformly.
- C The rate of change of velocity of the object will increase uniformly
- D The rate of change of velocity of the object will remain constant. (2)

1.4 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)

1.5 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)

[10]

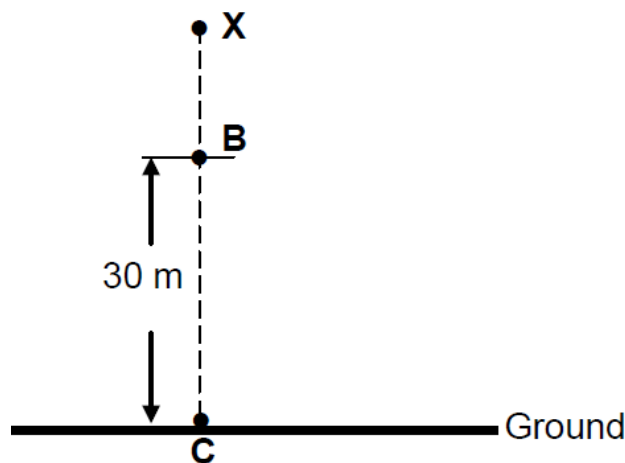
QUESTION 2

A learner drops a ball of mass $0,36 \text{ kg}$ from the window of his room on the second floor. The ball hits the ground with a speed of $12 \text{ m}\cdot\text{s}^{-1}$. Disregard air resistance

- 2.1 Calculate the time taken for the ball to reach the ground (5)
 - 2.2 Calculate the distance the ball falls until it hits the ground (4)
 - 2.3 Calculate the maximum **increase in the kinetic energy** of the ball during the fall. (4)
 - 2.4 Calculate the magnitude of the momentum of the ball with which it hits the ground (4)
- [17]**

QUESTIO 3

An object is released from rest from a point **X**, above the ground as shown in the diagram below. It travels the last 30 m (**BC**) in $1,5 \text{ s}$ before hitting the ground. Ignore the effects of air friction.



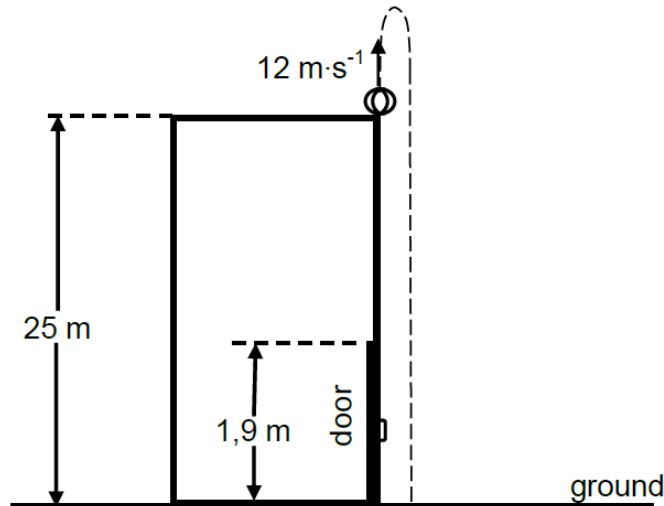
- 3.1 Name the type of motion described above (1)
 - 3.2 Calculate the:
 - 3.2.1 Magnitude of the velocity of the object at point B (4)
 - 3.2.2 Height of point **X** above the ground (5)
- After hitting the ground, the object bounces once and then comes to rest on the ground.
- 3.3 Sketch an acceleration-time graph for the entire motion of the object. (3)

[13]

QUESTION 4

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.



- 4.1 Define the term *free fall*. (2)
- 4.2 Calculate the:
- 4.2.1 Time taken for the ball to reach its maximum height (2)
- 4.2.2 Velocity with which the ball strikes the ground (4)
- 4.2.2 Time it took the ball to move from the top of the door to the ground (4)
- 4.3 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.

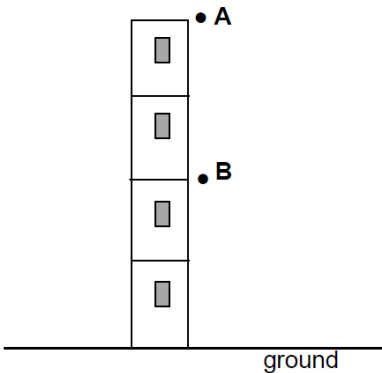
Clearly indicate the following on your graph:

- 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 5

In the diagram below, point **A** is at the top of a building. Point **B** is exactly **halfway** between the point **A** and the ground. Ignore air resistance



- 5.1 Define the term *free fall*. (2)
- A ball of mass 0,4 kg is dropped from point **A**. It passes point **B** after 1 s.
- 5.2 Calculate the height of point **A** above the ground. (3)
- When the ball strikes the ground, it is in contact with the ground for 0,2 s and then bounces vertically upwards, reaching a maximum height at point **B**.
- 5.3 Calculate the magnitude of the velocity of the ball when it strikes the ground (3)
- 5.4 Calculate the magnitude of the average net force exerted on the ball while it is in contact with the ground. (6)
- [14]

MOMENTUM & IMPULSE

OUTCOME: EASILY OBTAINABLE marks for QUESTION 3 is ± 06 MARKS

1. Possible definitions/ Laws: (2)
- Momentum, impulse, Newton’s 2nd law of motion in terms of momentum, Principle/law of conservation of momentum and mechanical energy.

Correct formulae (2)

Formulae		Marking creteria
$p=mv$ $F_{net}=\frac{\Delta p}{\Delta t}$	$\Sigma p_i=\Sigma p_f$ $(K + U)_i=(K + U)_f$ $K_i=\frac{1}{2}m_1v_{i1}^2+\frac{1}{2}m_1v_{f1}^2$	1 mark is awarded for a correct formula if and only if there is attempt of substitution✓

- 2×1 mark is awarded for a correct formula if and only if there is attempt of substitution✓

3. Correct Substitution(s)

(3)
- 3 marks awarded correct substitution✓✓✓

EASILY OBTAINABLE marks for QUESTION is

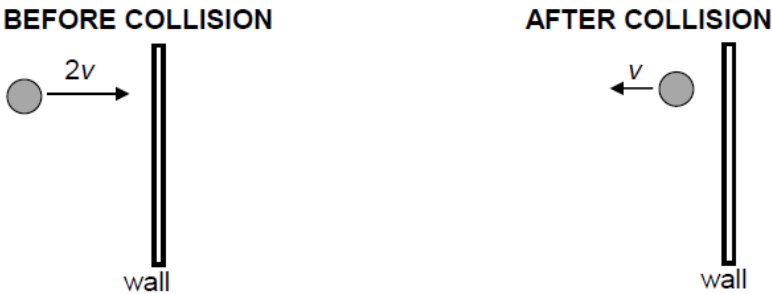
[±6]

QUESTION 1: MULTIPLE CHOICE QUESTIONS

- 1.1 Two bodies undergo an INELASTIC collision in the absence of friction. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	Not conserved	Conserved
B	Conserved	Not conserved
C	Not conserved	Not conserved
D	Conserved	Conserved

- 1.2 A ball, moving horizontally, hits a wall with a speed $2v$. The ball then bounces back horizontally with a speed v , as shown in the diagram below.



Which ONE of the following combinations regarding the linear momentum and the total kinetic energy of the ball for the collision above is CORRECT? Assume that the ball-wall system is isolated.

	LINEAR MOMENTUM	TOTAL KINETIC ENERGY
A	Conserved	Not conserved
B	Conserved	Conserved
C	Not conserved	Not conserved
D	Not conserved	Conserved

1.3 Airbags in modern cars provide more safety during an accident

The statements below are made by a learner to explain how airbags can ensure better safety in a collision

- i. The time of impact increases.
- ii. The impact force decreases.
- iii. The impulse increases.

Which of the statements above are CORRECT?

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

(2)

1.4 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)

1.5 Which physical quantity is equal to the rate of change of momentum?

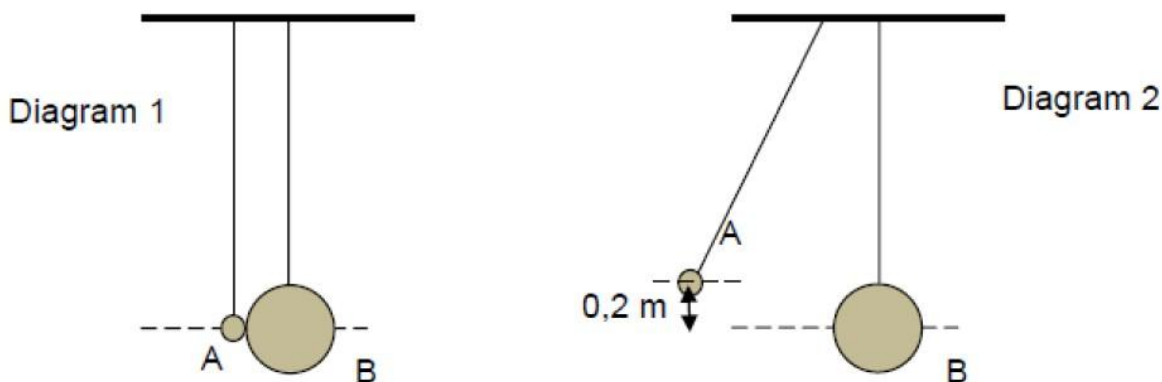
- A Mass
- B Impulse
- C Net force
- D Acceleration

(2)

[10]

QUESTION 2

Two stationary steel balls, A and B, are suspended next to each other by massless inelastic string as shown in Diagram 1 below.



