



eduresourceza.com



ST STITHIANS COLLEGE

DEPARTMENT OF PHYSICAL SCIENCES

PRELIMINARY EXAMINATIONS GRADE 12 PAPER 1 – PHYSICS

DATE: Saturday 9th September 2023

MARKS: 200

TIME: 3 hours

EXAMINERS: Girls' College

MODERATORS: Boys' College

INSTRUCTIONS:

1. Please make sure that your question paper is complete. There are **40** pages, including four blank pages should you need additional space.
2. A separate data sheet is included.
3. Read all the questions carefully.
4. It is in your own interest to write legibly and to set your work out neatly.
5. **Show all your working** and round off all **final answers to 2 decimal places** where required.

Q/No	1	2	3	4	5	6	7	8	9	10	11	Total	%
Mark													
Total	20	22	21	23	13	12	22	15	17	24	11	200	

QUESTION 1: MULTIPLE CHOICE

Answer these questions on the multiple-choice answer sheet below by making a cross (X) in the box corresponding to the letter that you consider to be correct.
Each question is worth 2 marks.

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

Here the option C has been marked as an example.

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

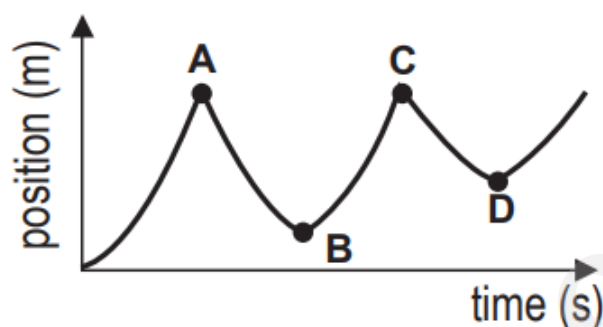
- 1.1 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and falls back to his hands.

Which of the following gives the acceleration of the ball at the various stages in its motion?

(Take vertically upwards as positive, and neglect air resistance).

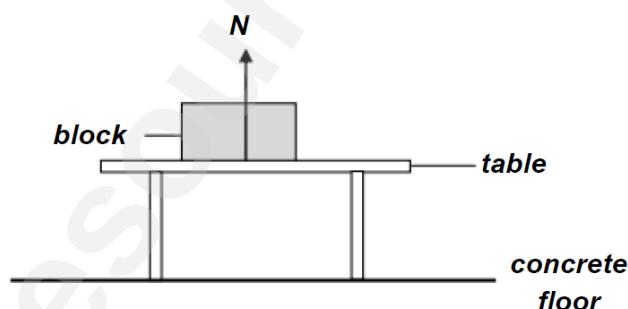
	Rising	At maximum height	Falling
A	$-9,8 \text{ m.s}^{-2}$	0	$+9,8 \text{ m.s}^{-2}$
B	$-9,8 \text{ m.s}^{-2}$	$-9,8 \text{ m.s}^{-2}$	$-9,8 \text{ m.s}^{-2}$
C	$+9,8 \text{ m.s}^{-2}$	$+9,8 \text{ m.s}^{-2}$	$+9,8 \text{ m.s}^{-2}$
D	$+9,8 \text{ m.s}^{-2}$	0	$-9,8 \text{ m.s}^{-2}$

- 1.2 A ball is released from rest from a certain height above the floor and bounces off the floor a number of times. The position-time graph represents the motion of the bouncing ball from the instant it is released.



Ignoring air resistance, which point (A, B, C or D) on the graph represents the position-time coordinates of the maximum height reached by the ball after the SECOND bounce?

- 1.3 A block rests on a table which stands on a concrete floor. The normal force is represented by N , as shown in the diagram below.



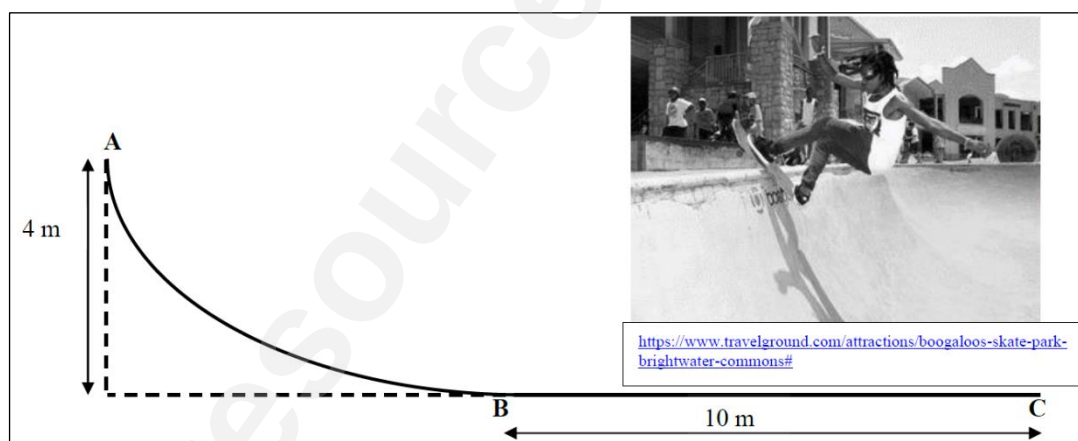
Which ONE of the following forces will form an action-reaction pair with the normal force, N ?

