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ST JOHN'S COLLEGE

UV JULY PRELIMINARY EXAMINATION
PHYSICAL SCIENCES: PAPER 1

EXAMINER: MR R MACDONALD

EXTERNAL MODERATOR: MRS N STOCKS

NAME: **MEMO** _____ TEACHER'S INITIALS: _____
Time: 3 hours 200 Marks

QUESTION 1: MULTIPLE CHOICE

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

✓✓ x 10 = 20

QUESTION 2: Braking Distances of Cars

- 2.1 Define *acceleration*. (2)

The rate of change of velocity. ✓✓
(AON)

- 2.2 Determine the initial velocity of the car before the brakes are applied. (4)

$$v^2 = u^2 + 2as$$

$$u^2 = -2(-2)(140) \quad \checkmark\checkmark$$

$$u = 23,66 \text{ m.s}^{-1} \text{ East} \quad \checkmark\checkmark$$

- 2.3 Determine the reaction time of the driver from the time he sees the tree to the time he applies the brakes. (2)

$$t = s/u$$

$$t = 60/23,6 \quad \checkmark \quad \text{coe from 2.2}$$

$$t = 2,54 \text{ s} \quad \checkmark$$

- 2.4 The speed limit of the road is 100 km/h. Determine whether the driver is breaking the speed limit. (2)

$$u = 23,66 \times 3600/1000 \quad \text{coe from 2.2}$$

$$u = 85,18 \text{ km.h}^{-1} \quad \checkmark$$

Therefore not braking the speed limit ✓

Or

$$100 \text{ km/h} = 27,78 \text{ m.s}^{-1} \quad \checkmark$$

Therefore not braking the speed limit ✓

[10]

QUESTION 3: Vertical Projectiles

- 3.1 Calculate the time for stone **A** to reach its maximum height. (3)

$$v = u + at \checkmark$$

$$t = (0 - 12)/-9.8 \checkmark$$

$$t = 1,22 \text{ s} \checkmark$$

- 3.2 Calculate the magnitude of velocity, v , with which stone **B** is thrown downwards. (3)

$$v = u + at$$

$$3v \checkmark = v + (-9,8) (1,22) \checkmark \quad \text{coe from 3.1}$$

$$2v = -11,956$$

$$v = -5.98 \text{ m.s}^{-1} \checkmark$$

- 3.3 Calculate the height of the building, h . (4)

$$s = ut + \frac{1}{2} at^2 \checkmark$$

$$s = -5,98 (2,44) \checkmark + \frac{1}{2} (-9,8) (2,44)^2 \checkmark \quad \text{coe from 3.2}$$

$$s = -43,76 \text{ m}$$

$$h = 43,76 \text{ m} \checkmark$$

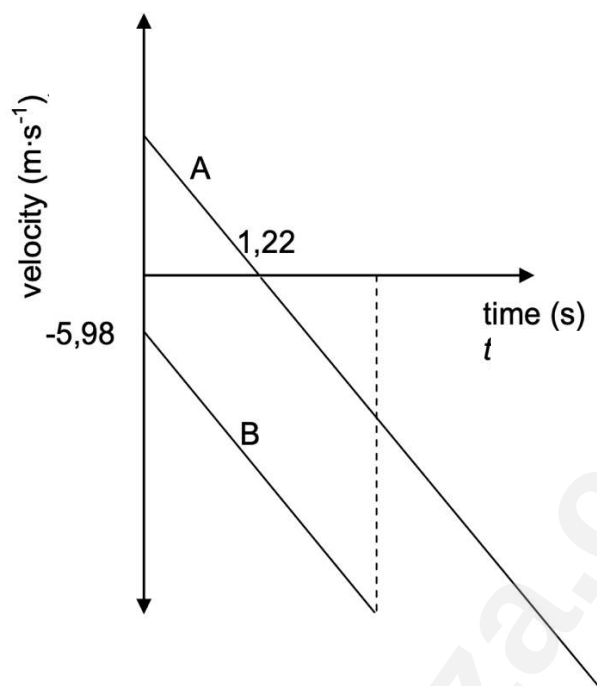
- 3.4 Sketch velocity-time graphs for the complete motions of the stones on the axes that are provided. Label your graphs for stone **A** and **B** clearly. (4)