Ball A of mass 0,2kg is displaced through a vertical distance of 0,2m as shown in Diagram 2 above. When ball A is released, it collides elastically and head-on with ball B. Ignore the effects of air friction.

2.1 What is meant by elastic collision (2)

Immediately after the collision, ball A moves horizontally backwards (to the left). Ball B acquires the kinetic energy of 0,12s J and moves horizontally forward (to the right)

Calculate the

2.2 Kinetic energy of ball A just before it collides with ball B (use energy principles only) (3)

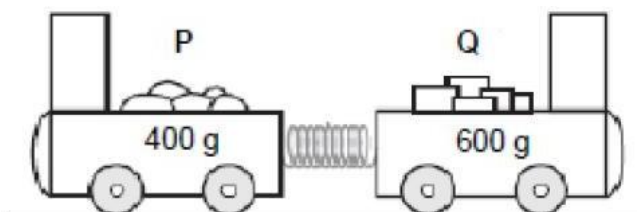
2.3 Speed of ball A immediately after the collision (4)

2.4 Magnitude of the impulse on ball A during the collision (5)

[14]

QUESTION 3

The diagram below shows two trolleys, P and Q, held together by means of a compressed spring on a flat, frictionless horizontal track. The masses of P and Q are 400 g and 600 g respectively.



When the trolleys are released, it takes 0,3 s for the spring to unwind to its natural length. Trolley Q then moves to the right at $4 \text{ m}\cdot\text{s}^{-1}$.

3.1 State the *principle of conservation of linear momentum* in words (2)

3.2 Calculate the:

3.2.1 Velocity of trolley P after the trolleys are released. (4)

3.2.2 Magnitude of average force exerted by the spring on trolley Q. (4)

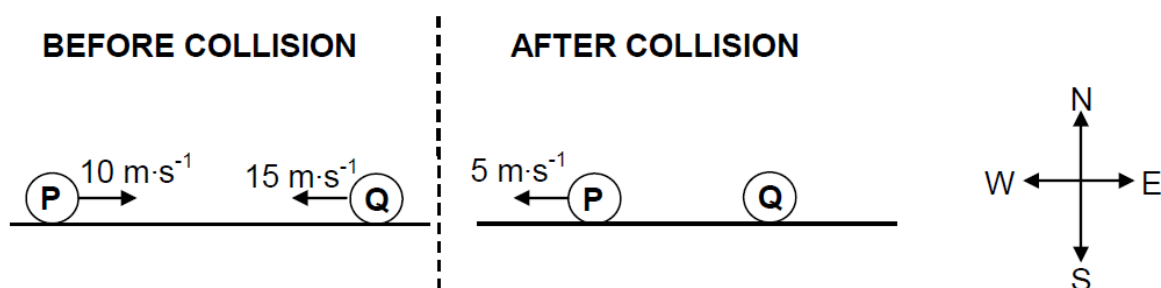
3.3 Use a calculation to show that this is an inelastic collision (4)

[14]

QUESTION 4

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

A box of mass 50 kg is thrown from the roof top and strikes the ground with a velocity of $5 \text{ m}\cdot\text{s}^{-1}$. It slides and comes to a complete stop in 0,2 seconds

5.1 Define the term *Impulse* of a force (2)

5.2 Calculate the momentum with which the box strikes the ground. (3)

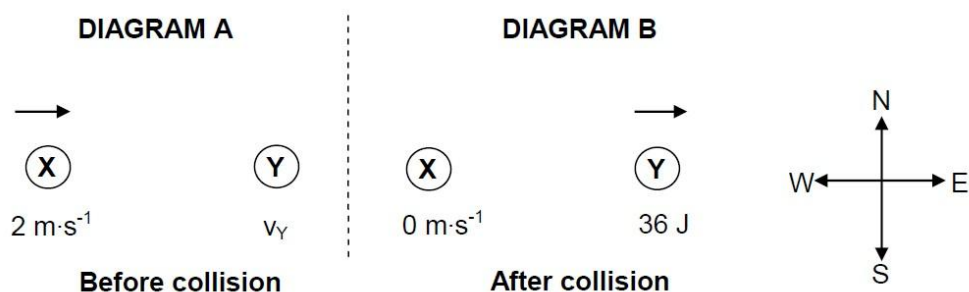
5.3 Calculate the magnitude of the net force exerted on the box by the ground. (3)

5.4 To improve passenger safety, modern cars are designed to crumple partially on impact, in addition of the presence of seat belts. Explain how seat belts in cars can improve passenger safety during an accident. Include a relevant physics equation in the explanation. (3)
[11]

QUESTION 6

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.



6.1 Explain the meaning of the term *elastic collision* (2)

6.2 Calculate velocity v_Y . (5)

The balls were in contact with each other for 0,1 s during the collision.

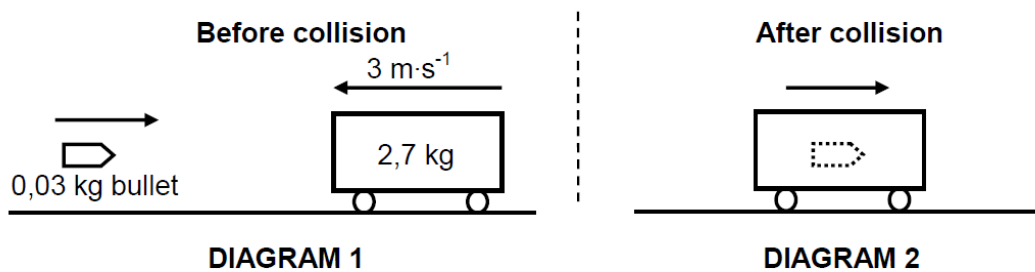
6.3 Calculate the magnitude of the force that ball **X** exerted on ball **Y** during the collision (3)

[10]

QUESTION 5

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.

- 5.1 Write down the magnitude and direction of the average net force that the bullet exerts on the trolley. (1)
- 5.2 Calculate the magnitude of the velocity with which the bullet strikes the trolley (4)
- 5.3 State the principle of conservation of linear momentum in words (2)
- 5.4 Calculate the magnitude of the velocity of the bullet-trolley combination after the collision. (4)

[11]

QUESTION 6

Trolley **A** of mass $7,2 \text{ kg}$ 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 $5,3 \text{ kg}$.

After the collision, the trolleys lock together and move to the right, as shown in the diagram below.

Ignore any frictional effect



- 6.1 State the *principle of conservation of linear momentum* in words. (2)
- 6.2 Calculate the magnitude of the: (2)
- 6.2.1 Velocity of the trolleys immediately after the collision (3)
- 6.2.2 Average net force exerted by trolley **A** on trolley **B** during the collision, if the collision time is 0,02 s (3)
- [08]

WORK, ENERGY & POWER

OUTCOME: EASILY OBTAINABLE marks for QUESTION 5 is ± 9 MARKS

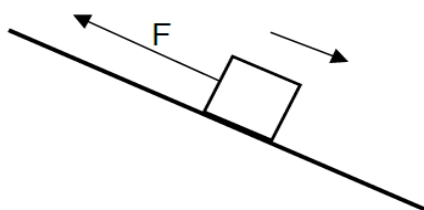
1. **Possible definitions/ Laws:** (2)
Work, work energy theorem, Power, conservative force and non-conservative force
 2. Drawing of a free-body diagram. (2-5)

Refer to question 2

 3. **Correct formulae** (2)
 4. **Correct Substitution** (3-4)
 - 3-4 marks awarded ✓✓✓
- EASILY OBTAINABLE marks for QUESTION is [9]

QUESTION 1

A force F acts on a box as the box moves from rest down a rough incline at a constant acceleration. The force is parallel to the incline, as shown in the diagram below

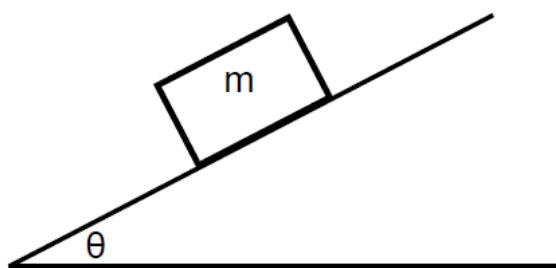


Choose the option that CORRECTLY completes the following statement

The work done by the gravitational force is ... the work done by the frictional force and the work done by F .