- A Force of the block on the Earth
- B Force of the table surface on the block
- C Force of the table on the concrete floor
- D Force of the block on the table

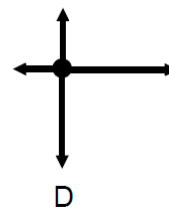
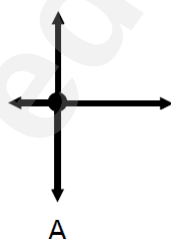
- 1.4 A ball of mass m , falling vertically downwards, hits the floor with a speed of v and bounces vertically upwards with a speed of $0,85v$. Which ONE of the following combinations regarding the change in momentum of the ball during the collision is CORRECT?

	Magnitude	Direction
A	$1,85mv$	Upwards
B	$1,85mv$	Downwards
C	$0,15mv$	Upwards
D	$0,15mv$	Downwards

- 1.5 A skater on a skateboard is initially at rest at the top (position A) of a skate rink. She skates down the slope and reaches a speed of $7,5 \text{ m.s}^{-1}$ at position B. The friction on the slope cannot be ignored.



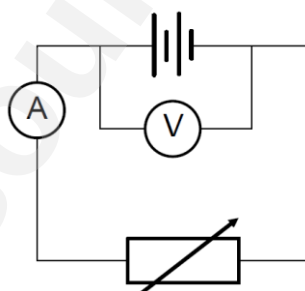
Write down the letter that corresponds to the free body diagram of the forces acting on the skater at position B.



- 1.6 The magnitude of acceleration due to gravity on the Earth's surface is 'g'. Planet Y has four times the mass and half the radius of the Earth. Which ONE of the following gives the correct magnitude of acceleration due to gravity on Planet Y?

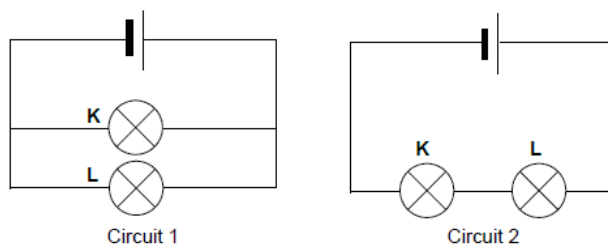
- A $\frac{1}{16}g$
B g
C 8g
D 16g

- 1.7 In the circuit shown below, the battery has **significant internal resistance**, the ammeter and connecting wires have negligible resistance, and the voltmeter has infinite resistance. Choose the letter from the table that correctly describes the effect on the readings on the ammeter and the voltmeter when the resistance of the rheostat is INCREASED.



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

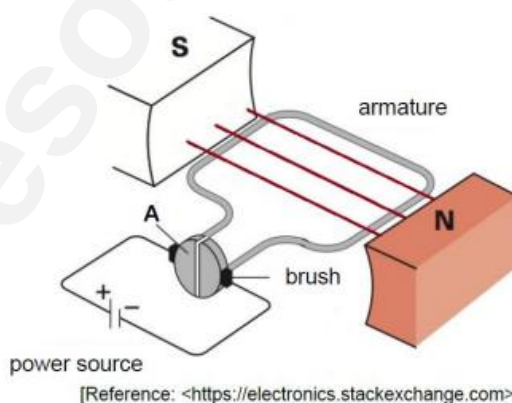
- 1.8 The same cell is connected in turn into each of the circuits shown below. Bulbs K and L have equal resistance and the cell has negligible internal resistance.



If the power in bulb L of Circuit 1 is P , what is the total power in Circuit 1 and Circuit 2 in terms of P ?

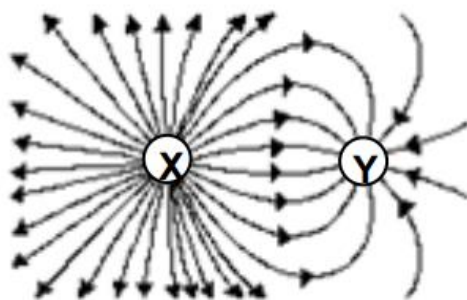
	Circuit 1	Circuit 2
A	$2P$	$\frac{1}{2}P$
B	$2P$	$\frac{1}{4}P$
C	$\frac{1}{2}P$	P
D	$\frac{1}{2}P$	$2P$

- 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	anticlockwise
B	Split ring commutator	clockwise
C	Slip ring	anticlockwise
D	Slip ring	Clockwise

- 1.10 The electric field diagram for two point charges, **X** and **Y**, is shown below.
Which one of the following gives the charges on **X** and **Y**?

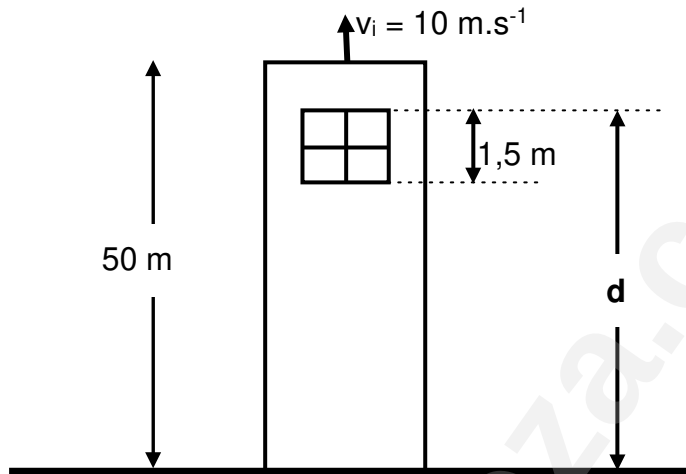


	Sign of charge on X (Q_X)	Sign of charge on Y (Q_Y)	Relative size of charges
A	-	+	Q_X greater than Q_Y
B	+	-	Q_X greater than Q_Y
C	+	-	Q_X less than Q_Y
D	-	+	Q_X less than Q_Y

[20 marks]

Question 2**KINEMATICS**

A ball is thrown vertically upward at a velocity of 10 m.s^{-1} from the top of a tower of height 50 m. After some time, the ball passes the edge of the tower and hits the ground below the tower. Ignore the effects of friction.



