



Physical Sciences

Grade 12

Preliminary Examinations: Paper 1

Examiner: M Pillay

Moderator: S Govender

Marks: 200

Time: 180 min

Date: 09 September 2024

+ 10 min reading time

READ THESE INSTRUCTIONS:

- This paper consists of 33 pages (including the front page). Ensure that your paper is complete.
- Take note of the mark allocation and read each question thoroughly.
- Answer all questions on the question paper in the space provided.
- Blank pages (7 and 23) have been provided. If you run out of space for a question, please use one of these pages. Clearly indicate this in the question to ensure that your answer is marked in full.
- All final numerical answers should be given to a maximum of **2 decimal places**, (unless otherwise stated), showing all working in all calculations. Fractions and surds will not be accepted.
- Units do not need to be included in the working of calculations, but appropriate units are required in the final answer.
- Use a pencil when drawing diagrams and graphs and a non-programmable calculator where required.
- A formulae sheet will be provided for you.

Exam Number: _____ **Choice** _____

QUESTION	1	2	3	4	5	6	7	8	9	10	TOTAL
Max Mark	20	17	25	25	18	15	20	24	18	18	200
Achieved Mark											
Markers Signature											
Moderated Mark											
Moderators Signature											

Acknowledgements: DBE; IEB ;St Benedicts; Curro Midrand, St Peters

On the grid below, place a clear cross over the letter of the correct answer for each question next to its corresponding question number.

Every question has only one correct answer.

In the first row, option C has been marked as an example

Example	A	B	~~C~~	D
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1.1	A	B	C	D	(2)
1.2	A	B	C	D	(2)
1.3	A	B	C	D	(2)
1.4	A	B	C	D	(2)
1.5	A	B	C	D	(2)
1.6	A	B	C	D	(2)
1.7	A	B	C	D	(2)
1.8	A	B	C	D	(2)
1.9	A	B	C	D	(2)
1.10	A	B	C	D	(2)

- 1.1 Which one of the following pairs consists of two vector quantities?
- A

work and power
- B

distance and displacement
- C

current and impulse
- D

momentum and velocity

- 1.2 The unit for energy is the joule. This can also be written as follows:
- A $\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$
 - B $\text{kg} \cdot \text{m} \cdot \text{s}^{-2}$
 - C $\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-2}$
 - D $\text{kg} \cdot \text{m}^2 \cdot \text{s}$
- 1.3 A gymnast is jumping on a trampoline. Just as she is about to leave the trampoline after bouncing into it, according to Newton's Third Law of Motion, the reaction force to the gymnast's weight is the force of the ...
- A gymnast on the trampoline.
 - B trampoline on the gymnast.
 - C earth on the gymnast.
 - D gymnast on the earth.
- 1.4 The magnitude of acceleration due to gravity on the Earth's surface is 'g'. Planet Y has five times the mass and half the radius of the Earth. Which ONE of the following gives the correct magnitude of the acceleration due to gravity on Planet Y?
- A $\frac{1}{25} g$
 - B 20 g
 - C 10 g
 - D 25 g

- 1.5 A cricket ball of mass $3m$ is traveling along a straight horizontal surface at a speed v . It collides with a stationary tennis ball of mass m . The surface on which they collide is frictionless. The cricket ball continues at one-third of its original speed after the collision. Find the speed of the tennis ball after the collision.

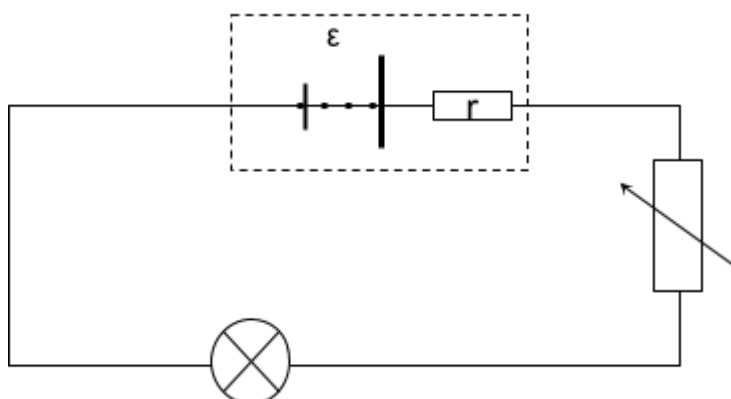
A $\frac{1}{3} v$

B $3 v$

C $2 v$

D $\frac{1}{2} v$

- 1.6 In the circuit below, a battery with an EMF, ϵ and significant internal resistance is connected to a rheostat and a lightbulb.



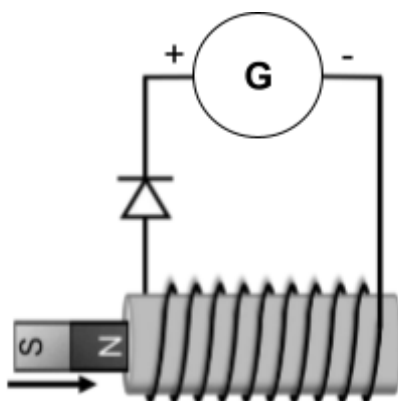
Which of the following correctly shows the changes to the voltage across the lightbulb, the emf and the internal voltage of the battery when the resistance of the rheostat is **increased**?