The time taken for stone **A** to reach its maximum height. $\checkmark$ *coe from 3.1*

The velocity with which stone **B** is thrown downwards. $\checkmark$ *coe from 3.2*

Parallel lines $\checkmark$

The line for stone A extending past stone B $\checkmark$



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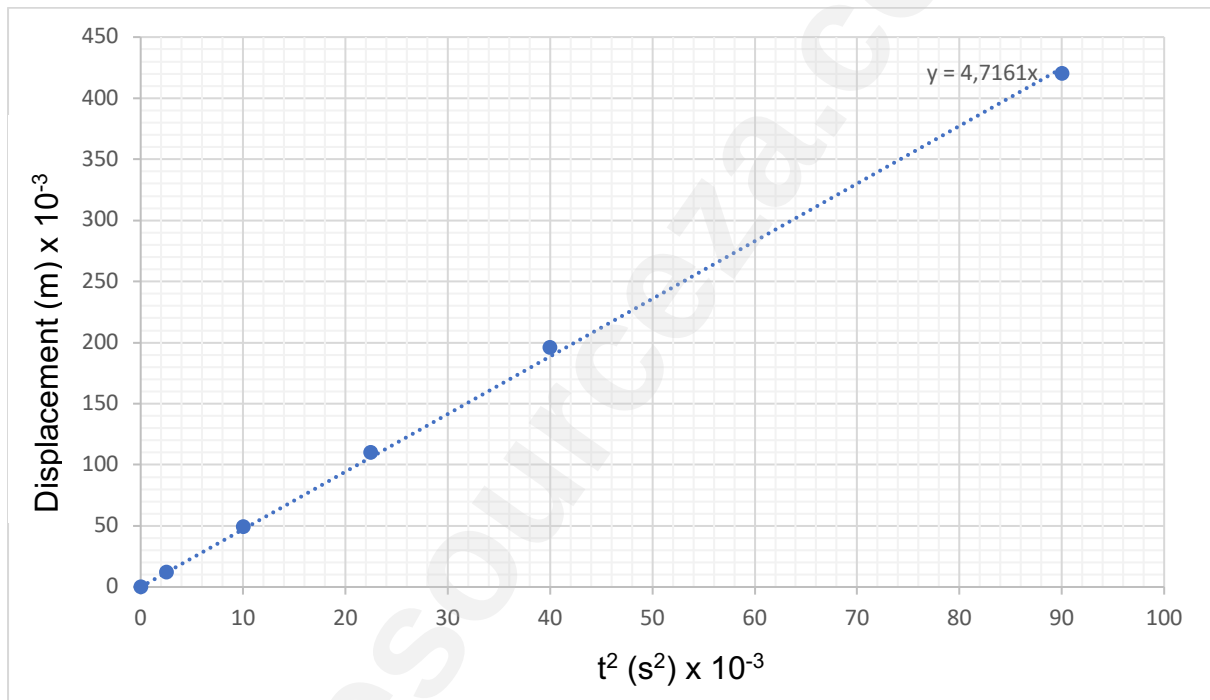
QUESTION 4: Investigating Free Fall

4.1 Explain what is meant by a projectile in *free fall*. (2)

Fall freely with the gravitational acceleration of g ✓✓, where $g = 9,8 \text{ m.s}^{-2}$

4.2 From the data given in the table, plot a displacement vs time² graph.

Heading: Displacement vs time²



Heading ✓
 Scale ✓
 Labelled Axes ✓ with correct units ✓
 Plotting ✓
 LOBF ✓

(6)