2.1 Define *velocity*.

(2)

2.2 Calculate the following:

2.2.1 The time taken by the ball to reach its maximum height above the ground. (3)

2.2.2 The maximum height that the ball reaches above the ground. (4)

2.2.3 The velocity with which the ball hits the ground. (3)

2.3 The ball is allowed to bounce and leaves the ground at 25 m.s^{-1} , after being in contact with the ground for 0,25 s. Sketch a velocity-time graph for the entire motion of the ball from when it is thrown until it is at the top of the bounce. Include all given and calculated values. (5)



- 2.4 On its way down, the ball takes 0,1 s to pass a window of length 1,5 m as shown in the diagram.

Calculate the distance (d) from the top of the window to the ground. (5)

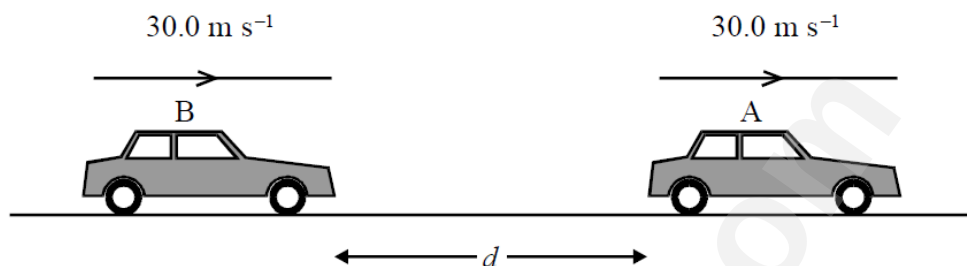
[22 marks]

THIS PAGE IS INTENTIONALLY LEFT BLANK

eduresourceza.com

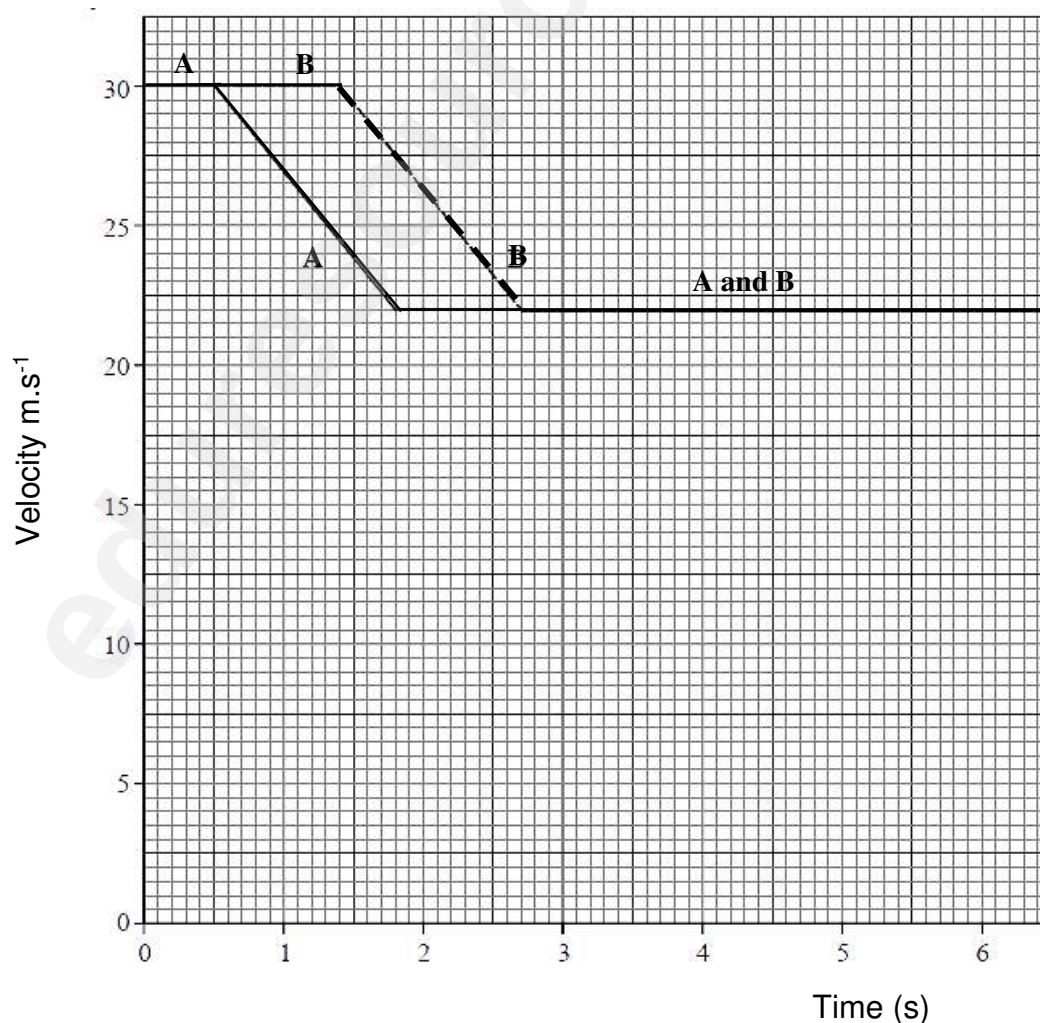
Question 3 **KINEMATICS**

- 3.1 Two cars, **A** and **B**, are travelling along the outside lane of a motorway at a velocity of $30,0 \text{ m.s}^{-1}$ East. They are a distance d apart.