	$V_{\text{lightbulb}}$	emf	V_{internal}
A	increases	increases	decreases
B	decreases	stays the same	increases
C	stays the same	decreases	decreases
D	decreases	stays the same	decreases

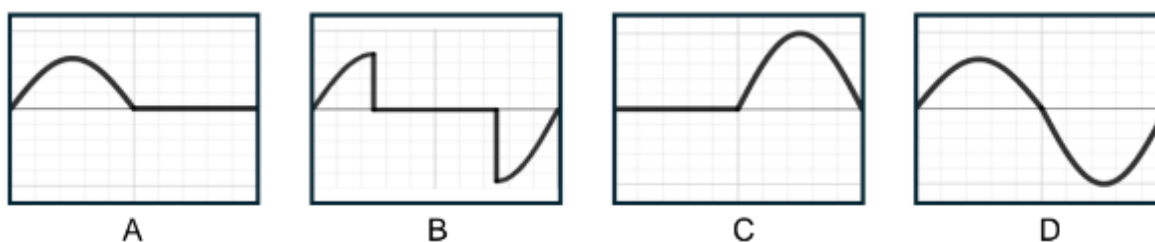
1.7 The cost of using a 200 W appliance for 30 minutes is x . What is the cost of electricity per kWh?

- A $10x$
- B $\frac{10x}{2}$
- C $\frac{10x}{30}$
- D $200x$

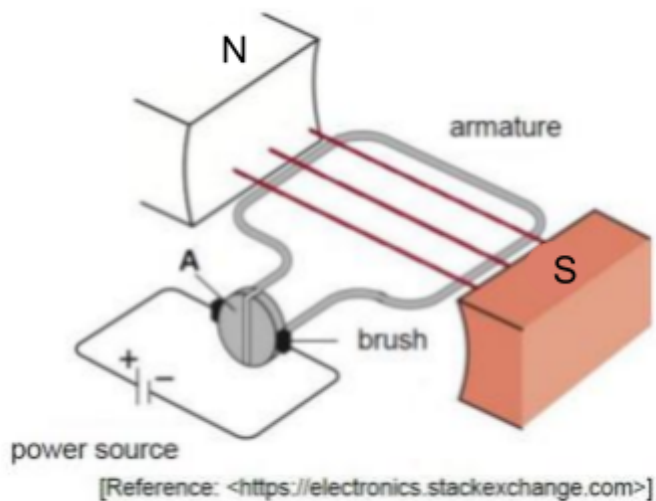
1.8 A magnet is moved through a coil connected to a circuit that contains a diode as shown below.



Which graph of current vs. time would be produced through the galvanometer?



1.9 The sketch below represents a DC motor. What part is represented by label **A** and in which direction does the armature rotate?



	Part (label A)	Rotation direction of armature
A	split-ring commutator	clockwise
B	slip rings	anticlockwise
C	slip rings	clockwise
D	split-ring commutator	anticlockwise

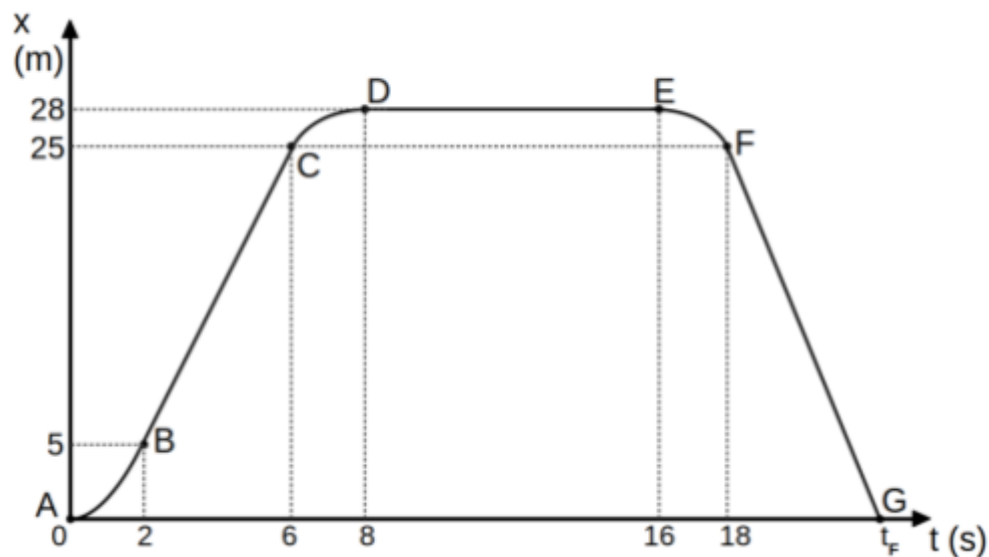
1.10 The wavelength of a light source **S** is half that of a light source **R**.
The energy of a photon from source **S** will be ... of a photon from source **R**.

