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TRINITYHOUSE HIGH SCHOOL

PHYSICAL SCIENCES GRADE 12 PRELIM EXAMINATION 2024

PAPER 1 - PHYSICS

MARKS: 200

TIME: 3 HOURS

EXAMINERS: MR ZINZOMBE; MRS SHEPPARD

MODERATED: MR TAM; MRS MILLETT-CLAY

NAME: _____ KEY: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of 31 pages and a Data Sheet.
2. Please make sure that your question paper is complete.
3. Write your name at the top of your front sheet.
4. Read the questions carefully.
5. ALL of the questions in this paper must be answered on the question paper.
6. Question 1 consists of 10 multiple-choice questions. There is only one correct answer to each question. The questions must be answered on the grid provided **at the beginning of the question**. The letter that corresponds with your choice of the correct answer must be marked with a cross as shown in the example below:

A	B	~~C~~	D
---	---	--------------	---

7. **At the end of the paper you will find two blank pages in case you need more space to answer the question or sub questions.**
8. Use data and formulae whenever necessary.
9. You may use approved, non-programmable and non-graphical calculators, unless otherwise stated.
10. Show the necessary steps in calculations.
11. Where appropriate take your final answer to 2 decimal places.
12. It is in your own interest to write legibly and to set out your work neatly.

QUESTION	1	2	3	4	5	6	7	8	9	TOT	%
MAXIMUM	20	13	29	25	23	28	25	20	17	200	
MARK											

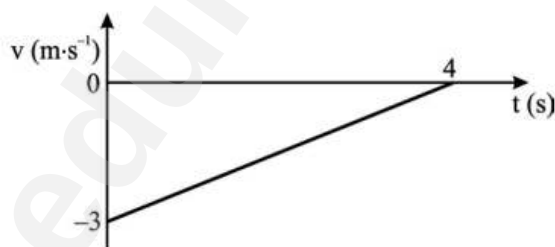
QUESTION 1: MULTIPLE CHOICE

Answer these questions on the multiple-choice grid below.

Make a cross (X) in the box corresponding to the letter that you consider to be correct.

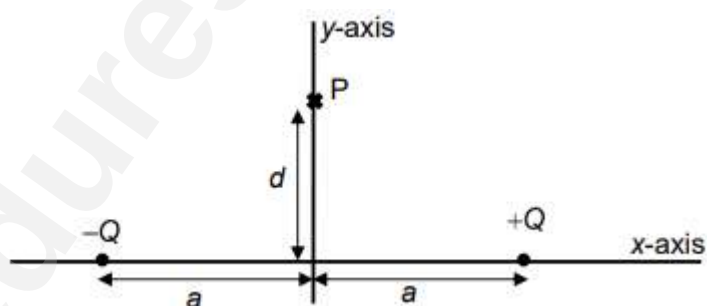
1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

- 1.1 A sketch of the velocity-time graph for a moving object is shown below. What is happening to the object's velocity and acceleration over the 4 s?



	v (m.s⁻¹)	a (m.s⁻²)
A	decreasing	negative
B	decreasing	positive
C	increasing	positive
D	increasing	negative

- 1.2 A ball is dropped from height **h** and strikes the floor with velocity **v**. The ball is then dropped again from another height which is half the previous height. What is its velocity now?
- A v
B $\frac{v}{2}$
C $\frac{v}{\sqrt{2}}$
D $2v$
- 1.3 A block is suspended by a single, vertical string from the ceiling. Which force forms a 'Newton's third law pair' with the weight of the block?
- A The gravitational force exerted by the block on the Earth.
B The force from the ceiling acting on the block.
C The weight of the block has no 'Newton's third law pair' as the block is in equilibrium.
D The force of tension in the string acting on the block
- 1.4 Two charges, $-Q$ and $+Q$ are fixed in place on the x-axis, each a distance **a** from the origin as shown in the diagram. What is the direction of the resultant electric field at the point labelled **P**, a distance **d** along the y-axis?



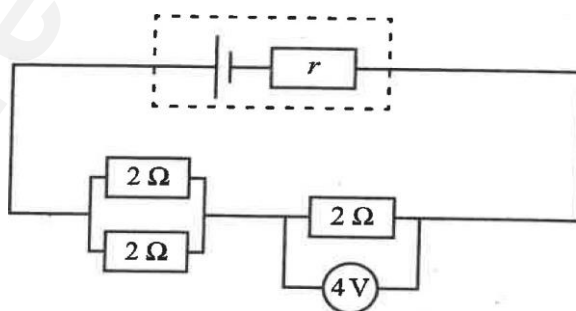
- A Along the positive y-axis.
B Along the negative y-axis.
C Horizontally to the left in the diagram.
D Horizontally to the right in the diagram.

- 1.5 A car has a mass m . A person pushes the car with a force F in order for the car to have an acceleration of a . The person then pushes the car with a force $3F$ to achieve an acceleration of $7a$. Which expression is equal to the constant resistive force opposing the motion of the car?

A	$\frac{ma}{2}$
B	ma
C	$3ma$
D	$2ma$

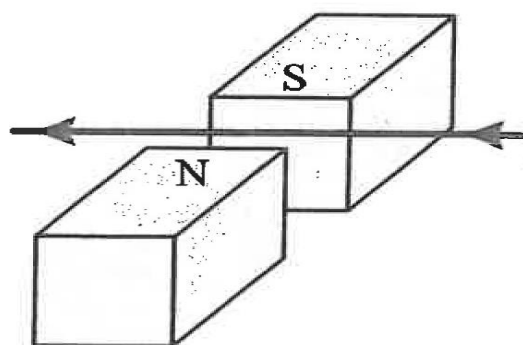
- 1.6 A car's engine develops 110 400 W of power to keep the car traveling at a constant velocity of 115,2 km.h⁻¹. What is the magnitude of the frictional force acting on the car?
- A 266,20 N
 B 958,33 N
 C 3 450,00 N
 D Can not be determined

- 1.7 In the circuit below, the battery has an emf of 6,2 V. The internal resistance of the battery is...