The driver of car **A** sees a slower vehicle move out in front of him, and brakes hard until his speed has decreased to $22,0 \text{ m.s}^{-1}$. The driver of car **B** sees car **A** brake, and after a reaction time of $0,90 \text{ s}$, brakes with the same constant acceleration as car **A**.

The diagram below shows the velocity-time graphs for car **A** (the solid line) and car **B** (the broken line).



- 3.1.1 Determine the acceleration of the cars whilst they are braking. (3)
- 3.1.2 Calculate the distance car **B** travels while reacting. (3)
- 3.1.3 What does the area under a velocity-time graph represent? (1)
- 3.1.4 Calculate the shaded area of the graph. (4)
- 3.1.5 What does the value calculated in 3.1.4 represent for car **A** and car **B**? (1)
- 3.1.6 Suppose that, instead of only slowing down to $22,0 \text{ m.s}^{-1}$, the cars had to stop. Add lines to the graph on the previous page to show the velocity–time graphs in this case.
(Assume that the cars come to rest with the same constant acceleration as before). (2)

3.1.7 Explain why a collision is now more likely between car A and car B. (2)

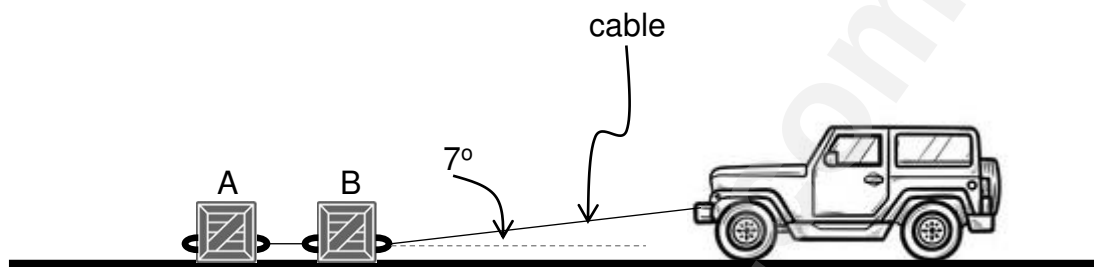
3.2 A lift accelerates upwards at a rate of $1,4 \text{ m.s}^{-2}$. As the lift starts to move, a light bulb falls from the ceiling of the lift. Determine how long it takes for the light bulb to reach the lift's floor. The height from the ceiling of the lift to the floor of the lift is 3 m. (5)

[21 marks]

Question 4 **NEWTON'S LAWS**

A Jeep uses a cable attached to the vehicle to drag two heavy wooden crates across a concrete surface to the right. The Jeep reverses, and as a result, a force of 1300 N is exerted on crate B by the cable at an angle of 7° to the horizontal. The Jeep and the crates accelerate to the right.

Crates A and B each have a mass of 100 kg and they are identical in all respects.



Crate A experiences a kinetic frictional force of 607,6 N.

While crate B is identical to crate A and has the same mass, it experiences a smaller kinetic frictional force during the motion.

4.1 Define *normal force*. (2)

4.2 Use a suitable equation to help you explain why crate B experiences a smaller kinetic frictional force than crate A, despite it being identical to crate A. (3)

4.3 Calculate the coefficient of kinetic friction for the concrete surface. (3)

4.4 Calculate the kinetic frictional force experienced by crate B. (4)

4.5 Draw a labelled free body diagram for crate B. (4)

4.6 Determine the acceleration of the crates. (5)

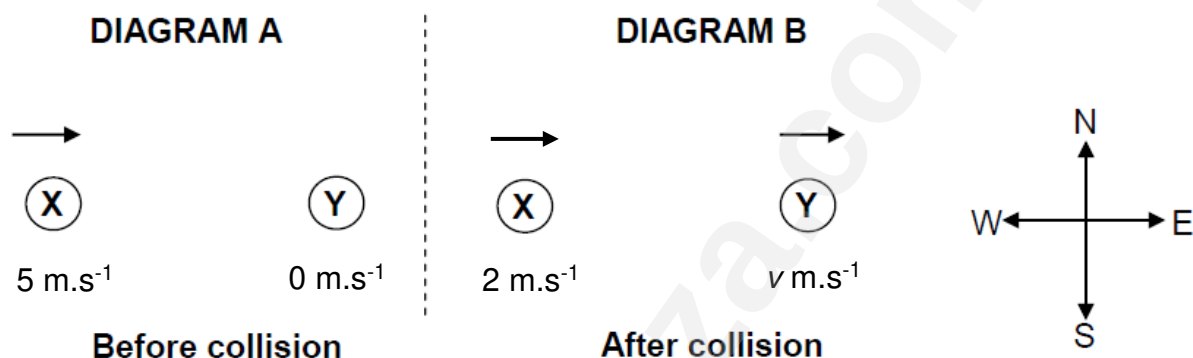
4.7. Hence, calculate the magnitude of the tension in the cable between the two crates. (2)

[23 marks]

Question 5 **MOMENTUM AND IMPULSE**

A ball, **X**, of mass 7 kg, is moving eastwards with a velocity of 5 m.s^{-1} . It collides ELASTICALLY with another ball, **Y**, of mass m kg which is stationary (see Diagram A). Immediately after the collision, ball **X** moves eastwards with a velocity of 2 m.s^{-1} and ball **Y** moves eastwards with a velocity of $v \text{ m.s}^{-1}$ (see Diagram B).