- A quarter of the energy
- twice the energy
- equal to the energy
- half the energy

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Germany's Jessica von Bredow-Werndl won gold in the Equestrian dressage riding her horse, Dalera.

- 2.1 Dalera starts from rest and begins to move forward. Her position is plotted on the position-time graph shown below.



- 2.1.1 Define *displacement*. (1)

- 2.1.2 What is the total displacement of Dalera during the interval **AG**? (1)

- 2.1.3 During what time interval is Dalera stationary? (1)

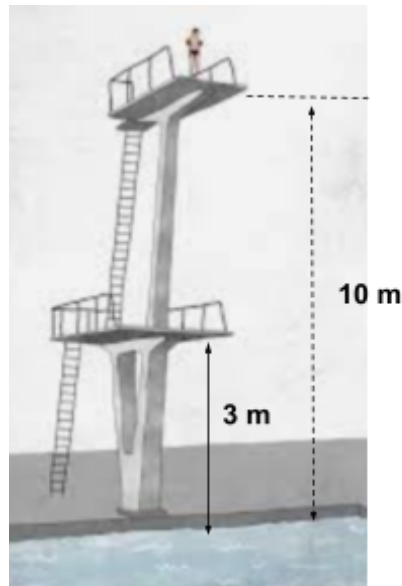
2.1.4 Determine Dalera's speed during the interval **BC**. (3)

2.1.5 If Dalera's speed during the interval **FG** is $6 \text{ m} \cdot \text{s}^{-1}$, find t_F . (3)

2.1.6 Determine the magnitude of Dalera's acceleration during the interval **AB**. (3)

2.2 In celebration, Jessica throws her hat vertically upward from the ground with an initial velocity of $20 \text{ m} \cdot \text{s}^{-1}$. At the same instant, a fan drops a folded flag from a height of 40 m directly above the point from which the hat was thrown. At what height above the ground will the two objects pass one another? (5)

During the Olympic Games, a diver, Quan Hongchan of China performs a high dive from a platform 10 meters above the water. She jumps off the platform with an initial upward velocity of $5 \text{ m} \cdot \text{s}^{-1}$. Quan has a mass of 65 kg.



3.1 Calculate the time it takes Quan to reach the maximum height after jumping off the platform. (3)

3.2 Determine the maximum height that Quan reaches above the water. (3)

3.3 Calculate the time it takes Quan, to pass the 3 m platform after jumping off the 10 m platform. (4)

3.4 Determine Quan's velocity just before she hits the water. (3)

3.5 When the diver hits the water, she stops in 0.5 seconds due to the water's resistance.

3.5.1 Calculate the average force exerted by the water on the diver during this time. (3)

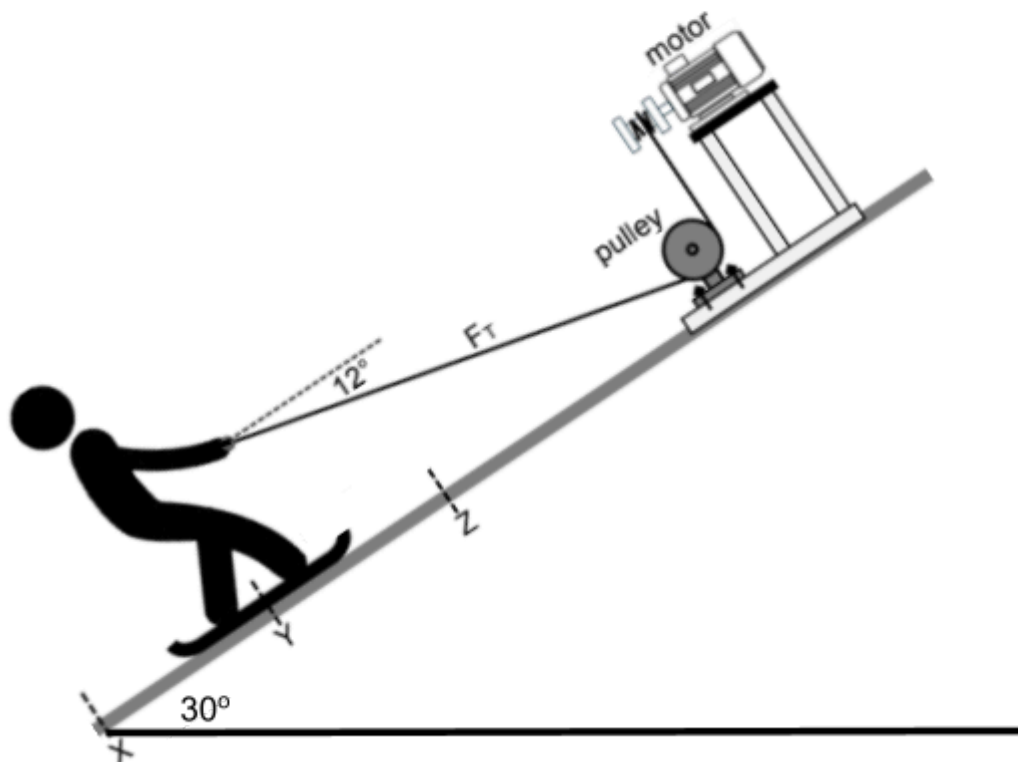
- 3.5.2 Determine Quan's acceleration in the water and hence the maximum depth she reaches. (5)