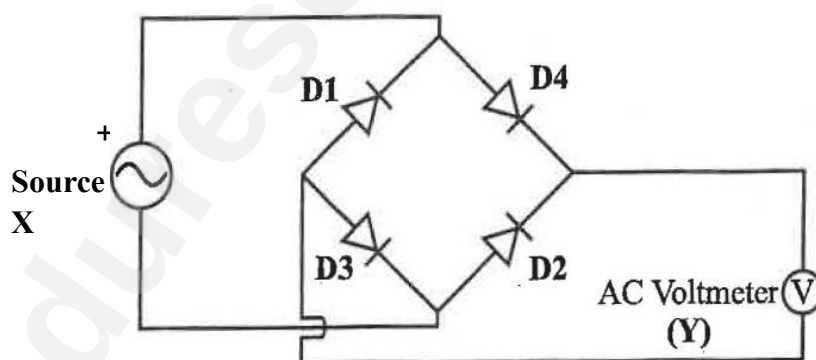
- A 1 Ω
 B 0,4 Ω
 C 0,2 Ω
 D 0,1 Ω

- 1.8 A current flows in a conductor placed between two magnets as shown in the diagram below. In which direction will the wire experience a force when the current is moving in the direction shown?



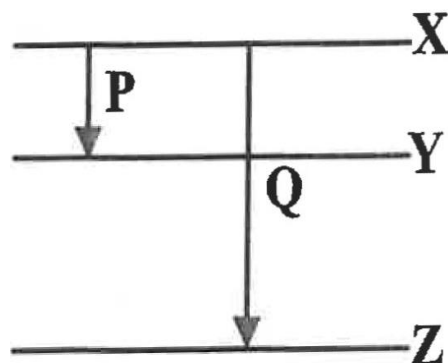
- A Upwards
- B Downwards
- C Towards the south pole
- D Towards the north pole

- 1.9 The diagram below shows a full wave bridge rectifier connected to an AC source. Which one of the following options gives the correct output of the AC voltmeter and the correct path of the current through the diode bridge for one complete cycle if the cycle is showing conventional current at the start?



	Output	Direction of current
A		$X \rightarrow D2 \rightarrow Y \rightarrow D1 \rightarrow X \rightarrow D4 \rightarrow Y \rightarrow D3 \rightarrow X$
B		$X \rightarrow D4 \rightarrow Y \rightarrow D3 \rightarrow X \rightarrow D2 \rightarrow Y \rightarrow D1 \rightarrow X$
C		$X \rightarrow D4 \rightarrow Y \rightarrow D3 \rightarrow X \rightarrow D2 \rightarrow Y \rightarrow D1 \rightarrow X$
D		$X \rightarrow D2 \rightarrow Y \rightarrow D1 \rightarrow X \rightarrow D4 \rightarrow Y \rightarrow D3 \rightarrow X$

- 1.10 The diagram below represents 3 energy levels, **X**, **Y** and **Z** in a certain atom. The energy difference between levels **Y** and **Z** is twice the energy difference between levels **X** and **Y**. If the wavelength of a photon emitted as a result of transition **P**, from level **X** to **Y**, is **d**, then what is the wavelength of the photon emitted during transition **Q**, from level **X** to **Z**?



- A 2d
B 3d
C 2/d
D 3/d

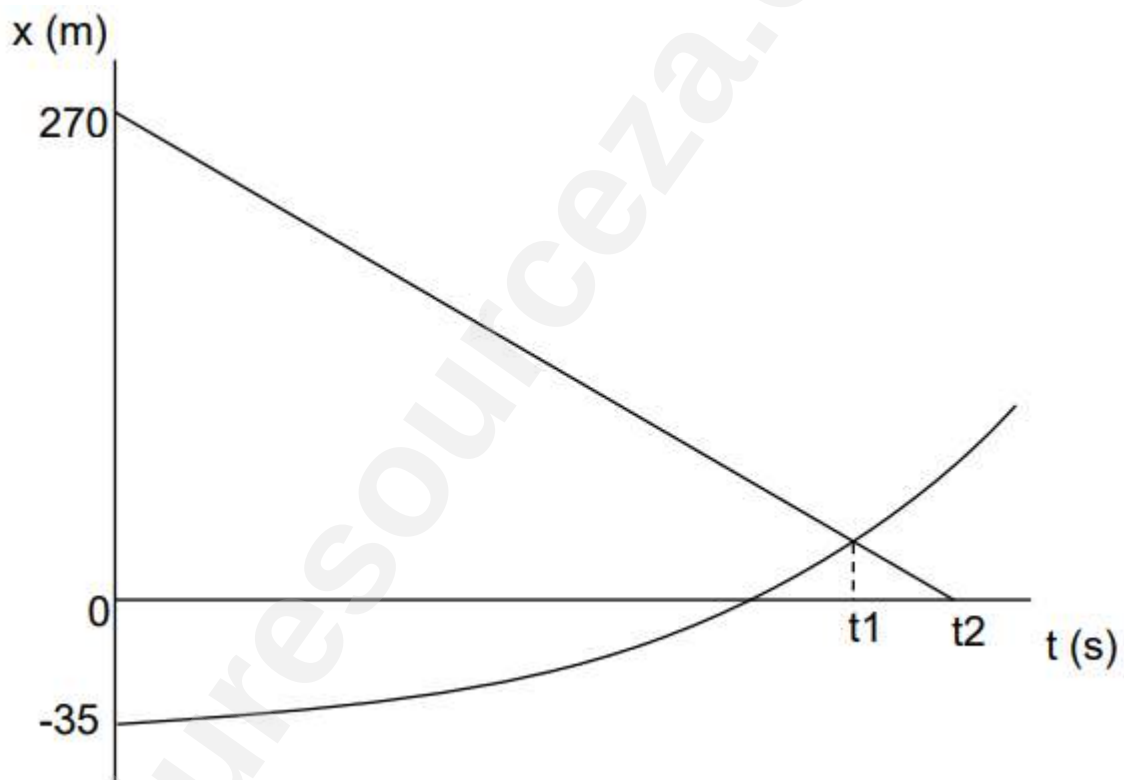
[10 x 2 = 20 marks]

