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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 **39** pages, including three blank pages at the back for 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.

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.

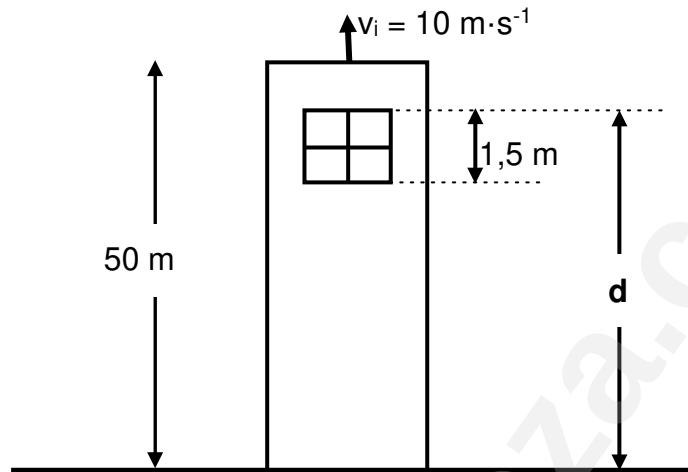
Each question is worth 2 marks.

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

[20 marks]

Question 2**KINEMATICS**

A ball is thrown vertically upward at a velocity of $10 \text{ m} \cdot \text{s}^{-1}$ 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)

**The rate of change of position or
the rate of displacement or
the rate of change of displacement**

2.2 Calculate the following:

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

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

$$0 = 10 + (-9,8)\Delta t$$

$$\Delta t = \frac{10}{9,8}$$

$$\Delta t = 1,02 \text{ s}$$

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

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

$$0 = 10^2 + 2(-9,8)\Delta x$$

$$\Delta x = \frac{100}{19,6}$$

$$\Delta x = 5,10 \text{ m}$$

$$\begin{aligned} \text{Max height} &= 50 + 5,10 \\ &= 55,10 \text{ m} \end{aligned}$$

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

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

$$v_f^2 = 0^2 + 2(-9,8)(-55,10)$$

$$v_f^2 = 1079,96$$

$$v_f = 32,86 \text{ m.s}^{-1}$$

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

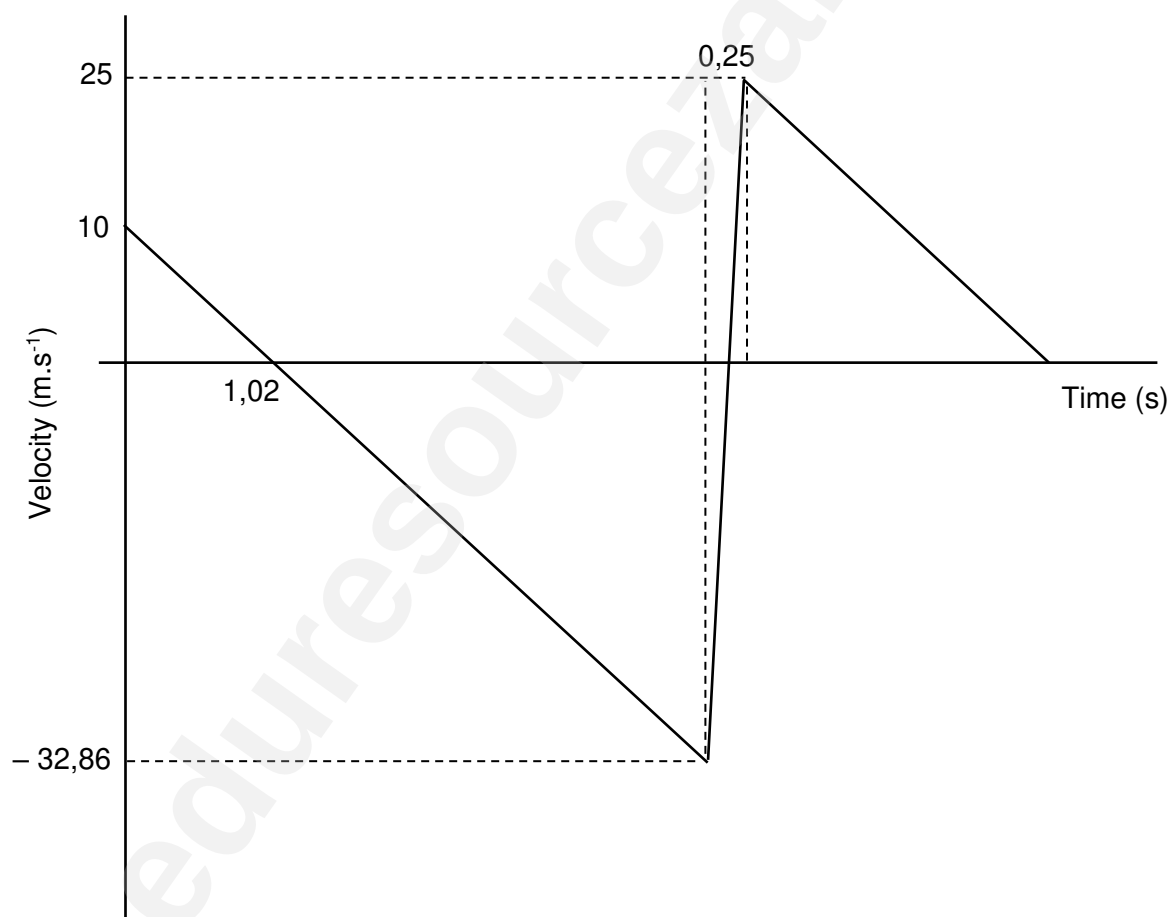
$$v_f^2 = 10^2 + 2(-9,8)(-50)$$

$$v_f^2 = 1080$$

$$v_f = 32,86 \text{ m.s}^{-1}$$

or

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 $0,25 \text{ s}$. 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)