- 3.6 Draw the displacement time graph of Quan's **entire** motion. DO NOT DRAW TO SCALE. Only show important displacement values in your graph axes. (4)



Snowboarding is a popular Winter Olympics sport. A person is standing on a snowboard (with a combined mass of 70 kg) at point **X**. A light inextensible cable, runs through a pulley to a motor that pulls them toward point **Y**. The slope is at an angle of 30° to the horizontal.

The coefficient of kinetic friction, μ_k , between the board and the snow is 0,60.



4.1 State *Newton's Second Law* in words.

(2)

- 4.2 Draw a labelled free-body diagram showing ALL the forces acting on the snowboarder. Take the snowboard and the person as one object. (4)

When the person reaches point Y, the tension in the rope is 1300 N. The angle between the cable and the slope is 12° .

- 4.3 Calculate the magnitude of normal force on the snowboarder. (4)

4.4 Define *frictional force*. (1)

4.5 Calculate the frictional force acting on the snowboarder at point **Y**. (4)

4.6 Determine the magnitude of the acceleration of the snowboarder at point **Y**. (6)

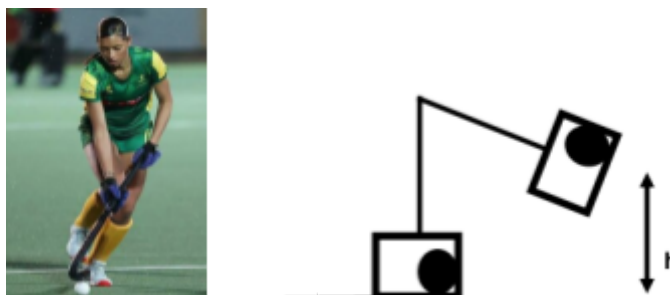
4.7 As the person moves from point **Y** to point **Z**, the angle between the cable the and the slope increases.

4.7.1 How is the acceleration experienced by the person affected?

Circle the correct option: **INCREASING** or **DECREASING** or **NO CHANGE** (1)

4.7.2 Explain your answer to QUESTION 4.7.1. (3)

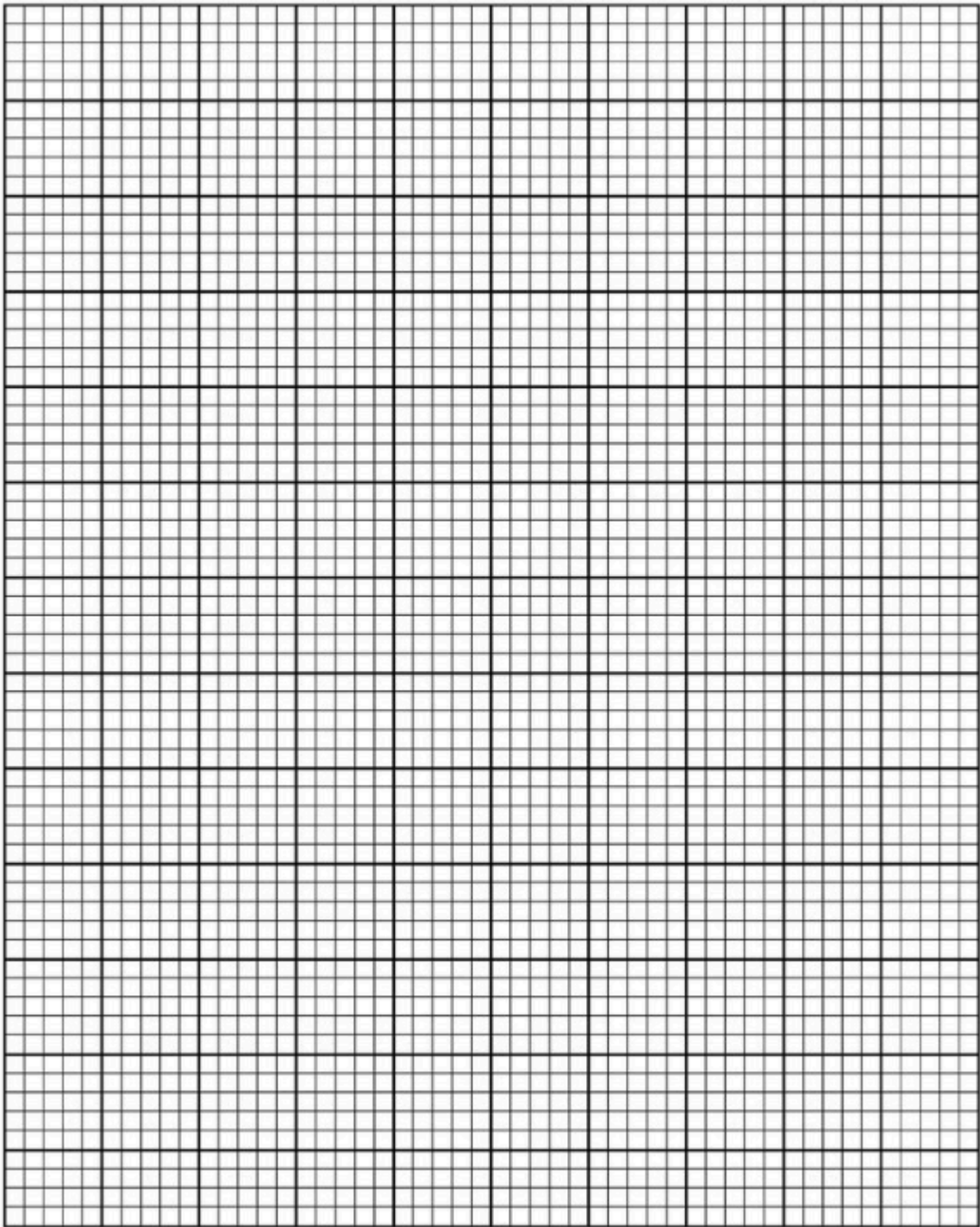
Beaulieu student, Paris-Gail practices her shooting for the Olympics. She hits a hockey ball horizontally into a hanging box. For different velocities of the ball and the box at the bottom of the swing, she measures the maximum height the box and ball reaches. Paris-Gail collects the data.