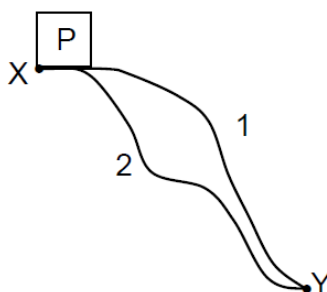
- A equal to the sum of
 - B less than the sum of
 - C greater than the sum of
 - D equal to the difference between
- (2)

- 1.2 A crate of mass m is stationary on a plane inclined at an angle θ with the horizontal.



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 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)

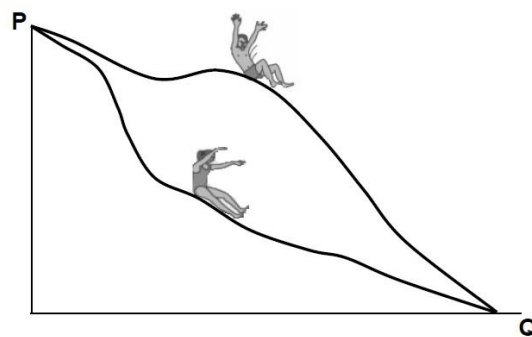
1.4 The base SI unit of the physical quantity 'work' is ...

- 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)

1.5 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 Which ONE of the following physical quantities is the same as the 'change in kinetic energy' of an object?

A Power

B Resultant force

C Acceleration

D Work

(2)

1.7 A object moves in a straight line on a ROUGH horizontal surface. If the net work done on the object is zero, then....

A the object has zero kinetic energy

B the object moves at constant speed

C the object moves at constant acceleration

D There is no frictional force acting on the object

(2)

1.8 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.

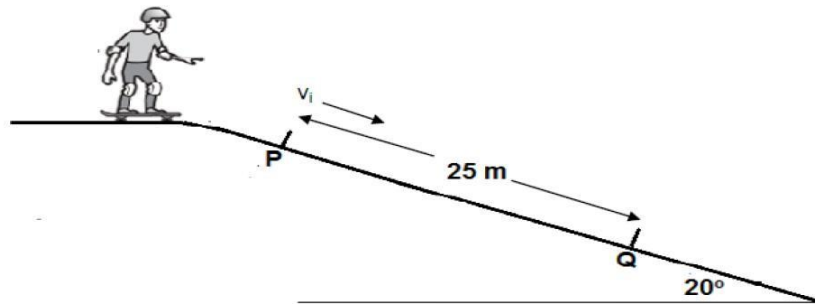
C has decreased.

D has not changed.

(2)

QUESTION 2

The diagram below shows a boy skateboarding on a ramp which is inclined at 20° to the horizontal. A constant frictional force of 50 N acts on the skateboard as it moves from P to Q. Consider the boy and the skateboard as a single unit of mass 60 kg . Ignore the effects of air friction.



- 2.1 Draw a labelled free-body diagram, show in ALL the forces acting on the boy-skateboard (3)

Points P and Q on the ramp are 25 m apart. The skateboarder passes point P at a speed V_i and passes point Q at a speed of $15\text{ m}\cdot\text{s}^{-1}$.

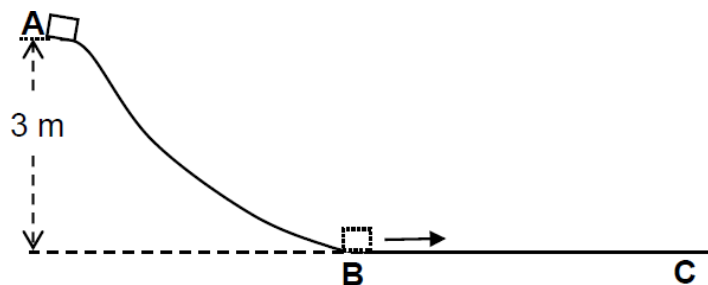
Ignore rotational effects due to the wheels of the skateboard

- 2.2 State the work – energy theorem in words (2)
- 2.3 Use energy principles to calculate the speed V_i of the skateboarder at point P (5)
- 2.4 Calculate the average power dissipated by the skateboarder to overcome friction between P and Q. (4)

[14]

QUESTION 2

A crate of mass 18 kg , initially at rest, slides down a frictionless slope from point A to point B. The crate then moves along a rough horizontal surface from point B towards point C. Point A is 3 m above the horizontal surface. See the diagram below.



- 2.1 State the principle of conservation of mechanical energy in words. (2)

- 2.2 Using ENERGY PRINCIPLES only, calculate the speed of the crate at point **B**. (3)

A constant frictional force of 40,6 N acts on the crate as it moves from point **B** towards point **C**. The crate comes to rest at point **C**.

- 2.3 State the *work-energy theorem* in words (2)

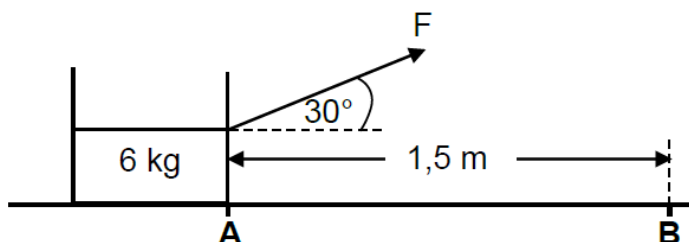
- 2.4 Using ENERGY PRINCIPLES only, calculate the distance that the crate travelled from point **B** to point **C**. (4)

[11]

QUESTION 3

A constant force F is applied at an angle of 30° to the horizontal on a crate of mass 6 kg that is initially at rest, as shown in the diagram below

A constant frictional force of 10 N acts on the crate as it moves from rest at point **A** along a horizontal surface to point **B**. The distance between point **A** and point **B** is 1,5 m. The speed of the crate at point **B** is $2 \text{ m}\cdot\text{s}^{-1}$.



- 3.1 Define the term *work done by a force*. (2)

- 3.2 Draw a labelled free-body diagram showing ALL the forces acting on the crate as it moves. (4)

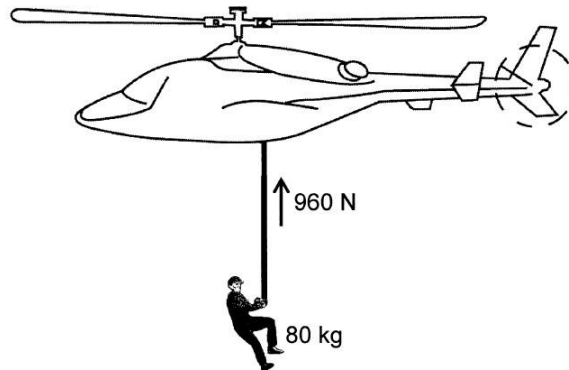
- 3.3 Using ENERGY PRINCIPLES ONLY, calculate the magnitude of force F . (4)

- 3.5 A 2 kg object is placed in the crate. What effect will this have on the work done by the same force F when the crate is again moved from point **A** to point **B**? Write only INCREASES, DECREASES or REMAINS THE SAME. (2)

[12]

QUESTION 4

A rescue helicopter is stationary(hovers)above a soldier. The soldier of mass 80 kg is lifted vertically upward through a height of 20m by a cable at a CONSTANT SPEED of $4 \text{ m}\cdot\text{s}^{-1}$. The tension in the cable is 960N. Assume that there is no sideways motion during the lift. AIR friction is not to be ignored.

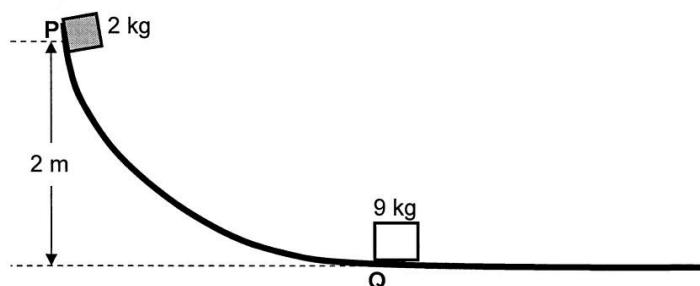


- 4.1 State the work-energy theorem in words (2)
- 4.2 Draw a labelled free- body diagram showing ALL the forces acting on the soldier while being lifted upwards. (3)
- 4.3 Write down the name of a non – contact force that force acts on the soldier during the upward lift (1)
- 4.4 Use the WORK – ENERGY THEOREM to calculate the work done on the Soldier by friction after moving through the height of 20m (5)

[11]

QUESTION 5

A wooden block of mass 2kg is released from rest at point P and slides down a curved slope from a vertical height of 2m, as shown in the diagram below. It reaches its lowest position, point Q, at a speed of $5 \text{ m}\cdot\text{s}^{-1}$.