Ignore friction.



- 5.1 State the *law of conservation of linear momentum*. (2)
- 5.2 Give the definition of an *elastic collision*. (2)
- 5.3 Calculate the mass (m) and velocity (v) of ball **Y** after the collision. (6)

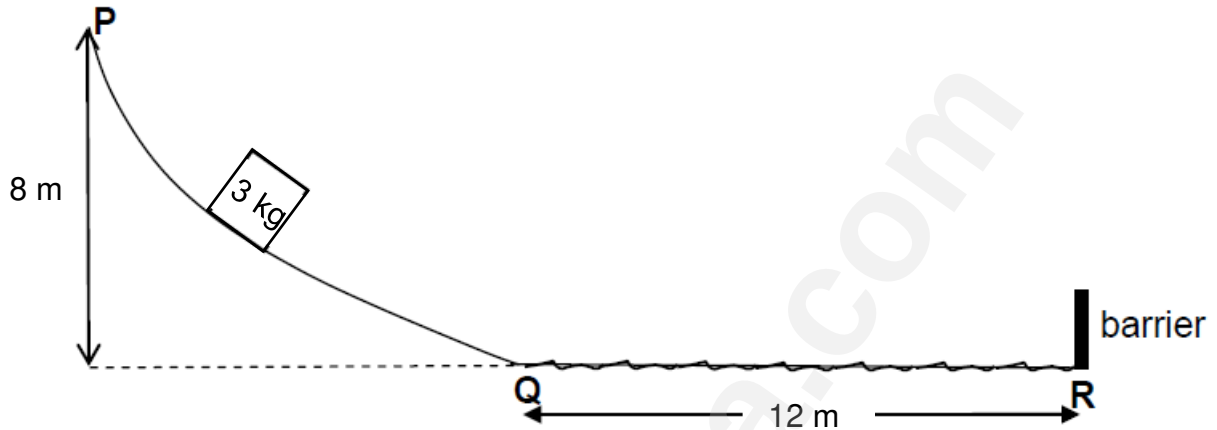
If the balls are in contact with each other for 0,1 s during the collision,

- 5.4 Calculate the magnitude of the force that ball **X** exerts on ball **Y** during the collision. (3)

[13 marks]

Question 6**WORK, ENERGY AND POWER**

A 3 kg box is released from rest at point P, 8 m above the ground. It slides down a smooth frictionless curved track PQ. See the diagram below.



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

6.2 Calculate the speed of the box when it reaches point Q. (3)

The box passes point Q and moves 12 m on a rough horizontal surface before striking a barrier at point R at a speed of 4 m.s^{-1} .

- 6.3 Use ENERGY PRINCIPLES to calculate the magnitude of the average frictional force acting on the box as it moves from Q to R. (4)

The barrier exerts an impulse of 14 N.s to the LEFT on the box when it strikes the barrier.

- 6.4 Calculate the velocity of the box after striking the barrier. (3)

[12 marks]

Question 7**FIELDS**

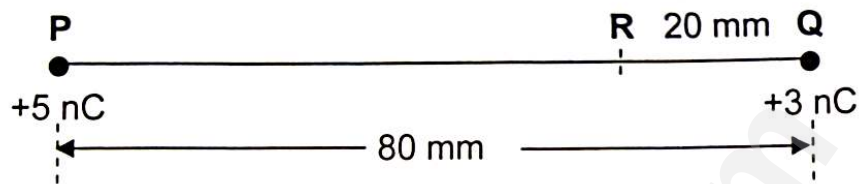
A favourite event at the annual Interhouse Arts event is the Street Art Competition. Members of each house create art works on the tar surface in the Girls' College carpark using chalk crayons and washable paint. The chalk is quite messy to work with because it creates a fine dust that annoyingly sticks to the artists' fingers rather than the tar road.



7.1 State *Coulombs Law*. (2)

7.2 Khanya, has some chalk dust stuck on her hand. While wiping away the chalk dust from her hands, she notices that the tiny chalk particles seem to push away from each other once they are in the air. Give a possible explanation for why this happens. (2)