The table below shows the square of velocities and the maximum heights the ball and box reaches.

$v^2 \text{ (m}^2 \cdot \text{s}^{-2}\text{)}$	$h \text{ (m)}$
2	0,10
4	0,20
15	0,77
37	1,88
50	2,55
55	2,80

- 5.1 On the graph paper provided, plot a graph of the maximum height reached by the ball and box vs v^2 . Include a line of best fit. (6)



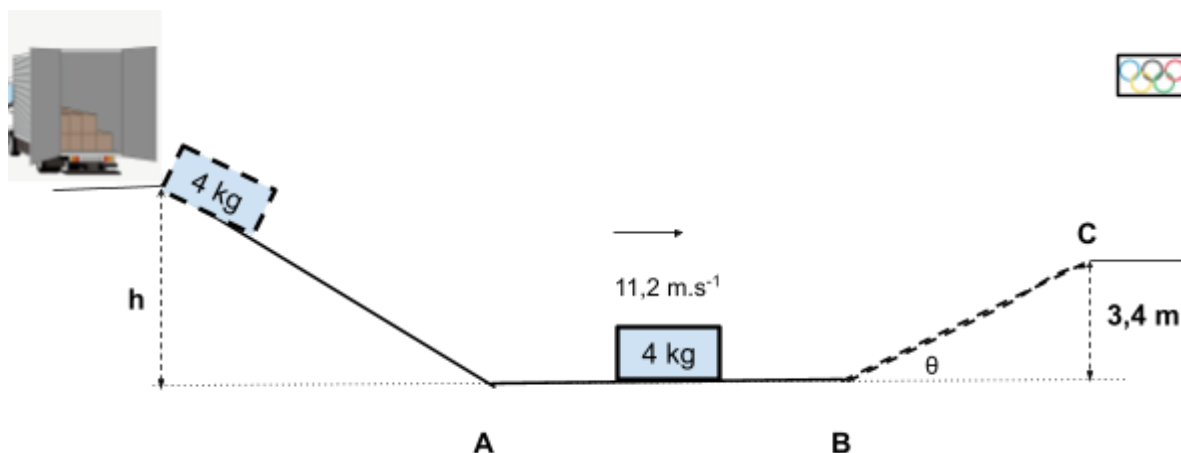
5.2 Determine the gradient of your graph. Show clearly on your graph, the points used. (4)

5.3 Define *mechanical energy*. (2)

5.4 Use the conservation of mechanical energy and write a simplified equation of the height reached by the box and ball (h) in terms of g and v^2 . (4)

5.5 Hence determine the value of the gravitational acceleration (g) using your gradient and your knowledge of a straight line graph. (2)

A 4 kg crate, containing important supplies for the athletes, is released from rest from height (h) and slides down a frictionless incline to point **A** as shown in the diagram below. It then moves along a frictionless horizontal path **AB** at a constant velocity of $11,2 \text{ m} \cdot \text{s}^{-1}$ and finally moves up a second rough inclined plane. It comes to rest at point **C** which is 3,4 m above the horizontal.