QUESTION 2 : KINEMATICS

A red car and a green car travel towards each other on a straight road. The green car travels at a constant speed of 20 m.s^{-1} to the left and the red car starts from rest and travels to the right at an acceleration of $0,9 \text{ m.s}^{-2}$.



The graph below shows the change in position against time for the two cars.



2.1 Define *displacement*. (2)

2.2 What distance separates the two cars at $t = 0 \text{ s}$? (1)

- 2.3 Describe the velocity of the red car in detail. (2)
- 2.4 Write a mathematical expression for the displacement of the red car from $t = 0 \text{ s}$ until time t_1 in terms of t . (1)
- 2.5 Use the expression from **QUESTION 2.4** to calculate time t_1 . (4)
- 2.6 Draw a labelled sketch graph of velocity against time in the space below for the **two cars on the same set of axes**. Include any relevant data points on the axes. Take the direction of the green car to the left as the negative direction. (3)

[13]

QUESTION 3 : PROJECTILE MOTION

- 3.1 Tayden throws a cricket ball vertically upwards while waiting for a match to start and Liam decides to design a scientific investigation around this. He uses light gates to determine the initial velocity, u , of the ball and investigates how the initial velocity affects the maximum height the ball reaches. Kiana suggests that their results should help them to confirm the value of gravitational acceleration.
- They use a video camera to determine the maximum height reached by the ball.

Their results are shown in the table below.

Initial velocity (m.s^{-1})	u^2	Maximum height reached (m)
8	64	4
11	v_i	6
17	289	15
23	529	27
29	841	42
30	900	46

- 3.1.1 Consider the **second column** in their table:

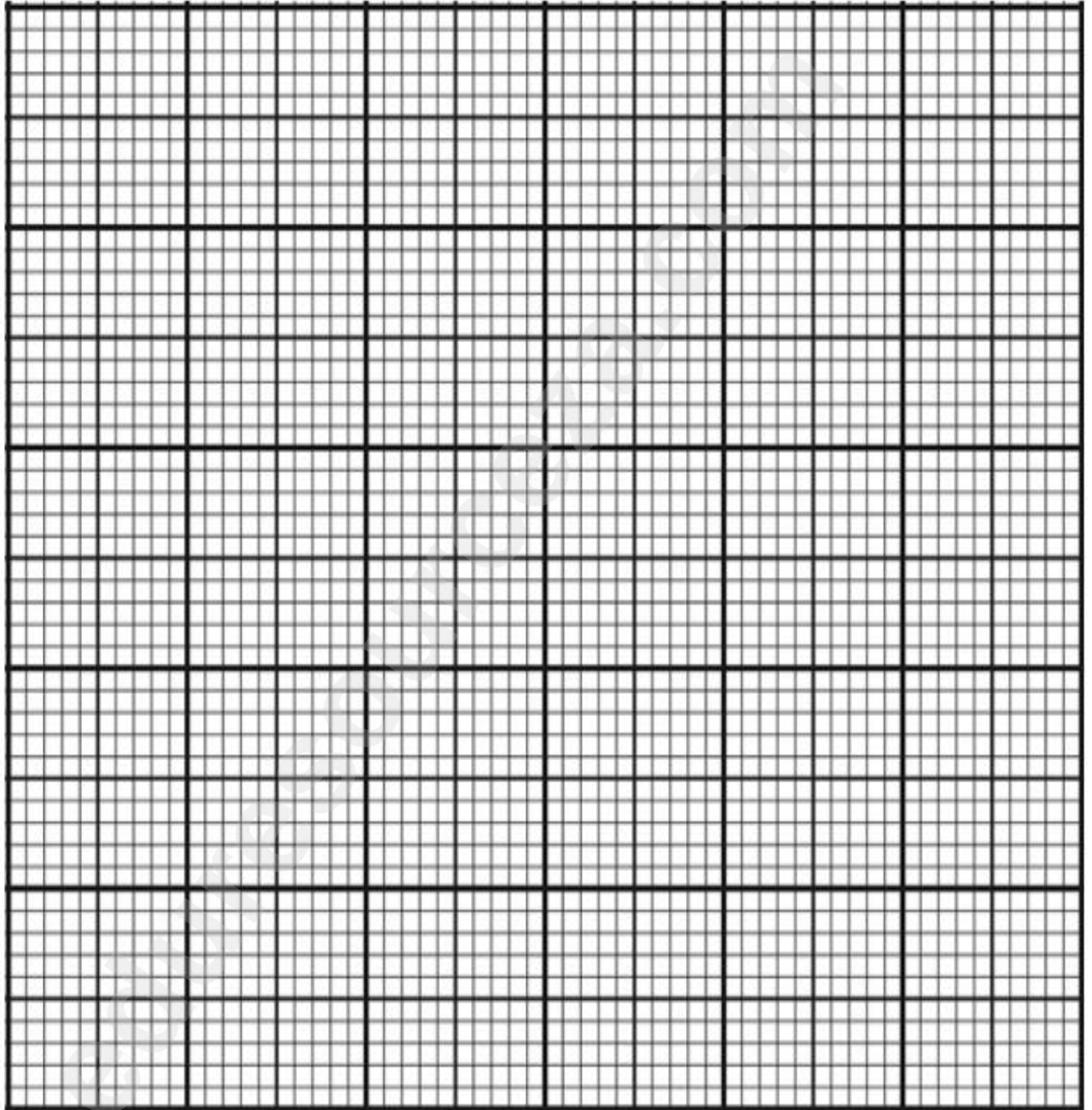
3.1.1a) Give the unit for this column. (1)