4.3 Calculate the gradient of the graph.

(4)

$$\text{Gradient} = \frac{\Delta y}{\Delta x}$$

Values used must be shown on graph and correctly substituted. ✓✓

Gradient = 4,71 ✓m.s⁻² ✓ range (4,6 – 4,8)

- 4.4 Using a suitable equation of motion, calculate the acceleration of the ball in free fall. (3)

$$s = ut + \frac{1}{2}at^2 \checkmark$$

$$a \text{ or } g = 2 (s / t^2) \checkmark$$

$$a \text{ or } g = 2 (4,71) \checkmark$$

$$a \text{ or } g = 9,42 \text{ m.s}^{-2} \checkmark$$

coe from 4.3

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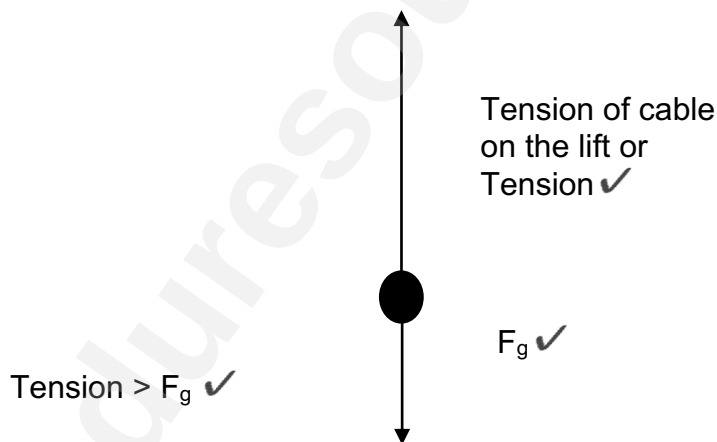
QUESTION 5: Lifts and Motors

- 5.1 State Newton's Second Law of motion. (2)

When a net force is applied to an object will accelerate in the direction of a net force $\checkmark$. The acceleration is directly proportional to the net force and inversely proportional the object's mass. $\checkmark$
(Part mark)

The net force is equal to the rate of change of momentum. $\checkmark\checkmark$
(AON)

- 5.2 Draw a free-body diagram of the lift. (3)



- 5.3 Show that the maximum acceleration of the lift is **1,45 m/s²** upwards. (3)

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

$$9000 - (800)(9,8) \checkmark = 800 a \checkmark$$

$$1160 / 800 = a$$

$$a = 1,45 \text{ m.s}^{-2}$$

- 5.4 A 75 kg student is standing on a bathroom scale, which is calibrated in kg, when the lift is accelerating upwards. Determine the reading on the bathroom scale during this time frame.

(4)

$$F_s - mg = ma \checkmark$$

$$F_s = (75)(1,45) + (75)(9,8) \checkmark$$

$$F_s = 843,75 \text{ N}$$

$$m = F_s/9,8 \checkmark$$

$$m = 86,1 \text{ kg} \checkmark$$

- 5.5 After 2s, the lift travels at a constant velocity of 2,9 m/s and the electric motor now provides a constant force of 7840 N. Calculate the power output of the electric motor.

(3)

$$P = F \cdot v \checkmark$$

$$P = (7840)(2,9) \checkmark$$

$$P = 22736 \text{ W} \checkmark$$

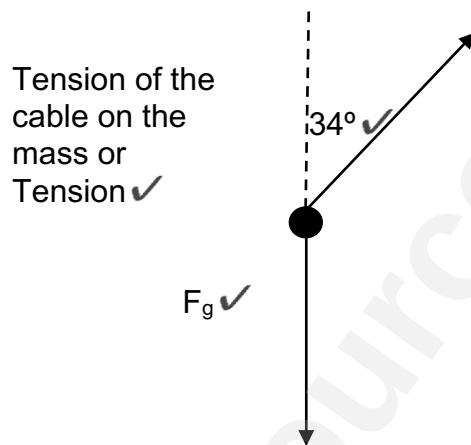
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QUESTION 6: Suspended Masses from Rockets