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

$$-1,5 = v_i (0,1) + \frac{1}{2} (-9,8) (0,1)^2$$

$$0,1 v_i = -1,451$$

$$v_i = -14,51$$

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

$$(-32,86)^2 = (-14,51)^2 + 2(-9,8)\Delta x$$

$$\Delta x = -\frac{869,24}{19,6}$$

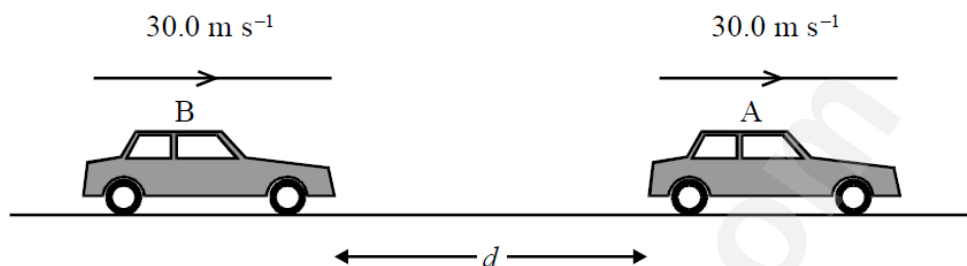
$$\Delta x = -44,35 \text{ m}$$

$$d = 44,35 \text{ m}$$

[22 marks]

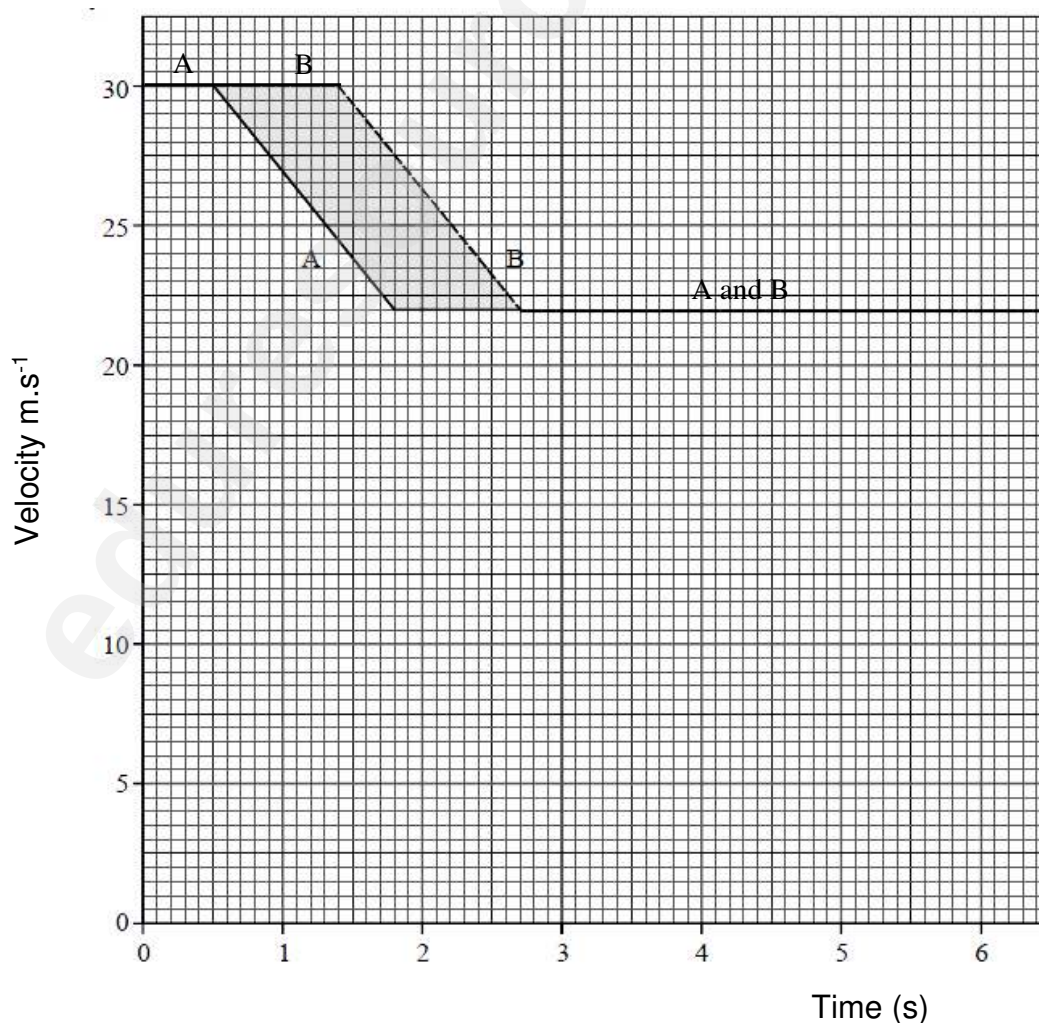
Question 3 **KINEMATICS**

- 3.1 Two cars, **A** and **B**, are travelling along the outside lane of a motorway at a speed of $30,0 \text{ m s}^{-1}$. 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 deceleration 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)