6.1 Using ENERGY PRINCIPLES ONLY, determine the height, h , from which the block was released. (4)

6.2 State the work-energy theorem. (2)

6.3 Calculate the work done against friction as the block moves from **B** to **C**. (4)

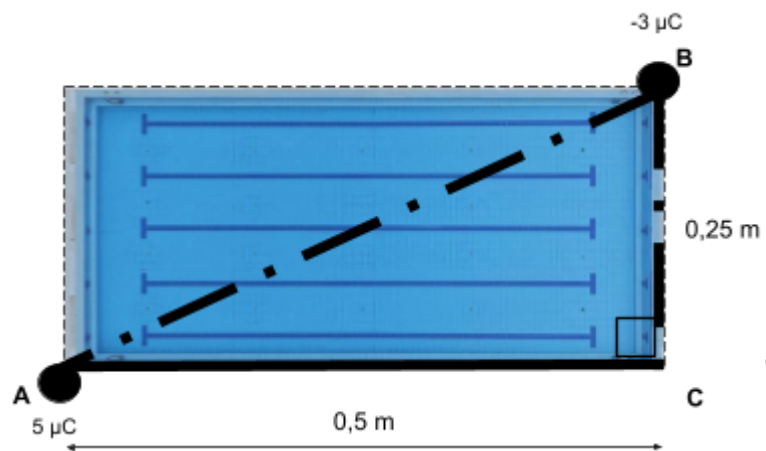
The frictional force between the block and surface from **B** to **C** is 21 N.

6.4.1 Calculate the length of slope **BC** to the horizontal. (3)

6.4.2 Calculate the angle (θ) from slope **BC** to the horizontal. (2)

- 7.1 During the construction of the Olympic swimming complex, a replica model was built with the following dimensions (length of 0,5 m and width of 0,25 m). Two point charges are positioned at the vertices of a right-angle triangle on insulating platforms. The charges are $Q_1 = 5 \mu\text{C}$ placed at vertex **A** and charge $Q_2 = -3 \mu\text{C}$ is at vertex **B**.

Position C is at the other vertex of the triangle, on the same side of the pool as **A**.



- 7.1.1 State *Coulomb's Law of Electrostatics*. (2)

- 7.1.2 Calculate the electrostatic force acting on the charge Q_1 due to charge Q_2 . (5)

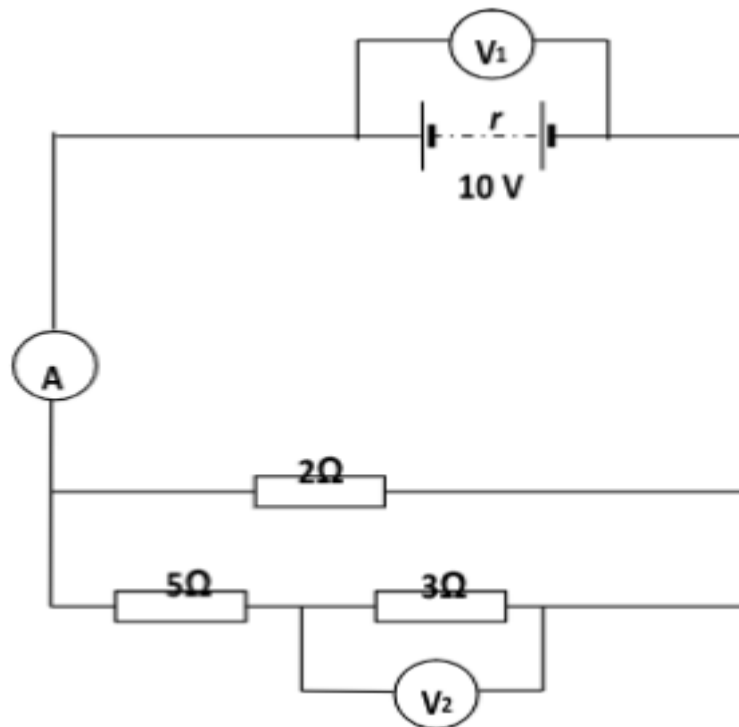
7.1.3 Define *electric field at a point*. (2)

7.1.4 Determine the magnitude of the net electric field at point **C**. (6)

7.2 The Olympics is broadcast to over 160 countries across the globe using satellites. A television satellite orbits the Earth at a height of 35 km above the surface of the Earth. Calculate the gravitational force the satellite experiences at that height due to the Earth. The satellite has a mass of 500 kg. The mass of the Earth is 6×10^{24} kg and its radius is 6×10^6 m. (5)

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Omega is the official timekeeper of the games. One of its devices has the following circuit. It consists of a battery with an emf of 10 V and an internal resistance, r . Three resistors, each of resistance 2Ω , 5Ω and 3Ω are connected as shown in the diagram.