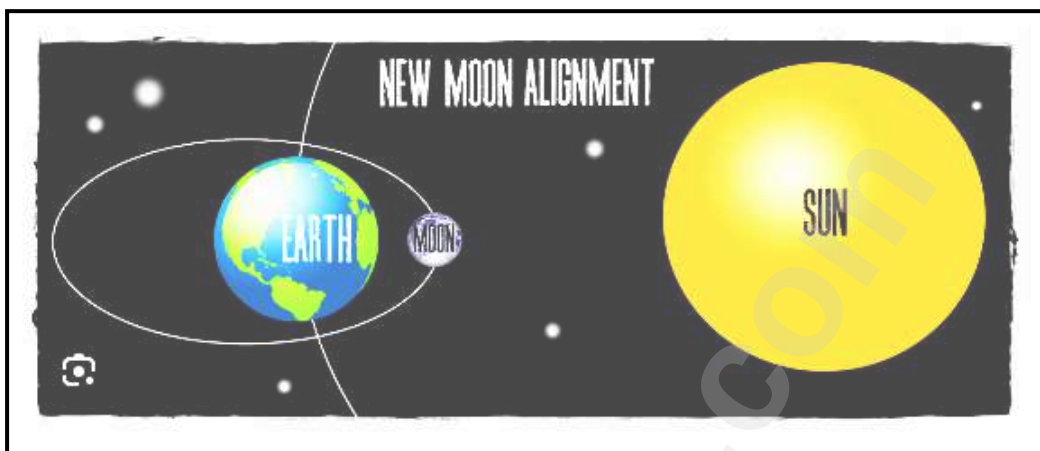
- 7.3 Two chalk dust particles, P and Q, are 80 mm apart. P carries a charge of +5 nC and Q carries a charge of +3 nC. R is a point 20 mm west of Q, as shown in the diagram below.



- 7.3.1 Calculate the magnitude and direction of the resultant electric field at point R. (5)

- 7.3.2 Another chalk dust particle that has a charge of -2 nC is placed at R. Calculate the magnitude of the force that this particle will experience. (3)

- 7.4 The mass of the Earth is $5,97 \times 10^{24}$ kg and the mass of the Moon is $7,35 \times 10^{22}$ kg. The distance between the centres of the Earth and the Moon is $3,84 \times 10^5$ km.



- 7.4.1 State *Newton's Law of Universal Gravitation*. (2)
- 7.4.2 Calculate the magnitude of the gravitational force of attraction between the Moon and the Earth. (4)

- 7.4.3 As the Earth, with its Moon, orbits the sun, a 'new moon' is observed once a month. A 'new moon' is when all three bodies line up in a straight line. When a 'new moon' is observed, the Moon experiences **a net zero gravitational force**.

The mass of the Sun can be taken as $1,99 \times 10^{30}$ kg.

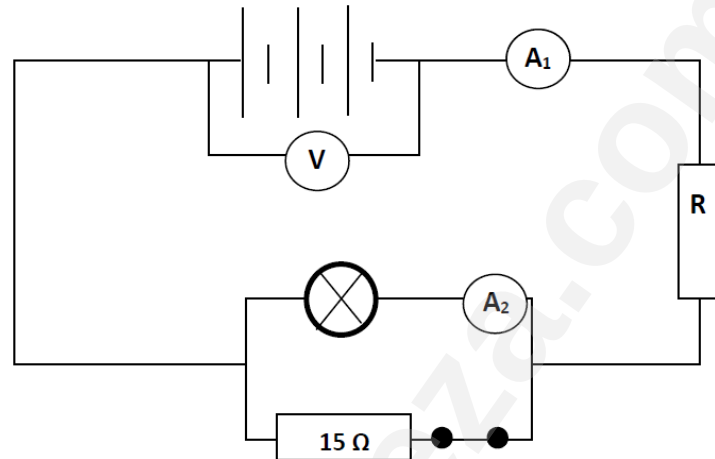
Calculate the distance between the centres of the Sun and the Moon during a 'new moon'.

(4)

[22 marks]

Question 8**ELECTRIC CIRCUITS**

In the circuit shown below, the resistance of the connecting wires, ammeter and switch can be ignored. The voltmeters have a very high resistance, and the battery has an internal resistance of $0,25\ \Omega$. The reading on the voltmeter across the battery reads $8,5\ \text{V}$ and the ammeter A_2 that measures the current passing through the $5\ \Omega$ bulb reads $1,5\ \text{A}$.



8.1 Calculate the reading on ammeter A_1 . (5)

8.2 Calculate the resistance of the unknown resistor R . (3)

8.3 Calculate the power of the bulb under these conditions. (3)

The switch is OPENED.

8.4 Refer to a relevant equation to explain how opening the switch will affect the brightness of the bulb. (4)

[15 marks]

Question 9**ELECTRIC CIRCUITS**

The appliance shown in the picture below is a hair dryer intended for camping, that can be plugged into the cigarette lighter socket in a car. It is rated 12 V, 150 W.

The resistance of the connecting wires and internal resistance of the battery can be ignored.



<https://www.outdoorwarehouse.co.za/product/12v-hair-dryer-150w>

9.1 Calculate the current that the hair dryer is designed to use under optimal conditions. (3)

9.2 Calculate the resistance of the hair dryer. (3)

9.3 To be able to use the hairdryer on a hike, far from the car, a student decides to take two 9 V batteries connected in series.

9.3.1 Define *resistance*. (2)

9.3.2 Should a resistor be connected in series or parallel with the hair dryer to ensure that the hair dryer works at optimal conditions? (1)

9.3.3 Calculate the resistance of the resistor needed to ensure that the hair dryer works at optimal conditions. (4)

9.3.4 The hairdryer can also be plugged into the mains electrical supply (240 V) provided a suitable transformer is used.