$$\begin{aligned}
 a &= \frac{\Delta v}{\Delta t} \\
 &= \frac{22 - 30}{1,8 - 0,5} \\
 &= -6,15 \text{ m.s}^{-2} \\
 &= 6,15 \text{ m.s}^{-2} \mid \text{West}
 \end{aligned}$$

- 3.1.2 Calculate the distance car **B** travels while reacting. (3)

$$\begin{aligned}
 \text{speed} &= \frac{\text{distance}}{\text{time}} \\
 \text{distance} &= 30(1,4 - 0,5) \\
 \text{distance} &= 27 \text{ m}
 \end{aligned}$$

- 3.1.3 What does the area under a velocity-time graph represent? (1)

Displacement

- 3.1.4 Calculate the shaded area of the graph. (4)

$$\begin{aligned}
 \text{Area of } \square \text{ gm} &= \text{base} \times \text{height} \\
 &= (1,4 - 0,5) \times (30 - 22) \\
 &= 0,9 \times 8 \\
 &= 7,2 \text{ m}
 \end{aligned}$$

- 3.1.5 What does the value calculated in 3.1.4 represent for car **A** and car **B**? (1)

The displacement between the two cars (d)

- 3.1.6 Suppose that, instead of only slowing down to 22,0 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 deceleration as before). (2)

Two parallel lines going from 30 m.s⁻¹ to 0 m.s⁻¹

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

Car B will still be moving when car A stops.

- 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)

$$\Delta t_{\text{lift}} = \Delta t_{\text{bulb}}$$

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

$$\Delta x_{\text{lift}} = 0 + \frac{1}{2} (1,4) \Delta t^2$$

$$\Delta x_{\text{lift}} = 0,7 \Delta t^2$$

$$\Delta x_{\text{bulb}} = 0 + \frac{1}{2} (9,8) \Delta t^2$$

$$3 - \Delta x_{\text{lift}} = 4,9 \Delta t^2$$

$$3 - 0,7 \Delta t^2 = 4,9 \Delta t^2$$

$$\Delta t^2 = \frac{3}{5,6}$$

$$\Delta t^2 = 0,54$$

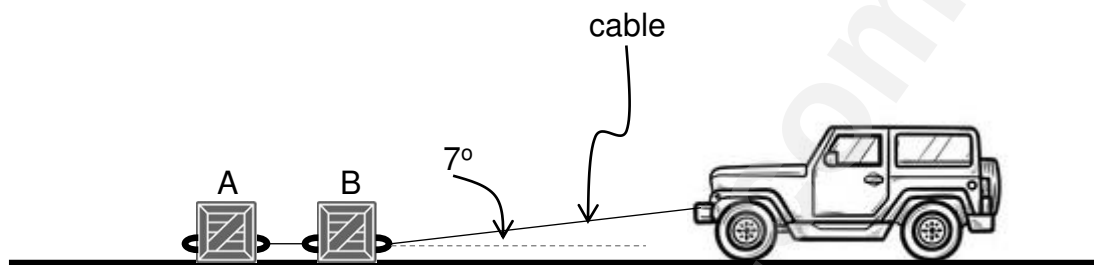
$$\Delta t = 0,73 \text{ s}$$

[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)

The perpendicular force exerted by a surface on an object in contact with it

- 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)

$$F_f = \mu F_N \text{ and } F_N = F_g - F_y \quad \text{so} \quad F_f = \mu (F_g - F_y)$$

**The normal force for block B is less than the normal force for block A
Thus, the frictional force for block B will be less than the frictional force for block A**