3.1.1b) Write down the value of v_i . (1)

- 3.1.2 Use an equation of motion to write a simplified equation showing the relationship between the **square** of the initial velocity, u , and the maximum height reached. (1)

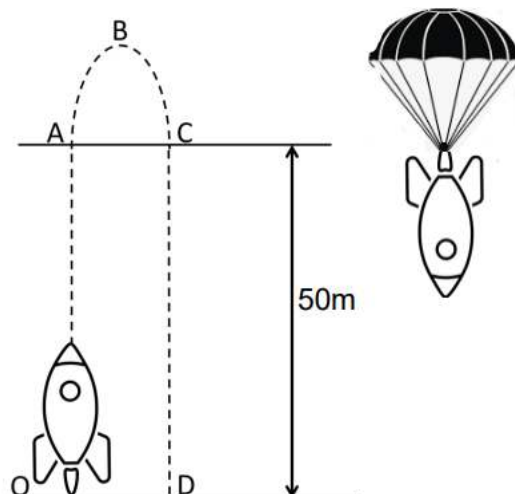
- 3.1.3 On the graph grid below, plot a graph of the maximum height reached vs the square of the initial velocity. Include a line of best fit.

(5)



- 3.1.4 Use your graph to determine the gradient of the line of best fit. Show the values you used on the graph. Label them **A** and **B**. (3)
- 3.1.5 Write the equation stated in **QUESTION 3.1.2** in the form $y = mx + c$ and use this equation to state the quantity given by the gradient of your graph. (2)
- 3.1.6 Determine the acceleration due to gravity using your answer to **QUESTION 3.1.5** and the gradient calculated in **QUESTION 3.1.4**. (2)

- 3.2 A model rocket is shot vertically upwards off the ground (position **O**). The rocket accelerates at 6 m.s^{-2} upwards from rest. The fuel completely burns out at position **A**, which is at a height of **50 m** above the ground. The rocket free falls from **A** to **C**. As the rocket passed position **C** a parachute attached to it opens as shown in the diagram. The velocity **decreased** at a constant acceleration and reached the original position (position **O**) with a velocity 5 m.s^{-1} . (Take up as positive). *Air resistance from position **O** to **C** is negligible and mass change is also negligible.*



3.2.1 Calculate the velocity at **A**. (2)

3.2.2 Calculate the height of **B** from the ground. (3)

3.2.3 Calculate the constant acceleration the rocket undergoes between **C** and **D**. (3)

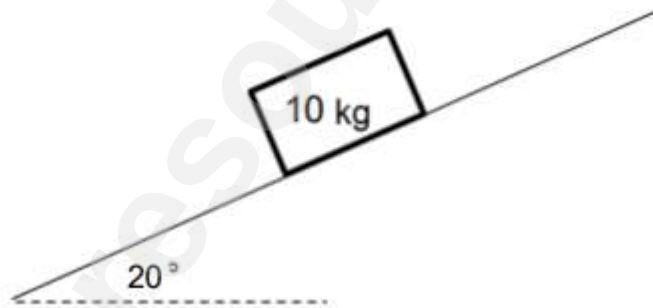
3.2.4 In the space provided below sketch a position vs time graph of the full motion **O** to **D**. Indicate positions at **O**, **A**, **C** and **D**. (3)

- 3.2.5 In the space provided, sketch an acceleration vs time graph of the full motion **O** to **D**. Indicate **O**, **A**, **C**, **D** and all the different accelerations. (3)

[29]

QUESTION 4 : NEWTON'S LAWS

- 4.1 A box (mass 10 kg) is at rest on a rough slope that makes an angle of 20° with the horizontal, as shown in the diagram below.

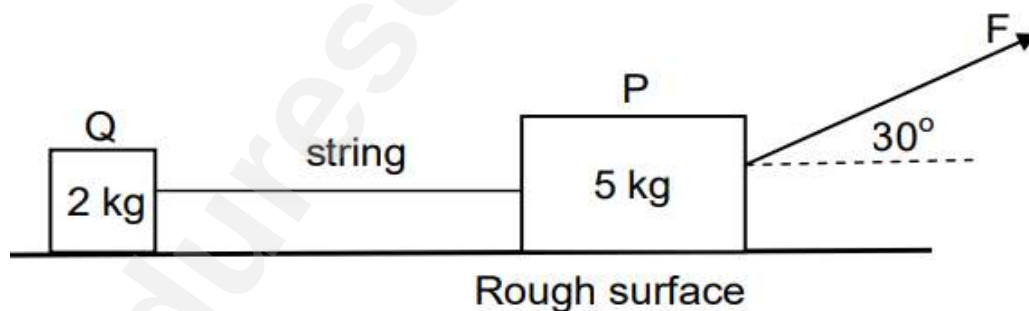


- 4.1.1 Define *frictional force*. (2)
- 4.1.2 Calculate the magnitude of the frictional force acting on the box. (3)

- 4.1.3 The angle of the slope is 20° and the coefficient of static friction between the box and the surface is **0,6**.
Calculate the minimum force that would have to be applied to the box parallel to the slope for the box to start sliding down the slope. Include the direction of the applied force in your answer. (4)

- 4.1.4 The angle of the slope is increased. Calculate at what angle the box will begin to slide without an external applied force? (1)

- 4.2 The two boxes below move to the right with a constant acceleration of $0,8 \text{ m}\cdot\text{s}^{-2}$. The kinetic frictional force between the surface and box **Q** is 5 N and the coefficient of friction between box **P** and the surface is 0,15.