9.3.4.1 Would a step-up or step-down transformer be needed? (1)

9.3.4.2 Calculate the number of turns on the secondary coil of the transformer if the primary coil has 20 turns. (3)

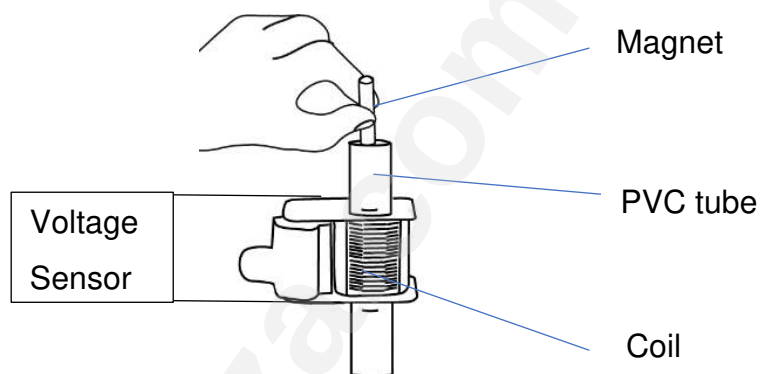
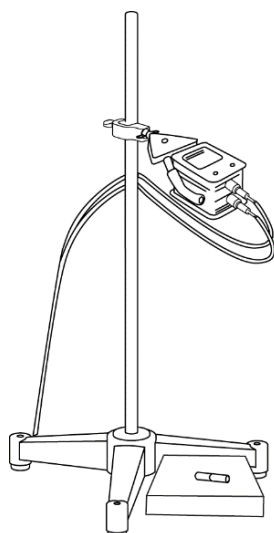
[17 marks]

Question 10 **ELECTRODYNAMICS**

Zoe and Hlulani investigate how the number of turn (N) on a coil affects the induced emf as predicted in Faraday's equation.

A 200-turn coil is mounted on a retort stand using a clamp.

A voltage sensor is connected to the coil to determine the induced emf when a magnet enters and leaves the coil.



A magnet is dropped from just above the coil opening, and from the same position each time with South pole first.

The 200-turn coil is replaced with a 400-turn, a 800-turn, and a 1600-turn coil, one at a time.

The same magnet is used for all the drops with all the coils, and data is collected for each coil.

10.1 Explain why an emf is induced when the magnet is dropped through the coil. (3)

10.2 State *Lenz's Law*. (2)

- 10.3 What is the pole of the magnetic field created by the induced current at the bottom of the coil? (1)

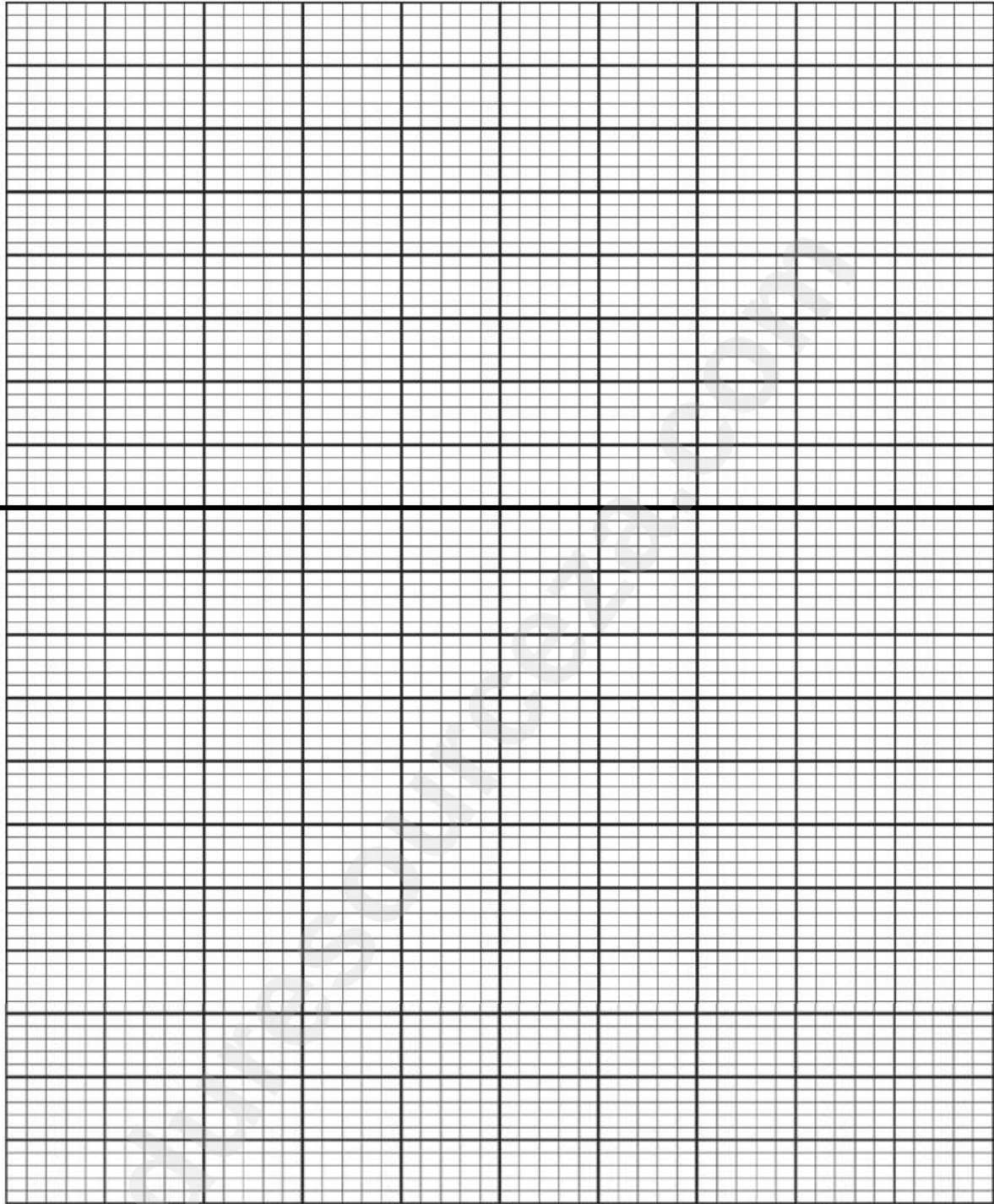
The data collected is represented in the table below:

Number of turns on the coil	Maximum Induced emf, $\mathcal{E}$ (Volts)	
	Magnet entering the coil	Magnet leaving the coil
200	0,26	– 0,56
400	0,52	– 1,15
800	0,99	– 2,30
1600	2,04	– 4,56

- 10.4 Use the graph paper on the next page to plot graphs on the SAME AXES of:
- Maximum induced emf vs number of turns on the coil for the magnet entering the coil. (4)
 - Maximum induced emf vs number of turns on the coil for the magnet leaving the coil. (4)

Maximum Induced emf ($\mathcal{E}$)

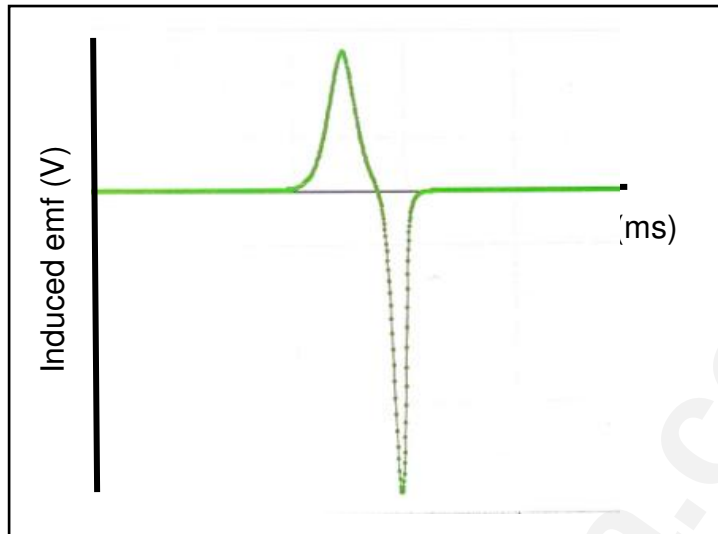
0



Number of turns on the coil (N)

- 10.5 What can be concluded about the relationship between the induced emf ($\mathcal{E}$) and the number of turns (N) on the coil? (1)
- 10.6 Do the results confirm or disprove Faraday's Law? Justify your answer with scientific reasoning. (2)
- 10.7 Calculate the **gradient** of the maximum induced emf vs number of turns on the coil for the magnet **entering** the coil. Include a unit for the gradient. Show the points used to calculate the gradient on the graph. (4)
- 10.8 What quantity (in words) does the gradient of the graph, of maximum induced emf versus number of turns on the coil, represent? (1)

The graph of induced emf vs time for the 400-turn coil is shown in the diagram below:



10.9 Using the equation:

$$\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$$

10.9.1 Express which physical quantity is represented by the area under the graph. (1)

10.9.2 **Name** the physical quantity represented by the area under the graph. (1)

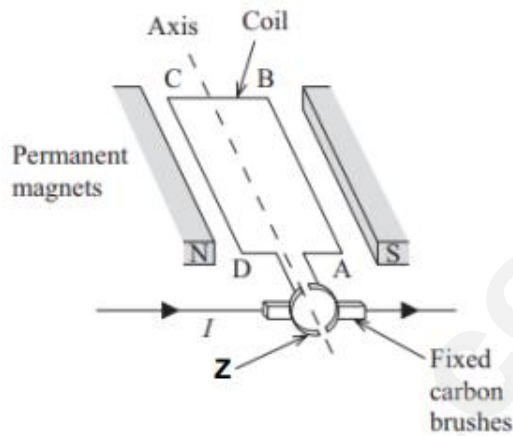
[24 marks]

THIS PAGE IS INTENTIONALLY LEFT BLANK

eduresourceza.com

Question 11 **ELECTRODYNAMICS**

The diagram below represents a DC electric motor.



- 11.1 What is indicated by the letter Z? (1)
- 11.2 What is the part indicated by the letter Z used for? (2)
- 11.3 In which direction does the coil rotate? (1)
- 11.4 Which rule did you use to determine the answer in 11.3? (1)
- 11.5 Give two ways that the speed of rotation can be reduced. (2)
- 11.4 Explain how this DC electric motor works. Refer to the input required and how it functions. (4)

[11 marks]

ADDITIONAL SPACE:

**REMEMBER TO CLEARLY INDICATE WHICH QUESTION
YOU USED THE ADDITIONAL SPACE FOR,
TO ENSURE THAT ALL ANSWERS ARE MARKED.**

eduresourceza.com

ADDITIONAL SPACE:

**REMEMBER TO CLEARLY INDICATE AT THE QUESTION
THAT YOU USED THE ADDITIONAL SPACE
TO ENSURE THAT ALL ANSWERS ARE MARKED**

eduresourceza.com