- 5.1 Define the term gravitational potential energy
- 5.2 Use the work- energy theorem to calculate the work done by the average frictional force on the wooden block when it reaches point Q (2)
- 5.3 Is mechanical energy conserved while the wooden block slides down the slope ? Give a reason for the answer. (2)

5.4 The wooden collides with a stationery crate of mass 9kg at point Q .After the collision, the crate moves to the right at $1 \text{ m}\cdot\text{s}^{-1}$.

5.4.1 Calculate the magnitudes of the velocity of the wooden block immediately after the collision (4)

5.4.2. The total kinetic energy of the system before collision is 25J .Use a calculation to show that the collision between the wooden block and crate is inelastic (5)

[19]

DOPPLER EFFECT

OUTCOME: EASILY OBTAINABLE marks for QUESTION 6 is ± 8 MARKS

1. **Possible definitions/ Laws:** (2)

Doppler Effect.

2. **Correct formulae** (1)

3. **Correct Substitution(s)** (3)

- 3 marks awarded✓✓✓

4. **Identifying direction (away/towards) of the motion of the sound source/listener relative to each other and explain.** (2)

- 1 mark awarded for the direction✓

- 1 mark for the explanation✓

EASILY OBTAINABLE marks for QUESTION is

[8]

QUESTION 1: MULTIPLE CHOICE QUESTIONS

The spectrum of helium emitted from a star moving away from Earth is compared to the spectrum of helium found on Earth.

Which ONE of the following statements is CORRECT?

The observed spectral lines from the moving star will have a ...

A lower frequency and a longer wavelength.

B lower frequency and a shorter wavelength.

C higher frequency and a shorter wavelength.

D higher frequency and a longer wavelength. (2)

- 1.2 A police car with its siren wailing is moving away from a stationary observer at constant speed. The siren emits a sound of constant frequency.

Which of the following characteristics associated with the sound of the siren, as perceived by the observer, is/are CORRECT?

- I. The speed remains the same
- II. The frequency increases
- III. The wavelength increases.
- IV. The pitch decreases.

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

(2)

- 1.3 A car travels at a constant velocity towards a stationary listener. The car's hooter emits a sound of constant frequency as it approaches the listener.

Which ONE of the following statements regarding the frequency and wavelength of the sound of the hooter is CORRECT as observed by the listener?

- A Both the frequency and wavelength have decreased.
- B The frequency has increased while the wavelength has decreased
- C The frequency has decreased while the wavelength has increased
- D Both the frequency and wavelength have increased

(2)

- 1.4 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)

- 1.5 In an experiment on the photoelectric effect, a scientist shines red light on a metal surface and observes that electrons are ejected from the metal surface. Later the scientist shines blue light, with the same intensity as the red light, on the same metal surface

Which ONE of the statements below will be the CORRECT observation as a result of this change?

- A The number of ejected electrons per second will increase.
- B The number of ejected electrons per second will decrease
- C The speed of the ejected electrons will decrease
- D The maximum kinetic energy of the ejected electrons will increase

(2)

[10]

QUESTION 2

A stationary listener records the frequency of the sound emitted by the siren of a police car. When the car which is travelling at a constant velocity of $26 \text{ m}\cdot\text{s}^{-1}$, approaches the listener, the recorded frequency is 615 Hz. The car passes the listener at time t_1 and then moves away from the listener. The recorded frequency now is 526 Hz.

Ignore the effects of wind.

- 2.1 State the Doppler effect in words.
- 2.2 Use the information given to calculate the speed of sound in
- 2.3 Calculate the wavelength of the sound emitted by the police siren.

(2)

(5)

(4)

[11]

QUESTION 3

The Doppler effect is applicable to both sound and light waves. It also has very important applications in our everyday lives.

- 3.1 A hooter on a stationary train emits sound with a frequency of 520 Hz, as detected by a person standing on the platform. Assume that the speed of sound is $340 \text{ m}\cdot\text{s}^{-1}$ in still air.

Calculate the :

- 3.1.1 Wavelength of the sound detected by the person (2)
- 3.1.2 Wavelength of the sound detected by the person when the train moves towards him/her at a constant speed of $15 \text{ m}\cdot\text{s}^{-1}$ with the hooter still emitting sound (6)
- 3.2 Explain why the wavelength calculated in QUESTION 3.1.1 differs from that obtained in QUESTION 3.1.2. (2)
- 3.3 Use your knowledge of the Doppler effect to explain *red shifts*. (2)
- [12]

ELECTROSTATICS

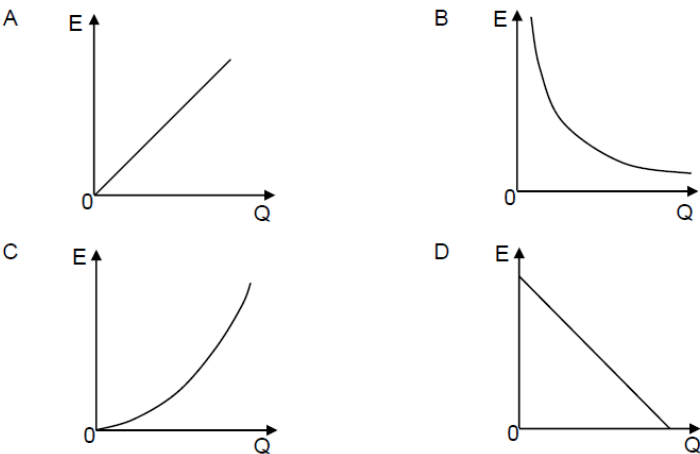
OUTCOME: EASILY OBTAINABLE marks for QUESTION 7 is ± 10 MARKS

1. **Possible definitions/ Laws:** (2)
Coulomb's law, Electric field and Electric field at a point
2. **Drawing of a free-body/ vector diagram.** (2-3)
• 2/3 marks awarded✓✓✓
Refer to question 2
-
- Drawing of electric field pattern**
2/3 marks awarded✓✓✓
3. **Correct formulae** (2)
2×1 mark is awarded for a correct formula if and only if there is attempt of substitution✓
4. **Correct Substitution(s)** (3-4)
3-4 marks awarded✓✓✓
EASILY OBTAINABLE marks for QUESTION is [10]

QUESTION 1: MULTIPLE CHOICE QUESTIONS

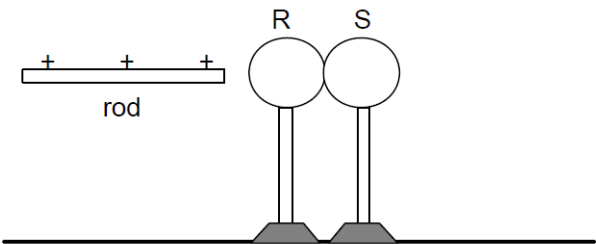
1.1 The magnitudes of electric fields generated by different point charges are measured at a fixed point. For each measurement, the distance between this fixed point and the charges are the same.

Which ONE of the following sketch graphs CORRECTLY shows the relationship between the magnitude of the electric field (E) and the magnitude of the charge (Q)?



(2)

1.2 Two neutral metal balls, R and S, each on an insulated stand, are in contact with each other. A positively charged rod is held near R without touching it, as shown below.

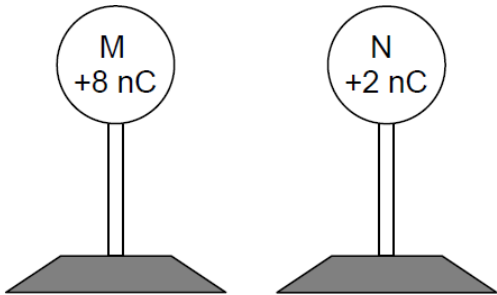


Ball S is then moved away from R and the rod is removed thereafter. What would be the nature of the charges on R and S?

	Charge on R	Charge on S
A	neutral	neutral
B	negative	neutral
C	negative	positive
D	positive	negative

(2)

1.3 Two identical metallic sphere , M and N on insulated stands , carry charges of +8 nC and +2 nC respectively.



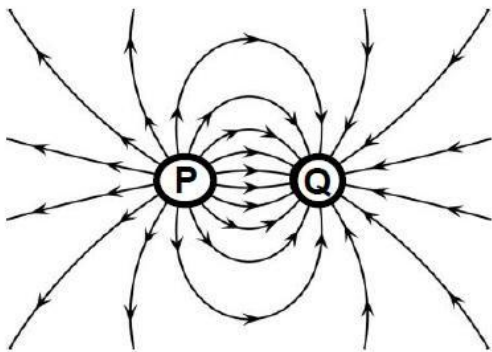
The two spheres are brought into contact with each other and are then separated again.