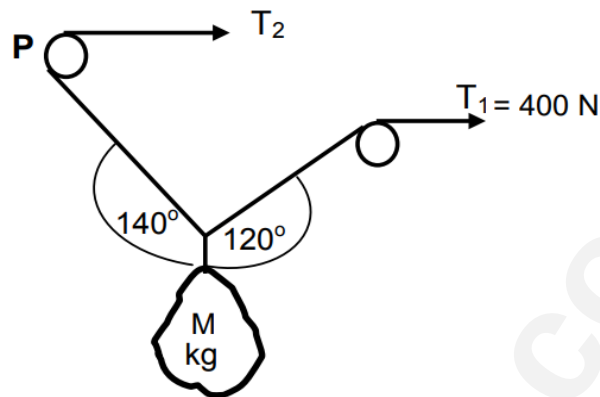
- 4.2.1 State *Newton's second law of motion* in words. (2)

4.2.2 Write an expression in terms of $\mathbf{F}$ for the normal force acting on the 5 kg box. (2)

4.2.3 Calculate the magnitude of force $\mathbf{F}$. (4)

4.2.4 The angle between the horizontal and $\mathbf{F}$ is now decreased. How is the acceleration of the system affected. Explain your answer. (2)

- 4.3 The diagram below shows a rope and pulley arrangement of a device being used to suspend a boulder of mass **M**. The boulder is at rest. Assume that the ropes are light and inextensible and that the pulley is light and frictionless.



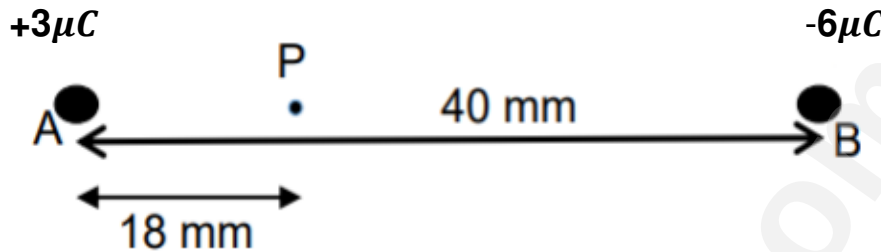
Calculate the boulder's mass **M**.

(5)

[25]

QUESTION 5 : FIELDS

- 5.1 Two small conducting spheres, **A** and **B**, which carry charges of $+3\ \mu\text{C}$ and $-6\ \mu\text{C}$ respectively are placed a distance of 40 mm apart. Point **P** lies 18 mm to the right of sphere **A** as shown in the diagram below:



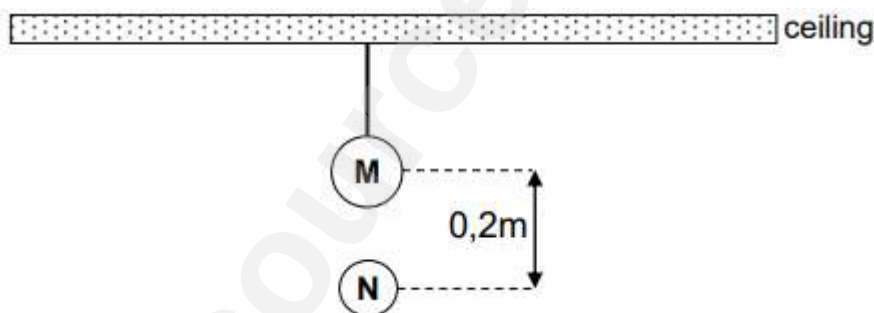
- 5.1.1 Define *electric field* at a point. (2)

- 5.1.2 Draw the resultant electric field pattern between the two charged spheres, **A** and **B**. (2)

- 5.1.3 a) Calculate the resultant electric field strength at point **P**. (4)

- b) An electron is now placed at point **P**. Determine the acceleration that the electron will experience due to the electric field. (4)

- 5.2 A charged sphere **M** is suspended from a ceiling by a light inextensible, insulated string. Another charged sphere **N**, of mass $2,04 \times 10^{-3} \text{ kg}$ and carrying a charge of $+8,6 \times 10^{-9} \text{ C}$, hangs AT REST vertically below sphere **M**. The centres of the spheres are 0,2 m apart, as shown in the diagram below



- 5.2.1 State *Coulomb's law* in words. (2)

- 5.2.2 State whether the charge on sphere **M** is **POSITIVE** or **NEGATIVE**. (1)

- 5.2.3 Draw the fully labelled free-body diagram of the forces acting on sphere **N**. (2)

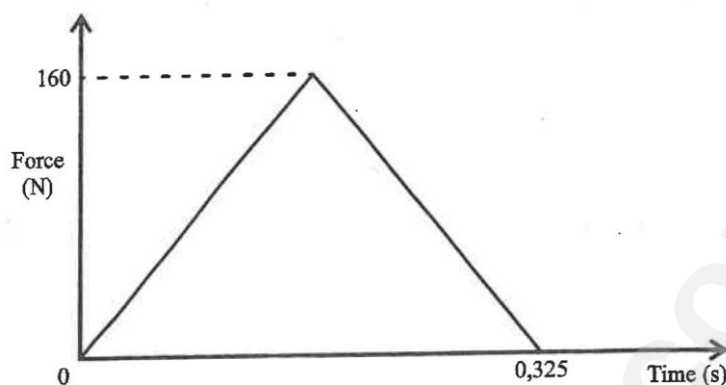
5.2.4 Calculate the magnitude of the charge on sphere **M**. (4)

5.2.5 How does the electrostatic force that sphere **M** exerts on sphere **N** compare to that exerted by sphere **N** on sphere **M**. Explain your answer using a physics principle. (2)

[23]

QUESTION 6 :MOMENTUM, IMPULSE, WORK, ENERGY AND POWER

- 6.1 The graph below shows the force exerted on a stationary hockey ball during the game between SA and the Netherlands in the 2024 Olympic Games.