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

$$F_f = \mu F_N$$

$$607,6 = \mu(100)(9,8)$$

$$\mu = \frac{607,6}{980}$$

$$\mu = 0,62$$

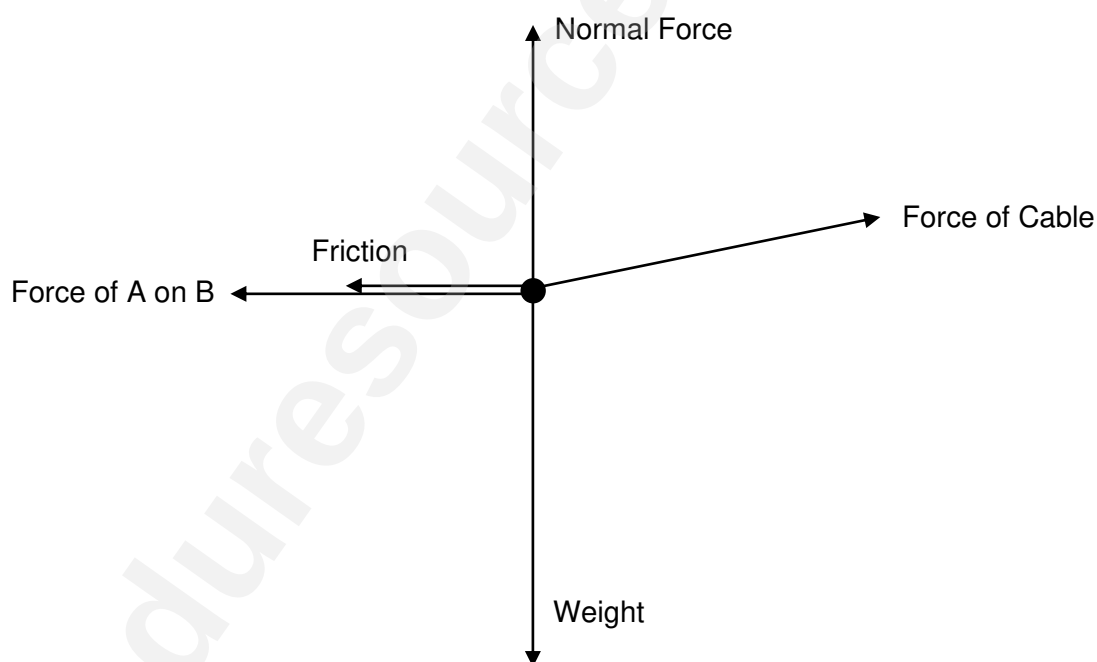
- 4.4 Calculate the kinetic frictional force experienced by crate B. (4)

$$F_f = \mu F_N$$

$$= 0,62[(100)(9,8) - (1300)\sin 7^\circ]$$

$$= 509,37 \text{ N}$$

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



–1 for each missing force

–1 for Weight < Normal

- 4.6 Determine the acceleration of the crates. (5)

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

$$F_{\text{net}} = F_x - F_f - T$$

$$(100)a = (1300)\cos 7^\circ - 509,37 - T$$

$$100a = 780,94 - T$$

$$T = 780,94 - 100a$$

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

$$F_{\text{net}} = F_f - T$$

$$(100)a = T - 607,6$$

$$100a = T - 607,6$$

$$T = 607,6 + 100a$$

$$780,94 - 100a = 607,6 + 100a$$

$$200a = 173,34$$

$$a = \frac{173,34}{200}$$

$$a = 0,87 \text{ m.s}^{-2} \quad \text{Right}$$

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

$$100a = 780,94 - T$$

$$100(0,87) = 780,94$$

$$T = 780,94 - 87$$

$$T = 693,94 \text{ N}$$

or

$$100a = T - 607,6$$

$$100(0,87) = T - 607,6$$

$$T = 87 + 607,6$$

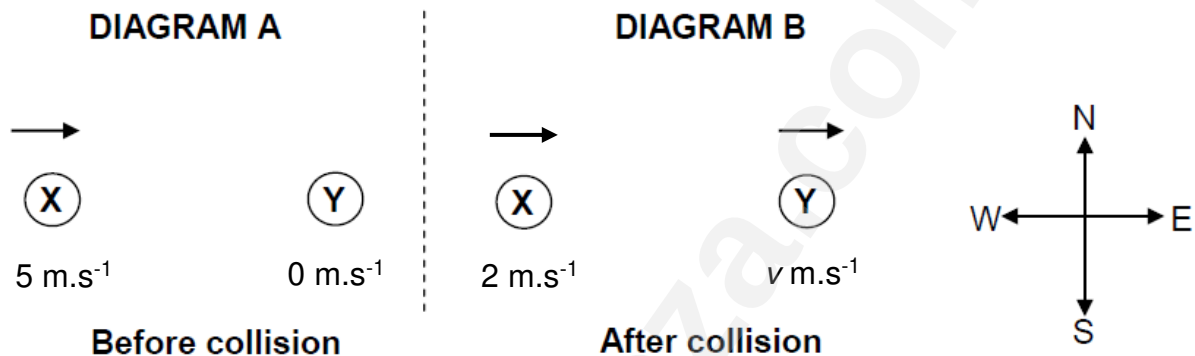
$$T = 694,60 \text{ N}$$

[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)

The total linear momentum of an isolated system remains constant (is conserved)

- 5.2 Give the definition of an *elastic collision*. (2)

A collision in which both momentum and kinetic energy are conserved

- 5.3 Calculate the mass (m) and velocity (v) of ball **Y** after the collision. (6)