Which ONE of the following combinations is the correct description of the type of charge transferred and the direction of transfer between the two spheres?

	Type of charge transferred	Direction of transfer
A	electrons	from N to M
B	protons	from N to M
C	electrons	from M to N
D	protons	from M to N

(2)

1.4 The diagram below shows the field lines for the combined electric field due to two small charged spheres **P** and **Q**.

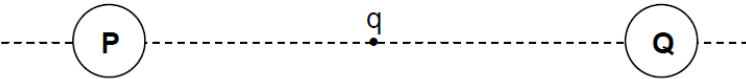


Which ONE of the combinations below correctly shows the polarity of spheres **P** and **Q**?

	SPHERE P	SPHERE Q
A	Negative	Positive
B	Negative	Negative
C	Positive	Positive
D	Positive	Negative

(2)

1.5 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?

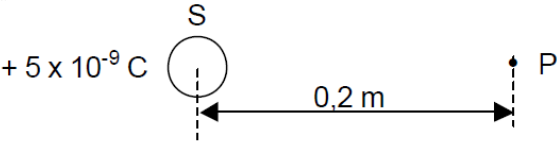
- A Zero
- B $\frac{1}{2}F$
- C F
- D 2F

(2)

[10]

QUESTION 2

S is a small, positively-charged sphere carrying a charge of $+ 5 \times 10^{-9} \text{ C}$. Consider point P at a distance of 0,2 m from the centre of S.

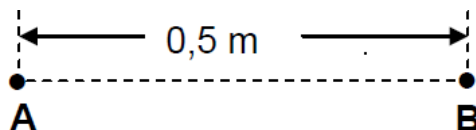


- 2.1 Draw the electric field pattern around S. (3)
- 2.2 Calculate the magnitude and direction of the electric field strength at P due to the charge on S. (5)
- 2.3 A small point charge, placed at P, experiences a repelling force of $3,375 \times 10^{-5}$ Calculate the magnitude of the charge at P and state whether it is positive or negative. (5)

[13]

QUESTION 3

Two identical negatively charged spheres, **A** and **B**, having charges of the **same magnitude**, are placed 0,5 m apart in vacuum. The magnitude of the electrostatic force that one sphere exerts on the other is $1,44 \times 10^{-1}$ N.



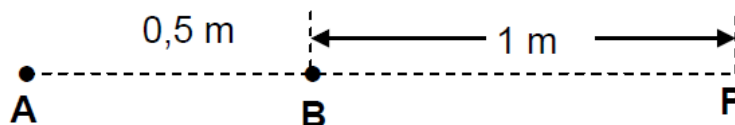
3.1 State Coulomb's law in words. (2)

3.2 Calculate the:

3.2.1 Magnitude of the charge on each sphere (4)

3.2.2 Excess number of electrons on sphere B (3)

3.3 **P** is a point at a distance of 1 m from sphere **B**.



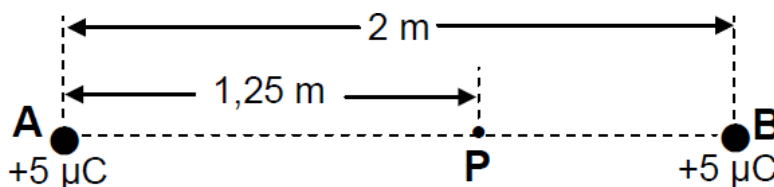
3.3.1 What is the direction of the net electric field at point **P**? (1)
[10]

QUESTION 4

Two small identical spheres, **A** and **B**, each carrying a charge of $+5 \mu\text{C}$, are placed 2 m apart.

Point **P** is in the electric field due to the charged spheres and is located 1,25 m from sphere **A**.

Study the diagram below.



4.1 Describe the term *electric field*. (2)

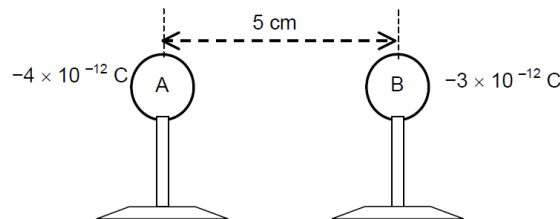
4.2 Draw the resultant electric field pattern due to the two charged spheres (3)

4.3 Calculate the magnitude of the net electric field at point **P**. (5)

[10]

QUESTION 5

Two small metal spheres, A and B carrying charges of $-4 \times 10^{-12} \text{ C}$ and $-3 \times 10^{-12} \text{ C}$ respectively, are mounted on insulated stands as shown. The distance between the centres of the spheres is 5 cm.



5.1 Draw the resultant electric field pattern produced by A and B (3)

5.2 Calculate the **magnitude and direction** of the force that A exerts on B. (6)

Sphere A is moved and makes contact with sphere B. It is then moved back to its original position.

5.3 Calculate the new charge on each of the spheres (3)

5.4 How does the magnitude of the force that sphere A exerts on sphere B change? Answer by writing **ONLY increases, decreases or remains the same**. (2)

[10]

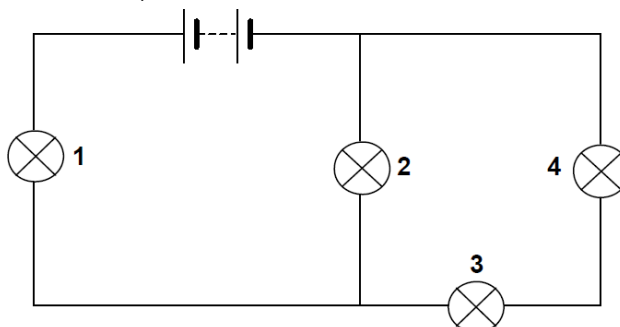
ELECTRIC CIRCUIT

OUTCOME: EASILY OBTAINABLE marks for QUESTION 7 is ± 10 MARKS

1. **Possible definitions/ Laws:** (2)
Ohm's law, Emf of a cell, Power, internal resistance, explain emf of 12V
 2. **Correct formulae** (3)
 - 3×1 mark is awarded for a correct formula if and only if there is attempt of substitution✓
 3. **Correct Substitution(s)** (3)
 - 3-4 marks awarded✓✓✓
 4. **Graph** (3)
 - Writing the emf from the graph✓
 - Determine the gradient of the graph✓✓
 5. **Explanation of the effect of increasing/decreasing the resistance.** (2-5)
 - 1 mark for I or V increase/decrease/remains constant✓
 - 1 mark for R_{total} decrease/increase✓
 - 1 mark for I_{total} increase/decrease✓
 - 1 mark for V_{internal} increase/decrease✓
 - Emf stays the same, V_{ext} increases✓ e.t.c.
- EASILY OBTAINABLE marks for QUESTION is [10]

QUESTION 1 : MULTIPLE CHOICE QUESTIONS

1.1 In the circuit represented below, the four bulbs are identical.

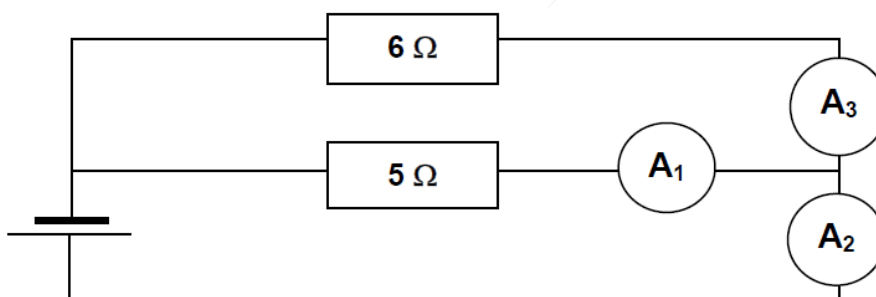


Which one of the following pairs of bulbs has equal brightness?

- A 2 and 4
- B 3 and 4
- C 1 and 3
- D 1 and 2.

(2)

1.2 The circuit represented below contains two resistors and three identical ammeters, registering readings I_1 , I_2 and I_3 on ammeters A_1 , A_2 and A_3 respectively.

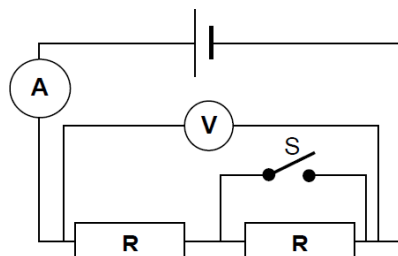


Which ONE of the following statements is FALSE?