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

8.2 Explain what is meant by a *battery with an emf 10V*. (2)

8.3 Determine the effective resistance of the external circuit. (3)

8.4 If the reading on the ammeter is 6 A, calculate the reading on

8.4.1 V_1 (3)

8.4.2 V_2 (4)

8.4.3 Calculate the internal resistance of the battery. (3)

8.4.4 Calculate the power generated in the 5Ω resistor when the current flows through it. (3)

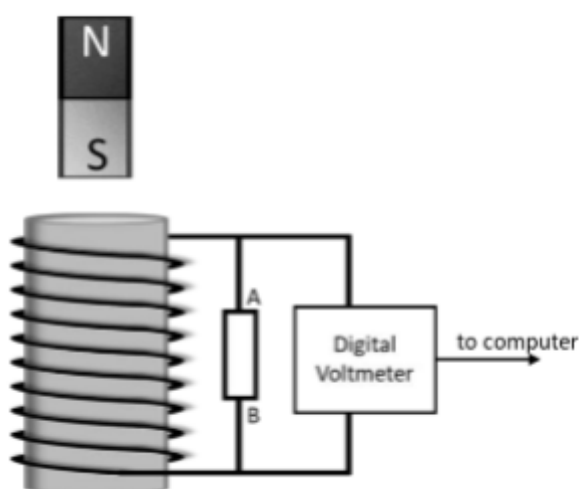
8.5 The 5Ω resistor is removed. How will the reading on voltmeter V_1 be affected. Choose only one of the following options.

8.5.1 The reading on V_1 (1)

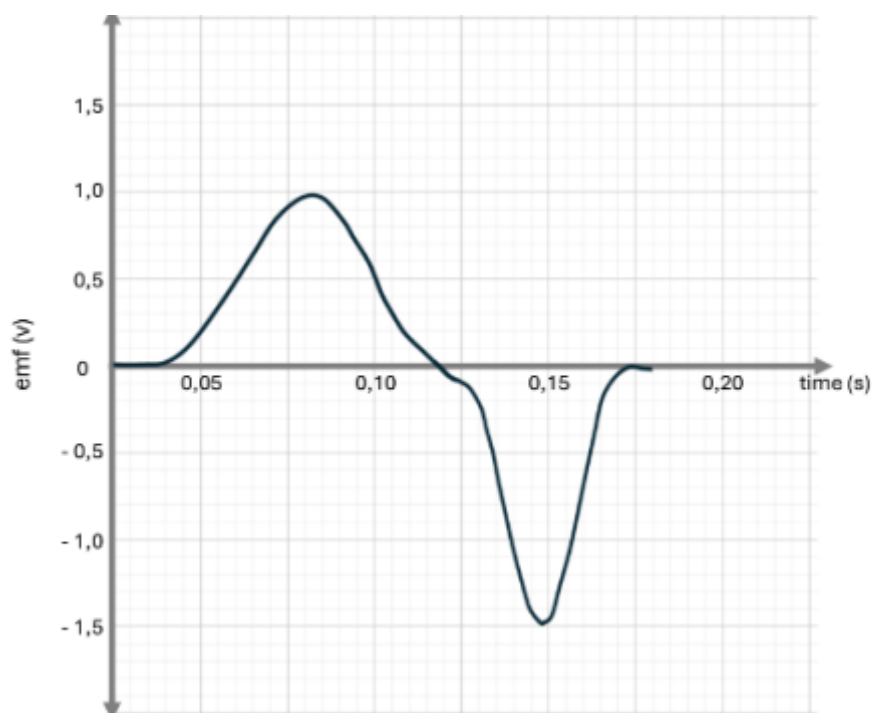
INCREASES	DECREASES	NO CHANGE
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8.5.2 Explain your answer in question 8.5.1 using good physics. (3)

- 9.1 In preparation for the Olympic Games, engineers are testing a new technology that measures the speed of athletes using a magnet and a coil system. A small, powerful bar magnet is embedded inside a baton used in a relay race. As the baton is passed through a checkpoint, it moves through a coil of wire attached to a digital voltmeter. This setup is connected to a computer that records and plots the induced electromotive force (emf) as a function of time, providing data about the baton's speed and motion.



Graph showing the relationship between emf and time



9.1.1 State *Faraday's Law of Electromagnetic Induction*. (2)

9.1.2 What is the polarity of the bottom of the coil as the magnet exits the coil.

Circle: **NORTH** or **SOUTH** (1)

9.1.3 Draw a labelled free-body diagram to represent the forces acting on the magnet as it exits the coil. Air resistance can be ignored. (2)