E_k before = E_k after

$$\left(\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 \right)_i = \left(\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 \right)_f$$

$$\frac{1}{2} (7) (5)^2 + \frac{1}{2} (m) (0)^2 = \frac{1}{2} (7) (2)^2 + \frac{1}{2} (m) (v)^2$$

$$87,5 + 0 = 14 + \frac{1}{2} m v^2$$

$$m v^2 = 2(87,5 - 14)$$

$$m v^2 = 147$$

$\Sigma \text{momentum before} = \Sigma \text{momentum after}$

$$(m_1 v_1 + m_2 v_2)_i = (m_1 v_1 + m_2 v_2)_f$$

$$(7)(5) + (m)(0) = (7)(2) + (m)(v)$$

$$35 + 0 = 14 + mv$$

$$mv = 35 - 14$$

$$mv = 21$$

$$mv^2 = 147$$

$$mv(v) = 147$$

$$21v = 147$$

$$v = 7 \text{ ms}^{-1} \text{ East}$$

$$m = \frac{21}{7}$$

$$m = 3 \text{ kg}$$

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)

$$\begin{aligned} \Delta p &= \Delta mv \\ &= (3)(7) - (3)(0) \\ &= 21 \end{aligned}$$

$$\begin{aligned} \Delta p_x &= mv_f - m v_i \\ &= 2(7) - 5(7) \\ &= -21 \text{ kgm.s}^{-1} \end{aligned}$$

OR

$$\begin{aligned} F_{\text{net}} &= \frac{\Delta p}{\Delta t} \\ &= \frac{21}{0,1} \\ &= 210 \text{ N} \end{aligned}$$

$$\Delta p_x = - \Delta p_y$$

$$F_{\text{net}} = \frac{\Delta p}{\Delta t}$$

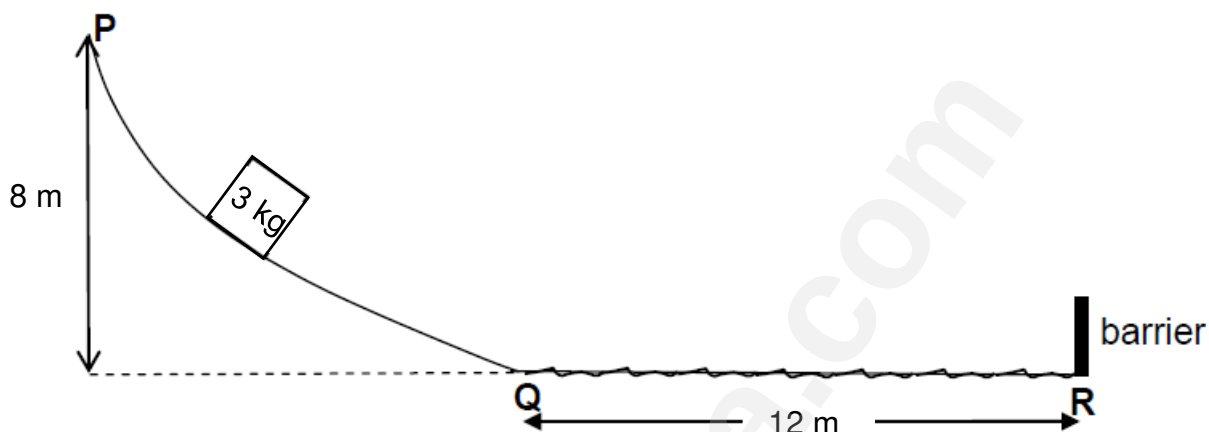
$$F_{\text{net}} = 27/0,1$$

$$F_{\text{net}} = 210 \text{ N}$$

[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)

In the absence of air resistance or any external forces, the mechanical energy of an object is constant

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

$$\begin{aligned}
 (E_p + E_k)_i &= (E_p + E_k)_f \\
 3(9,8)(8) + 0 &= 0 = \frac{1}{2}(3)v_Q^2 \\
 1,5 v_Q^2 &= 235,20 \\
 v_Q^2 &= 156,80 \\
 v_Q &= 12,52 \text{ m.s}^{-1}
 \end{aligned}$$

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)

$$W_{\text{net}} = F\Delta x = \Delta E_k$$

$$F_f(12) = \frac{1}{2}(3)(4^2 - 12,52^2)$$

$$12F_f = -211,13$$

$$F_f = -17,59 \text{ N}$$

$$F_f = 17,59 \text{ N (to the left)}$$

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)

$$J = \Delta p = \Delta mv$$

$$-14 = 3(v_f - 4)$$

$$v_f = -0,67 \text{ m.s}^{-1}$$

$$v_f = 0,67 \text{ m.s}^{-1} \text{ to the left}$$

[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.



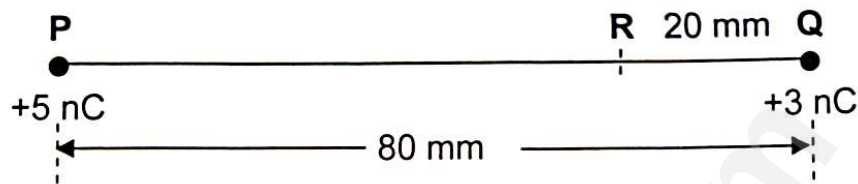
7.1 State *Coulombs Law*. (2)

Two point charges in free space or air exert forces on each other. The force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charges

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)

The dust particles have like charges and repel one another.