- A $I_2 = I_2 + I_3$
- B I_1 is less than I_3
- C I_2 is the current in the cell
- D I_3 is the current in the $6\ \Omega$ resistor.

(2)

- 1.3 In the circuit represented below, switch S is open. The internal resistance of the cell is negligible.



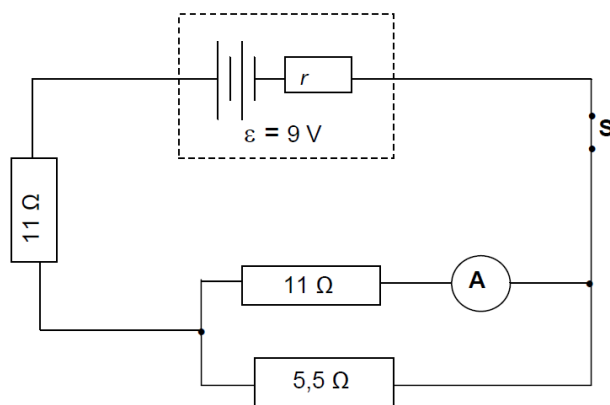
Which ONE of the following combinations correctly represents the change in the readings of the ammeter and the voltmeter when switch S is closed?

	Ammeter reading	Voltmeter reading
A	decreases	increases
B	decreases	remains the same
C	increases	increases
D	increases	remains the same

(2)

QUESTION 2

In the circuit below the reading on ammeter A is 0,2 A. The battery has an emf of 9 V and internal resistance r .

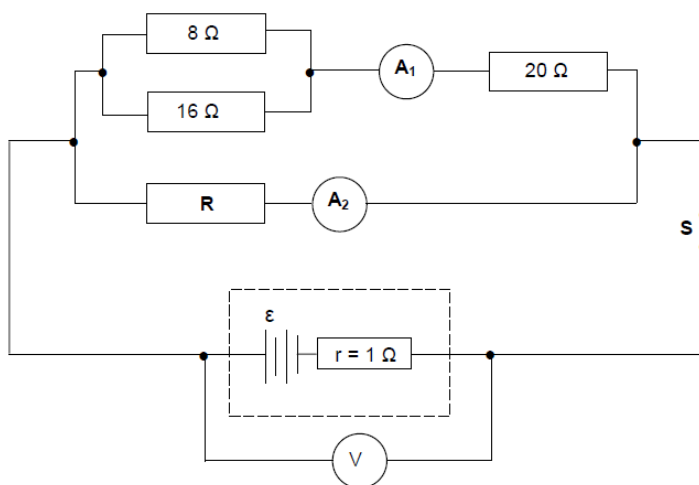


- 2.1 Calculate the current through the 5,5 Ω resistor (3)
- 2.2 Calculate the internal resistance of the battery (7)
- 2.3 Will the ammeter reading INCREASE, DECREASE or REMAIN THE SAME if the 5,5 Ω resistor is removed from the circuit? Give a reason for the answer (2)

[12]

QUESTION 3

A battery with an internal resistance of $1\ \Omega$ and an unknown emf (ϵ) is connected in a circuit, as shown below. A high-resistance voltmeter (V) is connected across the battery. A_1 and A_2 represent ammeters of negligible resistance.

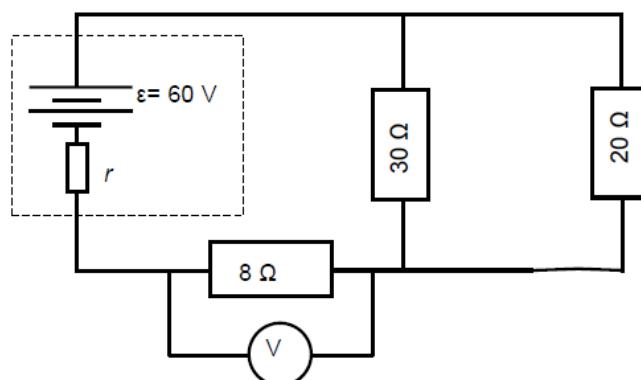


With switch **S** closed, the current passing through the $8\ \Omega$ resistor is $0,5\text{ A}$.

- 3.1 State Ohm's law in words. (2)
 - 3.2 Calculate the reading on ammeter A_1 . (4)
 - 3.3 If device **R** delivers power of 12 W , calculate the reading on ammeter A_2 . (5)
 - 3.4 Calculate the reading on the voltmeter when switch **S** is open. (3)
- [14]**

QUESTION 4

The circuit diagram below shows a battery with an emf (ϵ) of 60 V and an unknown internal resistance r , connected to three resistors.



A voltmeter connected across the $8\ \Omega$ resistor reads 21,84 V.

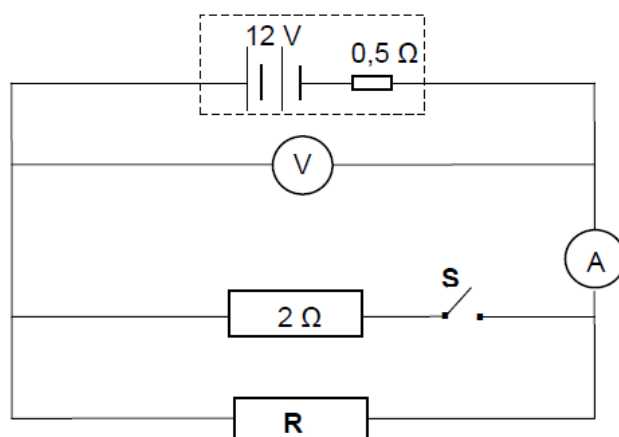
Calculate the:

- 4.1 Current in the $8\ \Omega$ resistor (3)
- 4.2 Equivalent resistance of the resistors in parallel (2)
- 4.3 Internal resistance r of the battery (4)
- 4.4 Heat dissipated in the external circuit in 0,2 seconds (3)

[12]

QUESTION 5

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.



- 5.1 What is the meaning of the following statement? (2)

The emf of the battery is 12 V.

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

5.2 Calculate the:

5.2.1 Reading on the voltmeter (3)

5.2.2 Resistance of resistor R (2)

Switch **S** is now CLOSED.

5.3 How does this change affect the reading on the voltmeter? Choose from: INCREASES, DECREASES or REMAINS THE SAME. (4)
Explain the answer.

[11]

ELECTRODYNAMICS

OUTCOME: EASILY OBTAINABLE marks for QUESTION 9 is ± 10 MARKS

1. **Possible definitions/ Laws:** (2)

State energy conversion of a motor/generator and rms of current/voltage.

2. **Correct formulae** (2)

- 2×1 mark is awarded for a correct formula if and only if there is attempt of substitution✓

3. **Correct Substitution(s)** (3)

- 3 marks awarded✓✓✓

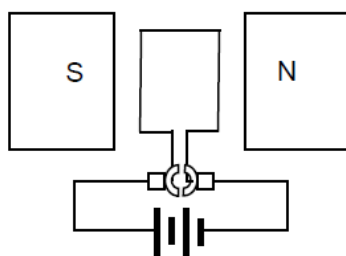
Sketching of the graph (3)

- 3 marks awarded✓✓✓

[10]

QUESTION 1: MULTIPLE CHOICE QUESTION

A simplified diagram of an electrical machine is shown below.

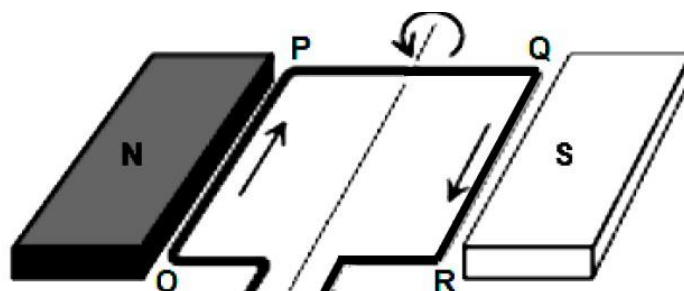


1.1 What type of machine is this?

- A A DC motor
- B An AC motor
- C A DC generator
- D An AC generator

(2)

1.2 A DC current passes through a rectangular wire loop OPQR placed between two pole pieces of a magnet, as shown below.



Which TWO segments of the loop will experience an electromagnetic force when the loop is in the position above?