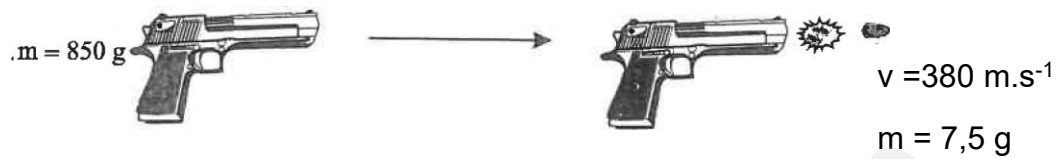


- 6.1.1 Define the term *impulse*. (2)

- 6.1.2 Calculate the impulse experienced by the hockey ball. (3)

- 6.1.3 Determine the mass of the hockey ball if it leaves the hockey stick with a speed of $172,5 \text{ m}\cdot\text{s}^{-1}$. (3)

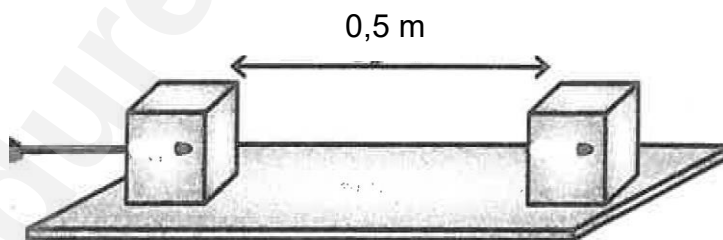
- 6.2 During the pistol shooting competition a competitor wants to calculate the recoil velocity of the gun so that he can adequately prepare for the event.



The fully loaded gun has a mass of 850 g and it fires a bullet of mass 7,5 g at the target. Determine the recoil velocity of the gun for the competitor.

(4)

- 6.3 At the archery, an arrow with mass 120 g, is shot horizontally at a speed of 550 m.s⁻¹ towards the wooden target block which is stationary and has a mass of 1,5 kg. The arrow stays embedded in the block causing it to slide 0,5 m along the rough horizontal surface before coming to rest.



6.3.1 State the *Law of conservation of linear momentum*.

(2)

6.3.2 Calculate the speed of the arrow and block immediately after the collision. (3)

6.3.3 Use relevant calculations to prove whether the collision was elastic or inelastic. (5)

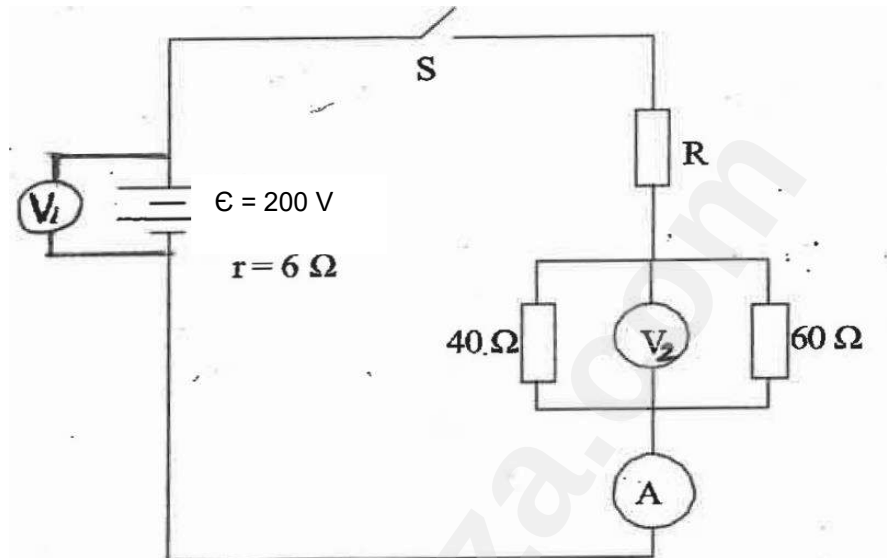
6.3.4 State the *work energy theorem*. (2)

6.3.5 Calculate the magnitude of the frictional force that brings the arrow and block to rest. (4)

[28]

QUESTION 7 : ELECTRIC CIRCUITS

In the circuit below the emf of the power supply is 200 V and the internal resistance is $6\ \Omega$. The $40\ \Omega$ resistor uses 21 000 J of energy in 1 minute when the switch **S** is closed.



7.1 State *Ohm's Law*. (2)

7.2 Calculate the reading on voltmeter V_2 . (4)

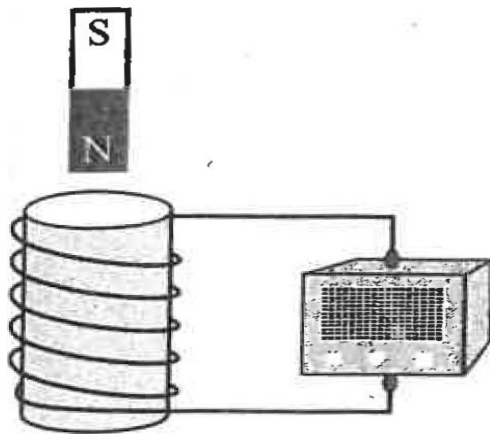
7.3 Calculate the current in the $60\ \Omega$ resistor. (3)