- 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)

$$\begin{aligned}
 E_P &= \frac{kQ}{r^2} \\
 &= \frac{9 \times 10^9 (5 \times 10^{-9})}{(60 \times 10^{-3})^2} \\
 &= 12\,500 \text{ (right)}
 \end{aligned}$$

$$\begin{aligned}
 E_Q &= \frac{kQ}{r^2} \\
 &= \frac{9 \times 10^9 (3 \times 10^{-9})}{(20 \times 10^{-3})^2} \\
 &= 67\,500 \text{ (left)}
 \end{aligned}$$

$$\begin{aligned}
 E_{\text{net}} &= 67\,500 - 12\,500 \\
 &= 55\,000 \text{ N.C}^{-1} \text{ to the left}
 \end{aligned}$$

- 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)

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

$$55\,000 = \frac{F}{2 \times 10^{-9}}$$

$$F = 1,1 \times 10^{-4} \text{ N (to the right)}$$

- 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)

Every particle with mass in the universe attracts every other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres

- 7.4.2 Calculate the gravitational force of attraction between the Moon and the Earth. (4)

$$\begin{aligned}
 F &= \frac{Gm_1m_2}{r^2} \\
 &= \frac{6,7 \times 10^{-11} (5,97 \times 10^{24}) (7,35 \times 10^{22})}{(3,84 \times 10^8)^2} \\
 &= 1,99 \times 10^{20} \text{ N}
 \end{aligned}$$

- 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)

$$F = \frac{Gm_1m_2}{r^2}$$

$$1,99 \times 10^{20} = \frac{6,7 \times 10^{-11} (1,99 \times 10^{30}) (7,35 \times 10^{22})}{r^2}$$

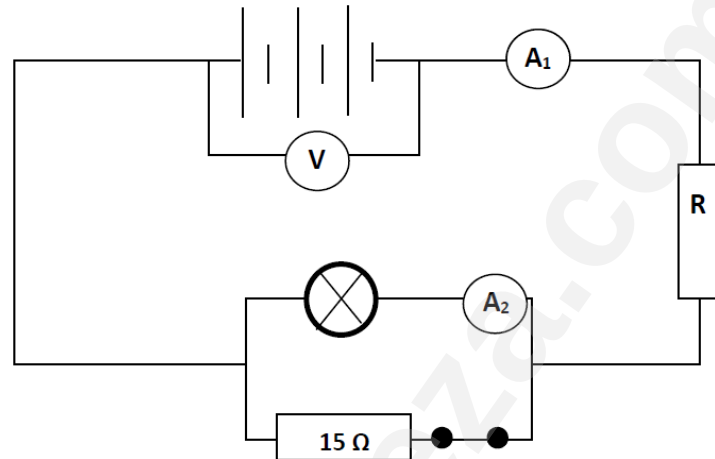
$$r^2 = 4,92 \times 10^{22}$$

$$r = 2,22 \times 10^{11} \text{ m or } 2,22 \times 10^8 \text{ km}$$

[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 5Ω bulb measures $1,5 \text{ A}$.



8.1 Calculate the reading on ammeter A_1 .

(5)

$$V = IR$$

$$V = 1,5(5)$$

$$V = 7,5 \text{ V}$$

$$V = IR$$

$$7,5 = I(15)$$

$$I = 0,5 \text{ A}$$

$$I = 1,5 + 0,5$$

$$I = 2 \text{ A}$$

OR

Resistance

$$5 : 15$$

$$1 : 3$$

Current

$$3 : 1$$

$$1,5 = I_T \left(\frac{3}{4}\right)$$

$$I = 2 \text{ A}$$

8.2 Calculate the resistance of the unknown resistor R .

(3)

$$\begin{aligned} V_R &= 8,5 - 7,5 \\ &= 1,0 \text{ V} \end{aligned}$$

$$V_R = IR$$

$$1,0 = (2)R$$

$$R = 0,5 \Omega$$

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{15}$$

$$R_p = 3,75 \Omega$$

$$R = \frac{V}{I}$$

$$R = 8,5/2$$

$$R = 4,45 \Omega$$

$$R = 0,5 \Omega$$

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

$$\begin{array}{lll}
 \mathbf{P = IV} & & \mathbf{P = I^2 R} & & \mathbf{P = V^2 / R} \\
 = 1,5(7,5) & \text{or} & = 1,5^2 (5) & \text{or} & = (7,5)^2 / 5 \\
 = 11,25 \text{ W} & & = 11,25 \text{ W} & & = 11,25 \text{ W}
 \end{array}$$

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)

$$\mathbf{P = I^2 R}$$

R_T increases, I_T decreases $\therefore V_{int}$ decreases, V_{ext} increases
the current through the bulb will increase from 1,5 A to 1,55 A
Thus, the brightness of the bulb will increase.

OR

R_T increases, I_T decreases $\therefore V_{int}$ decreases, V_{ext} increases
 V_R decreases, therefore $V_{//}$ increases
 $P_{//} = V_{//}^2 / R$
Thus, the brightness of the bulb will increase.