- A OP and PQ
- B QR and RO
- C OP and QR
- D RO and OP

(2)

1.3 Which ONE of the following energy conversions takes place when an AC generator is in operation?

- A Electrical to mechanical
- B Mechanical to electrical
- C Heat to mechanical
- D Electrical to potential

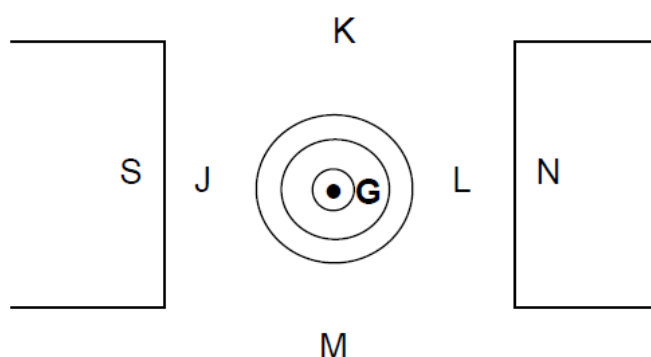
(2)

1.4 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)

1.5 In the diagram below a straight, copper conductor G, carries a current out of the page towards the observer. It experiences a force when placed in a magnetic field that is produced by two permanent bar magnets. N represents the north pole and S the south pole of the magnets.



- A Towards K
- B Towards L
- C Towards M
- D Towards J

(2)

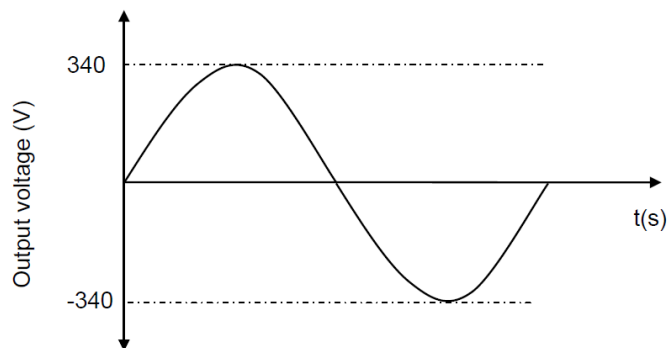
1.6 The direction of the induced current in the coil of a generator depends on the ...

- 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)
[12]

QUESTION 2

The graph below shows the output voltage from a household AC generator for one cycle of rotation of the coils.



2.1 A 100 W light bulb is connected to this generator and it glows at its maximum brightness.:

Use the information from the graph to calculate the

2.1.1 Resistance of the bulb

(5)

2.1.2 rms current through the bulb

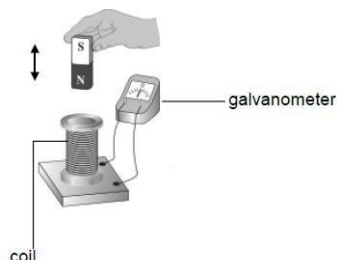
(3)

2.2 Give ONE reason why AC voltage is preferred to DC voltage for everyday use.

(1)
[09]

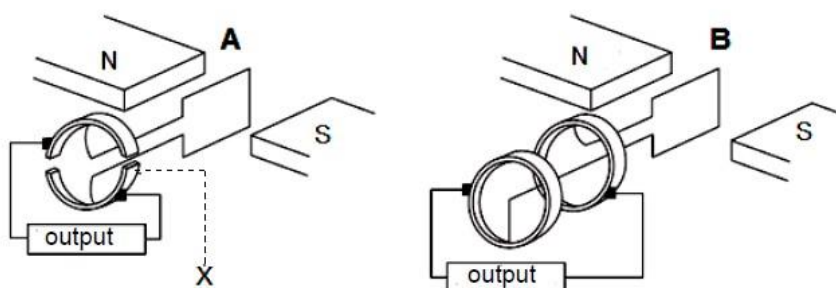
QUESTION 3

A teacher demonstrates how current can be obtained using a bar magnet, a coil and a galvanometer. The teacher moves the bar magnet up and down, as shown by the arrow in the diagram below.



- 3.1.1 Briefly describe how the magnet must be moved in order to obtain a LARGE deflection on the galvanometer. (2)

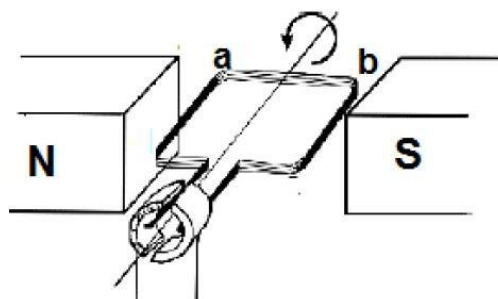
The two devices, **A** and **B**, below operate on the principle described in QUESTION 3.1.1 above.



- 3.1.2 Write down the name of the principle. (1)
- 3.1.3 Write down the name of part **X** in device **A**. (1)
- 3.2 A 220 V, AC voltage is supplied from a wall socket to an electric kettle of resistance $40,33 \, \Omega$. Wall sockets provide rms voltages and currents
- Calculate the:
- 3.2.1 Electrical energy consumed by the kettle per second (4)
- 3.2.1 Maximum (peak) current through the kettle (3)
- [11]

QUESTION 4

4.1 A part of a simplified DC motor is shown in the sketch below.



4.1.1 In which direction (**a to b**, OR **b to a**) is the current flowing through the coil if the coil rotates anticlockwise as indicated in the diagram? (1)

4.1.2 Name the rule you used to answer QUESTION 4.1.1 (1)

4.1.3 Which component in the diagram must be replaced in order for the device to operate as an AC generator? (1)

4.2 An electrical device of resistance $400\ \Omega$ is connected across an AC generator that produces a maximum emf of 430 V. The resistance of the coils of the generator can be ignored

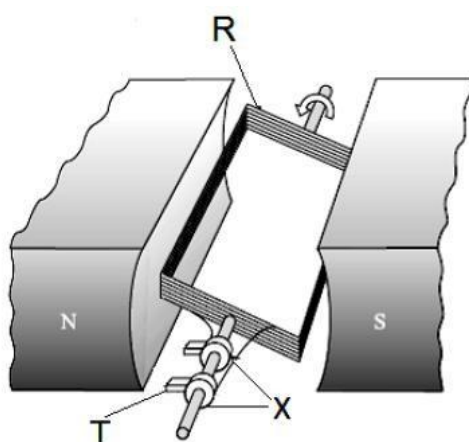
4.2.1 State the energy conversion that takes place when the AC generator is in operation. (2)

4.2.2 Calculate the root mean square value of the current passing through the resistor. (5)

[11]

QUESTION 5

5.1 The diagram below shows a simplified version of a generator



5.1.1 Write down the name of EACH part, **R**, **T** and **X**. (3)

5.1.2 Give the NAME of the law upon which the operation of the generator is based. (1)

5.2 An AC supply is connected to a light bulb. The light bulb lights up with the same brightness as it does when connect to a 15 V battery.

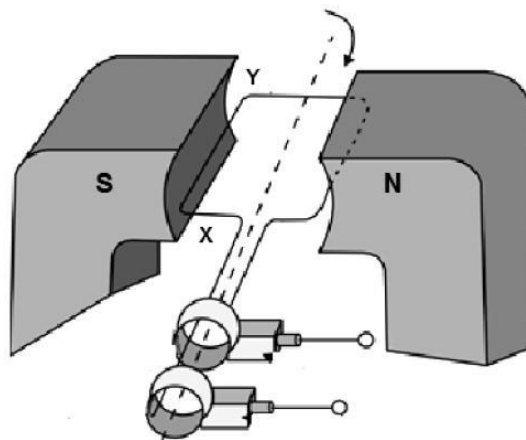
5.2.1 Write down the rms value of the potential difference of the AC supply. (1)

5.2.2 If the resistance of the light bulb is $45\ \Omega$, calculate the maximum current delivered to the light bulb. (4)

[09]

QUESTION 6

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



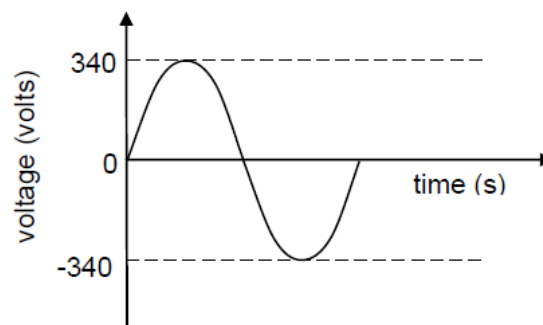
6.1.1 In which direction does the induced current flow in the coil? (1)

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

6.1.2 On which principle or law is the working of the generator based? (1)

6.1.3 State the energy conversion that takes place while the generator is in operation. (2)

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



6.2.1 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.

6.2.2 Calculate the rms voltage delivered to the stove. (3)

6.2.3 Calculate the resistance of the stove. (3)

[11]

PHOTOELECTRIC EFFECT

OUTCOME: EASILY OBTAINABLE marks for QUESTION 10 is ± 9 MARKS

1. Possible definitions/ Laws: (2)

Photoelectric effect, threshold frequency, work function.