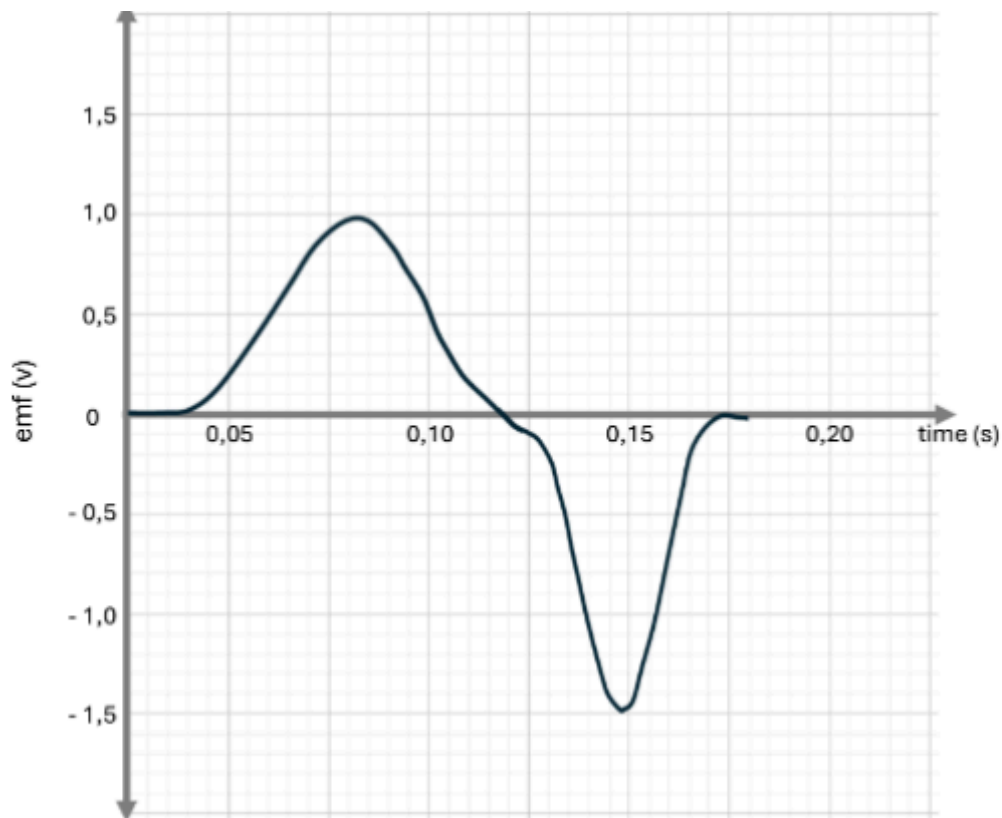
9.1.4 Explain why an emf is induced when the magnet leaves the bottom of the coil, refer to Faraday's Law in your explanation. (3)

9.1.5 Why is the magnitude of the maximum induced emf greater as the magnet exits the coil than when it enters the coil? Refer to the relevant formula/s in your explanation. (2)

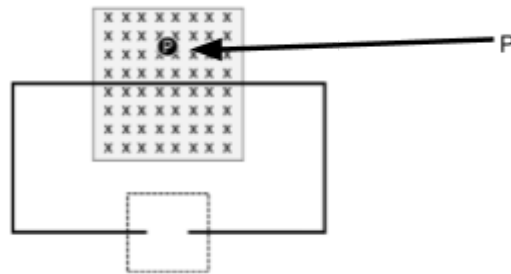
9.1.6 Determine the direction the current flows through the resistor when the magnet leaves the bottom of the coil.

Circle: **A to B** or **B to A** (1)

9.1.7 On the axes provided, draw a graph to that represents the following changes made to the initial experiment respectively. The same magnet is dropped from a GREATER HEIGHT through the same coil with the NORTH pole entering the coil first. (2)



- 9.2 A current-carrying conductor is placed in a uniform magnetic field pointing into the page as shown below.



At point **P**, the resultant magnetic field is zero.

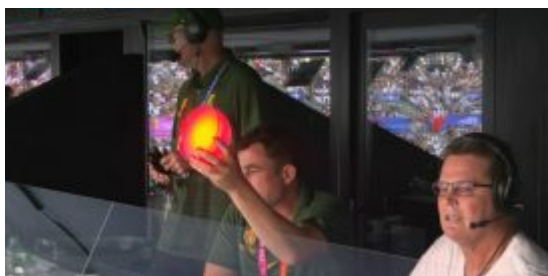
- 9.2.1 ON THE DIAGRAM, show the direction that the current is flowing in the wire. (1)

- 9.2.2 Justify your answer to QUESTION 9.2.1 (2)

- 9.2.3 In what direction does the electromagnetic force push the wire, relative to point **P**. (1)

- 9.2.4 A current carrying conductor placed in a magnetic field will not always experience a force. Describe a situation in which a current carrying conductor in a magnetic field will not experience a force. (1)

Rassie Erasmus, the coach of the South African rugby team, wants to use a photoelectric signalling system to communicate with the players on the field during a match. The system uses a red LED light mounted on a metal plate to signal players. The light is detected by a photoelectric sensor, which then triggers a response from a microcontroller. Red light has a wavelength of 650 nm.



10.1 Define *threshold frequency*. (2)

10.2 Calculate the threshold frequency (f_0) of the photoelectric sensor if the work function (W_0) of the metal used in the sensor is 1,5 eV. (4)

10.3 Show with calculations that the red LED light will be able to cause photoelectric emission in the sensor? (3)

10.4 Calculate the energy of the photons emitted by the red LED light in electron volts (eV). (3)

10.5 If the red LED light can cause photoelectric emission, calculate the maximum kinetic energy of the emitted electrons. (3)

10.6 Rassie changes the colour of the light to green with a wavelength of 530 nm. Discuss how this change would affect the operation of the sensor regarding the energy and the maximum kinetic energy of the photoelectrons. (3)

ADDITIONAL SPACE

Clearly indicate next to the question if any working out on this page must be marked otherwise it will be considered rough work.