[14 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)

$$P = IV$$

$$150 = I(12)$$

$$I = \frac{150}{12}$$

$$I = 12,5 \text{ A}$$

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

$$V = IR$$

$$12 = (12,5)R$$

$$R = \frac{12}{12,5}$$

$$R = 0,96 \, \Omega$$

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)

A material's opposition to the flow of electric current

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)

It should be connected in SERIES

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

$$V = (9 \times 2) - 12$$

$$V = 6 \text{ V}$$

$$V = IR$$

$$6 = (12,5)R$$

$$R = \frac{6}{12,5}$$

$$R = 0,48 \Omega$$

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)

Step-down transformer

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

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$\frac{N_s}{20} = \frac{12}{240}$$

$$N_s = 1$$

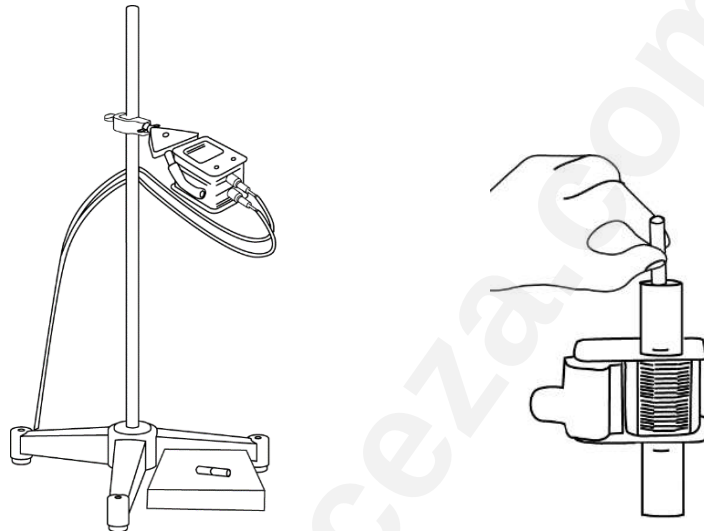
[13 marks]

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 the 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)

As the magnet drops through the coil, there is a changing magnet flux inside the coil. According to Faraday's Law, a change in magnetic flux inside a coil will induce an emf.

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

The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux

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

South

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

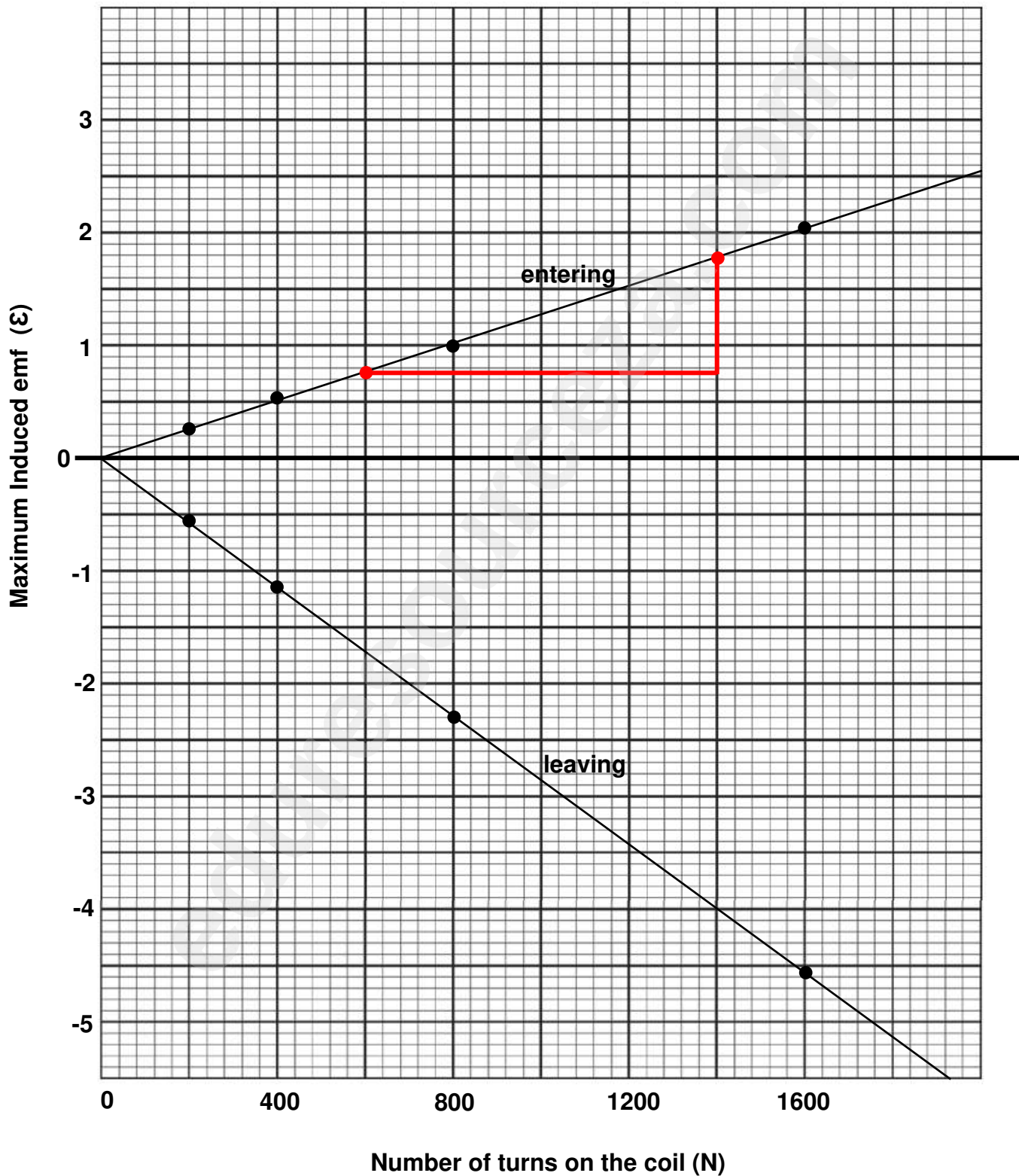
- 10.4 Use the graph paper on the next page to plot graphs on the SAME AXES of:
- Maximum induced emf vs number of turns on the coil for the magnet entering the coil. (4)
 - Maximum induced emf vs number of turns on the coil for the magnet leaving the coil. (4)
- 10.5 What can be concluded about the relationship between the induced emf ($\mathcal{E}$) and the number of turns (N) on the coil? (1)