- 7.4 Calculate the reading on the ammeter **A**. (3)
- 7.5 Calculate the resistance of **R**. (5)
- 7.6 If the 60 ohm resistor were to break, what would happen to the reading on the voltmeter **V₁** (i.e. the potential difference of the circuit). Explain fully. (4)
- 7.7 The 40 Ω resistor is a small electric fan. If electricity today costs R 2,48 per kWh, what would the total cost be to run it for 3 hours a day, in a 30-day month? (4)

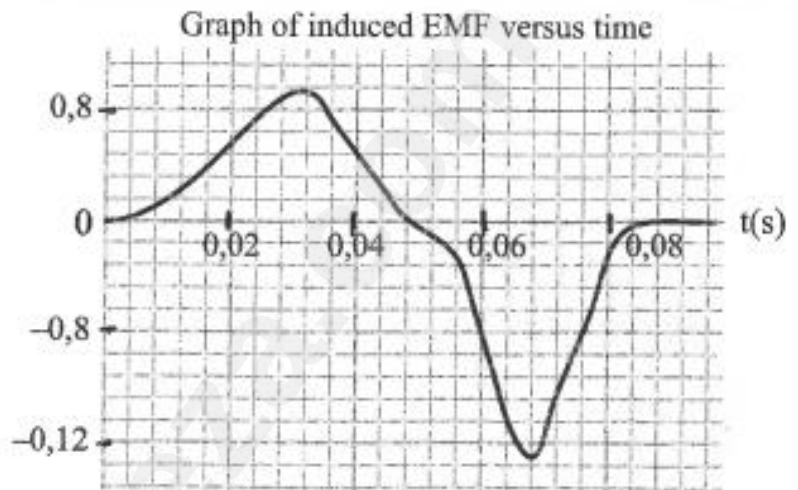
[25]

QUESTION 8 : ELECTRODYNAMICS

A bar magnet is dropped through a coil attached to an oscilloscope as shown in the diagram below. As the magnet falls through the coil it induces an emf in the coil. The oscilloscope plots the graph, shown below to the right, of the induced emf against time.



Graph of induced emf vs time



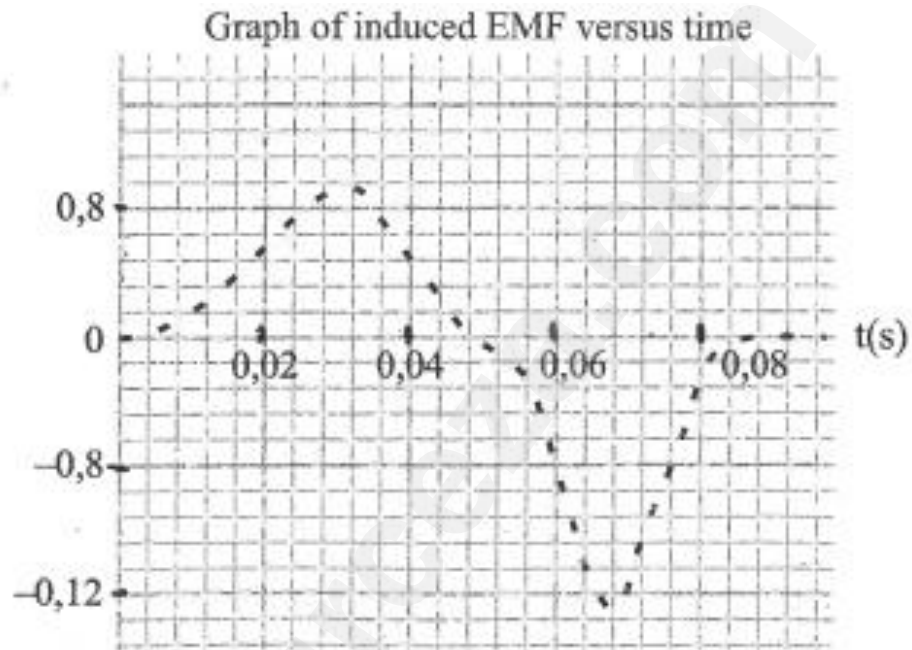
- 8.1 State *Lenz's Law*. (2)
- 8.2 Determine the polarity of the top of the coil as the magnet enters the coil. (1)
- 8.3 At what time is the magnitude of the induced emf at a maximum? (2)
- 8.4 State *Faraday's Law* of electromagnetic induction. (2)
- 8.5 Name the energy conversion taking place when the magnet drops through the coil. (2)

- 8.6 On the graph below, the dotted line represents the original experiment.