6.1 Define *Inertia*. (2)

The property of an object that causes an object to resist change ✓ in its state of rest or uniform motion. ✓
(Part mark)

6.2 Draw a free-body diagram of all the forces acting on the mass. The angle of 34° must be included in your diagram. (3)



6.3 Write a simplified expression illustrating that the mass has no vertical acceleration. (3)

$$F_{\text{net}} = 0 \quad \checkmark \quad (\text{in case of using the wrong trig ratio})$$

$$T \cos 34^\circ = F_g \quad \checkmark \checkmark$$

or

$$0,83 T = mg \quad \checkmark \checkmark$$

6.4 Write an expression for the net force acting on the mass. (2)

$$F_{\text{net}} = ma \quad \checkmark \quad (\text{in case of using the wrong trig ratio})$$

$$T \sin 34^\circ = 10m \quad \checkmark$$

or

$$0,56 T = 10m \quad \checkmark$$

- 6.5 Hence, calculate acceleration due to gravity on this planet. (3)

$$0,56 T = 10m \dots 1$$

$$T = mg/0.83 \dots 2$$

Subst 2 into 1

$$0,56 (mg/0.83) \checkmark = 10 m \checkmark$$

$$g = 14,82 \text{ m/s}^2 \checkmark$$

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QUESTION 7: Carts and Forces

- 7.1 Using the graph, calculate the distance the cart travels while compressing the spring. (4)

Area under the graph = displacement $\checkmark$

$$\text{Area} = \frac{1}{2} (2,35 - 2,32) \checkmark (6,5) \checkmark$$

$$s = 0,097 \text{ m} \checkmark$$

or

$$s = 0,10 \text{ m} \checkmark$$

- 7.2 Calculate the acceleration of the cart during the collision. (4)

$$a = (v - u) / t \text{ or } a = \text{slope of the } v \text{ vs } t \text{ graph} \checkmark$$

$$a = (0 - 6,5) / (2,35 - 2,32) \checkmark$$

$$a = -216,67 \text{ m.s}^{-2}$$

$a = 216,67 \text{ m.s}^{-2} \checkmark$ to the right or away from the hoop or in an opposite direction the original direction $\checkmark$

- 7.3 Define *Impulse*. (2)

Is the product of a net force and contact time acting on an object. $\checkmark \checkmark$
(AON)

- 7.4 Calculate the impulse that the spring exerts on the cart. (5)

$$J = F_{\text{net}} \times t \checkmark$$

$$J = (-216,67) (0,3) \checkmark \times (2,39 - 2,32) \checkmark \quad \text{coe from 7.2}$$

$$J = -4,55 \text{ N.s}$$

$$J = 4,55 \text{ N.s} \checkmark \text{ to the right or away from the hoop} \checkmark$$

or

$$\Delta p = mv - mu \checkmark$$

$$\Delta p = 0,3 (-8,7 - 6,5) \checkmark \checkmark$$

$$\Delta p = -4,55 \text{ kg.m.s}^{-1}$$

$$\Delta p = 4,55 \text{ kg.m.s}^{-1} \checkmark \text{ to the right or away from the hoop} \checkmark$$

- 7.5 Calculate the magnitude of the velocity (v) that the cart recoils off the spring. (4)

$$J = \Delta p \checkmark$$

$$-4,55 = (0,3) (v - 6,5) \checkmark \checkmark \quad \text{coe from 7.4}$$

$$v = -8,67 \text{ m.s}^{-1}$$

$$v = 8,67 \text{ m.s}^{-1} \checkmark$$

or

$$v = u + at \checkmark$$

$$v = 6,5 + (-216,67) (2,39 - 2,32) \checkmark \checkmark \quad \text{coe from 7.2}$$

$$v = -8,67 \text{ m.s}^{-1}$$

$$v = 8,67 \text{ m.s}^{-1} \checkmark$$

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QUESTION 8: Sliding Blocks and Inclines