Maximum induced $\mathcal{E}$ is DIRECTLY PROPORTIONAL to the number of turns on the coil

- 10.6 Do the results confirm or disprove Faraday's Law? Justify your answer with scientific reasoning. (2)

The results confirm Faraday's Law, because emf is directly proportional to the number of turns according to the straight-line graph through the origin. So, $\text{emf} \propto N$.

Graph of maximum induced emf vs number of turns on the coil
for a magnet entering and leaving the coil



- 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)

$$\text{gradient} = \frac{\Delta \text{emf}}{\Delta \text{no of turns}}$$

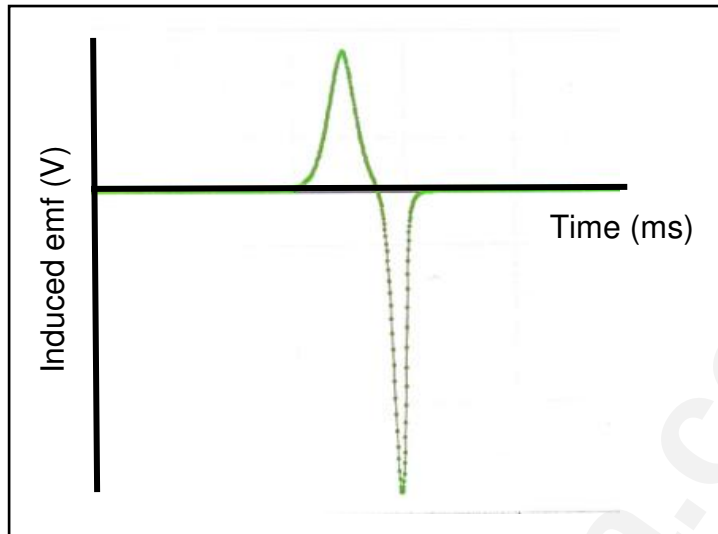
$$= \frac{1,78 - 0,76}{1400 - 600}$$

$$= 0,001275 \text{ V}$$

- 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 rate of change of magnetic flux

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)

$$\varepsilon \Delta t = -N \Delta\Phi$$

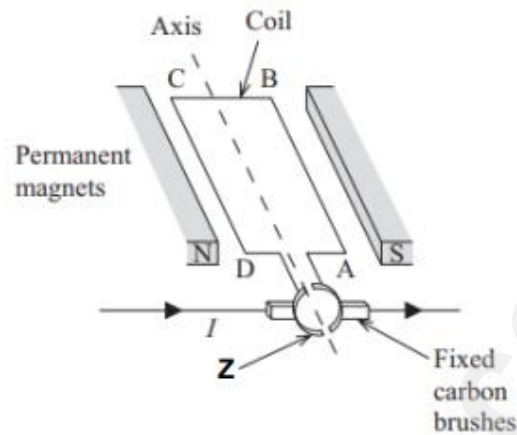
10.9.2 **Name** the physical quantity represented by the area under the graph. (1)

(change in) Magnetic flux linkage

[24 marks]

Question 11

The diagram below represents a DC electric motor.



11.1 What is indicated by the letter Z? (1)

Split ring commutator

11.2 What is the part indicated by the letter Z used for? (2)

Changes the direction of current every half turn for continuous rotation

11.3 In which direction does the coil rotate? (1)

Anti-clockwise

11.4 Which rule did you use to determine the answer in 11.3? (1)

Flemming's Left Hand Motor Rule

11.5 Give two ways that the speed of rotation can be reduced. (2)

**Use weaker magnets
Decrease the current**

11.4 Explain how this DC electric motor works. Refer to the input required and how it functions. (4)

- * **Input: DC power source**
- * **Current causes magnetic field around conductor**
- * **Two magnetic fields interact cause the coil to experience a force and Rotate.**
- * **Commutator reverses the current so the coil rotates continuously.**

[11 marks]