Correct formulae	
$E = hf$ hc $E = \frac{hc}{\lambda}$	$E = W_0 + E_{k(max)}$ $E_{k(Max)} = \frac{1}{2}mv_{max}^2$

- 2×1 mark is awarded for a correct formula if and only if there is attempt of substitution✓

(2)

3. Correct Substitution(s) (3)

- 3-4 marks awarded✓✓✓

4. Effect of change in intensity/frequency of light on current / kinetic energy of light.

- Increase/decrease/remain the same✓
- Explanation✓✓

5. Explanation of redshift✓✓ (2)

EASILY OBTAINABLE marks for QUESTION is

[10]

QUESTION 1 : MULTIPLE CHOICE QUESTIONS

1.1 Which ONE of the following combinations is CORRECT for a line absorption spectrum in terms of the ENERGY TRANSITIONS OF THE ATOMS and the APPEARANCE OF THE NARROW LINES IN THE SPECTRUM?

	ENERGY TRANSITION OF THE ATOMS	APPEARANCE OF THE NARROW LINES IN THE SPECTRUM
A	Higher to lower energy state	Dark lines
B	Lower to higher energy state	Coloured lines
C	Lower to higher energy state	Dark lines
D	Higher to lower energy state	Coloured lines

1.2 When light of a certain wavelength is incident on a metal surface, no electrons are ejected. Which ONE of the following changes may result in electrons being ejected from the metal surface?

- A Increase the intensity of the light.
- B Use light with a much shorter wavelength
- C Use metal with a larger work function.
- D Increase the surface area of the metal (2)

1.3 In an experiment on the photoelectric effect, a scientist shines red light on a metal surface and observes that electrons are ejected from the metal surface. Later the scientist shines blue light, with the same intensity as the red light, on the same metal surface.

Which ONE of the statements below will be the CORRECT observation as a result of this change?

- A The number of ejected electrons per second will increase.
- B The number of ejected electrons per second will decrease
- C The speed of the ejected electrons will decrease.
- D The maximum kinetic energy of the ejected electrons will increase. (2)

1.4 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.

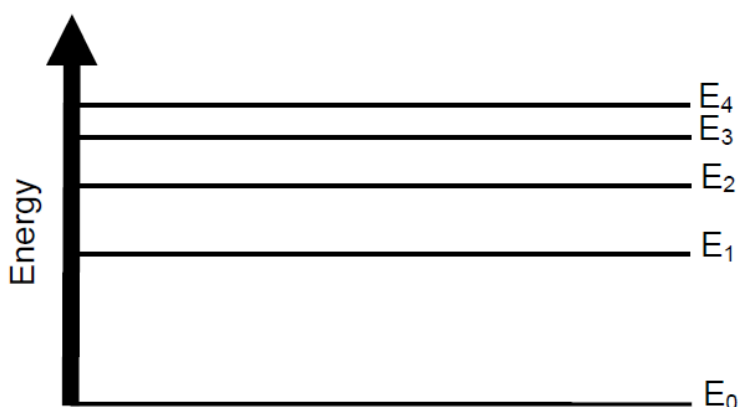
Which ONE of the following combinations of the statements above is CORRECT?

- A (i) only
- B (ii) only
- C (ii) and (iii) only
- D (i) and (iii) only (2)

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

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

1.6 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)

1.7 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. (2)

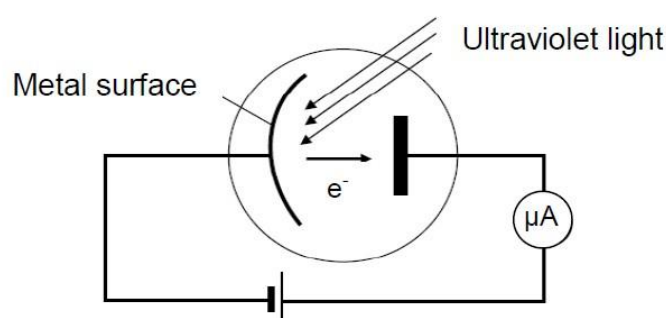
Which of the statements above is/are CORRECT?

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

(2)

QUESTION 2

A learner uses photocells to determine the maximum kinetic energy of ejected photoelectrons. One photocell has a caesium cathode and the other has a sodium cathode. Each photocell is radiated by ultraviolet light from the same source as shown below.



The incomplete results obtained are shown in the table below.

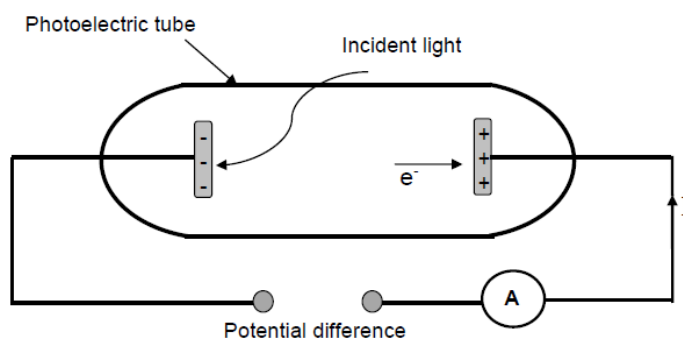
NAME OF THE METAL	WORK FUNCTION OF THE METAL (J)	MAXIMUM KINETIC ENERGY OF PHOTOELECTRONS (J)
Caesium	$3,36 \times 10^{-19}$	$2,32 \times 10^{-19}$
Sodium	$3,65 \times 10^{-19}$	E_k

- 2.1 Define the term *work function of a metal*. (2)
- 2.2 Use the information in the table to calculate the wavelength of the ultraviolet light used in the experiment (4)
- 2.3 Calculate the maximum kinetic energy, E_k , of an electron ejected from the sodium metal. (4)
- 2.4 The intensity of the incident ultraviolet light was then increase
- 2.4.1 Give a reason why this change does NOT affect the maximum kinetic energy of the ejected photoelectrons. (1)
- 2.4.2 How does the increased intensity affect the reading on the ammeter? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
- 2.4.3 Explain the answer to QUESTION 2.4.2. (2)

[14]

QUESTION 3

A simplified diagram of an apparatus for an experiment to investigate the photoelectric effect is shown below. Light of a fixed frequency is incident on the cathode of a photoelectric tube. During the experiment the ammeter (**A**) registers the photocurrent



- 3.1 Define the term *photoelectric effect*. (2)

The intensity of the incident light is now increased.

- 3.2 State how this increase in intensity will affect the reading on the ammeter. Choose from INCREASE, DECREASE or REMAIN THE SAME.

Give a reason for the answer. (3)

When the frequency of the incident light is $5,9 \times 10^{14}$ Hz, the maximum recorded kinetic energy of photoelectrons is $2,9 \times 10^{-19}$ J.

- 3.3 Calculate the maximum wavelength (threshold wavelength) of the incident light that will emit an electron from the cathode of the photo-electric tube. (5)

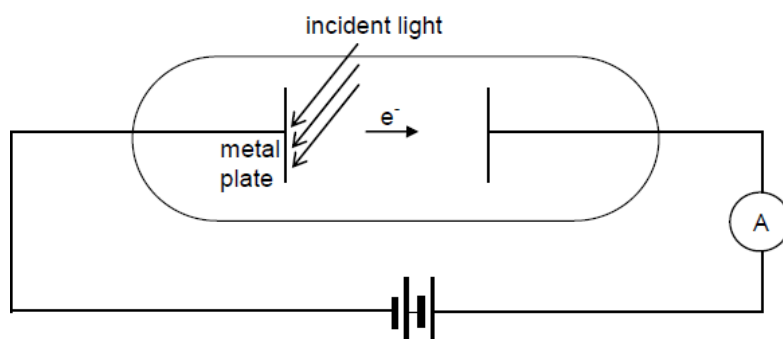
The maximum kinetic energy of the photoelectrons ejected increases when light of a higher frequency is used.

- 3.4 Use the photoelectric equation to explain this observation. (2)

[12]

QUESTION 4

- 4.1 The apparatus illustrated in the simplified diagram below is used to demonstrate the photoelectric effect



- 4.1.1 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:

- 4.1.2 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)
- 4.1.3 Maximum speed of a photoelectron if the threshold frequency of the metal plate is $9,09 \times 10^{14}$ Hz (5)
- 4.2 Briefly explain how an emission spectrum is formed in terms of energy transitions (2)

[13]

**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 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>Spoeed 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 $\Delta K = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ 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 $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or/of $E = W_0 + K_{(\text{max})}$ where/waar	
$E = hf$ and/en $W_0 = hf_0$ and/en $E_k = \frac{1}{2}mv_{\text{max}}^2$ 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

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