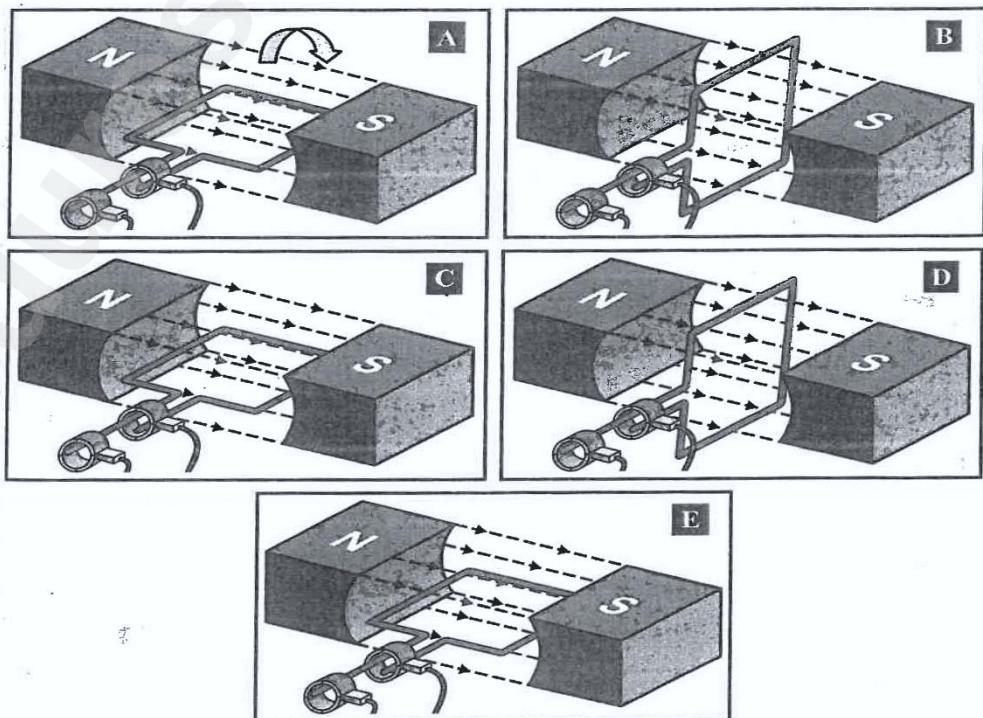
On the same graph axes, sketch how the graph will change if a magnet of the same mass and length, is dropped from the same height with a north pole entering the coil, but with half the strength.

(2)

Graph of induced emf vs time

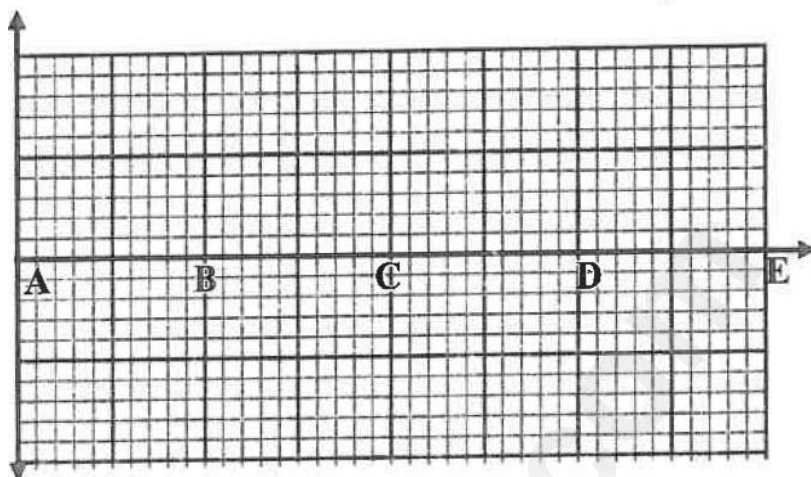


- 8.7 Consider the diagrams below, which show 5 positions of a coil completing a full rotation in a simple generator. On the graph grids on the following page, draw the corresponding sketch graphs of ...



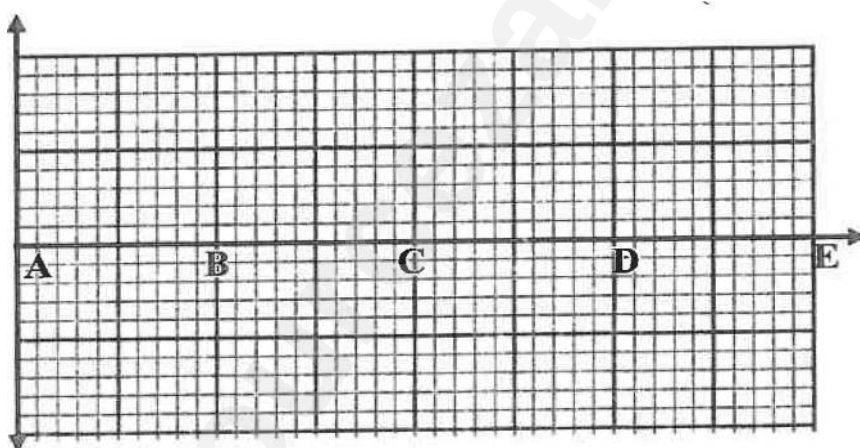
8.7.1 magnetic flux vs time.

(2)



8.7.2 emf vs time.

(2)



8.8 Power stations produce electricity at 20 000 V. This electricity is sent through the national grid cables at 765 000 V.

8.8.1 Name the type of transformer that changes the 20 kV to 765 kV.

(1)

8.8.2 Calculate the number of turns in the secondary coil of the transformer mentioned in **QUESTION 8.8.1** if the primary coil has 1500 turns.

(2)

8.8.3 If the input current to the primary coil is 0,25 A, calculate the current in the secondary coil if the transformer is 80 % efficient.

(2)

[20]

QUESTION 9 : PHOTONS AND ELECTRONS

Potassium has a work function of 2,5 eV. The metal is irradiated with light of wavelength 400 nm.

9.1 Define the term *work function*. (2)

9.2 Determine the maximum kinetic energy of the emitted electrons. (4)

9.3 Calculate the velocity of the emitted electrons. (3)

- 9.4 There are 2 sources of light, with different wavelengths, that you can shine onto the potassium metal.

Use calculations to help you decide which light source will be able to release electrons from the potassium metal.

Light source **A** with a wavelength of 600 nm

Light source **B** with a wavelength of 250 nm.

(6)

- 9.5 Explain what you would do to ensure more electrons are emitted per second from the metal, if the light source used ejects electrons. (2)

[17]

TOTAL FOR PAPER = 200

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IF YOU USE THIS SPACE TO COMPLETE A QUESTION, PLEASE MAKE A NOTE IN THE QUESTION TO DIRECT THE EXAMINER'S ATTENTION WHEN MARKING. ALSO WRITE DOWN THE QUESTION NUMBER.

If there is no mention made, whatever you write here will not be marked.

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