- 8.1 Define *Mechanical Energy*. (2)

The sum of kinetic energy and gravitational potential energy $\checkmark$ at a point (or at a position). $\checkmark$

(Part mark)

- 8.2 Calculate the total mechanical energy of the **2 kg block** just before it slides down the incline. (4)

$$E_{\text{mech}} = \frac{1}{2} m v^2 + mgh \checkmark$$

$$E_{\text{mech}} = 0,5 (2) (2,5)^2 \checkmark + (2) (9,8) (3) \checkmark$$

$$E_{\text{mech}} = 65,05 \text{ J} \checkmark$$

- 8.3 Determine the work done by friction acting on the **2 kg block** as it slides down the curved surface. (4)

$$E_{\text{mech top}} > E_{\text{mech bottom}}$$

$$65,05 \checkmark = 0,5 (2) (3,7)^2 \checkmark + W_f \checkmark \quad \text{coe from 8.2}$$

$$W_f = 51,36 \text{ J} \checkmark$$

- 8.4 State the law the *conservation of linear momentum*. (2)

The total linear momentum of an isolated system remains constant or is conserved.

✓✓

(AON)

- 8.5 Show, using conservation principles, the that the final velocity of the 3 kg block is 2,47 m.s⁻¹. (3)

$$P_{\text{before}} = P_{\text{after}} \quad \checkmark$$

$$(2) (3,7) \checkmark = (3) (v) \quad \checkmark$$

$$v = 2,47 \text{ m/s to the right}$$

- 8.6 Define the *Work-Energy Theorem*. (2)

The work done by the net force on an object ✓ is equal the change of the kinetic energy ✓ of that object.

(Part mark)

- 8.7 Calculate the total length of A to B. (4)

$$W_{F_{\text{net}}} \cdot s = \Delta E_k \quad \checkmark$$

$$-2,4 \cdot s \checkmark = 0,5 (3) (1,8^2 - 2,47^2) \quad \checkmark$$

$$s = 1,79 \text{ m} \quad \checkmark$$

- 8.8 Calculate the height, h , that the **3 kg block** comes to rest. (5)

$$W_{F_{\text{net}}} \cdot s = \Delta E_k$$

$$(-1,2 - (3) (9,8) \sin 20^\circ \checkmark) \checkmark \cdot s = 0,5 (3) (0 - 1,8^2) \quad \checkmark$$

$$s = 0,432 \quad \checkmark$$

$$h = 0,432 \times \sin 20^\circ$$

$$h = 0,15 \text{ m} \quad \checkmark$$

or

$$E_{\text{MECH B}} = 0,5 (3) (1,8)^2 = 4,86$$

$$E_{\text{MECH C}} = 3 (9,8) (h) = 29,4h$$

$$E_B - W_f = E_C \quad \checkmark$$

$$4,86 \checkmark - 1,2(h/\sin 20) \checkmark = 29,4 h \quad \checkmark$$

$$4,86 = 32,9 h$$

$$h = 0,15 \text{ m} \quad \checkmark$$

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QUESTION 9: Satellites

- 9.1 State Newton's Law of Gravitation. (2)

Every particle in the universe attracts every other particle with a force ✓ which is directly proportional to the product of their masses and is inversely proportional to the square of the distance between their centers. ✓
(Part mark)

- 9.2 Calculate the magnitude of gravitational force that TOI 700 e exerts on the satellite. (4)

$$F_1 = G m_1 m_2 / r^2 ✓$$

$$F_g = (6,7 \times 10^{-11}) (5,8 \times 10^{24}) (500) ✓ / (7,4 \times 10^6 ✓)^2$$

$$F_g = 3548,21 \text{ N} ✓$$

- 9.3 Calculate the ratio of the force $\frac{F_2}{F_1}$. (4)

$$F_2 = (2/3) ✓ GmM / (2.5r)^2 ✓$$

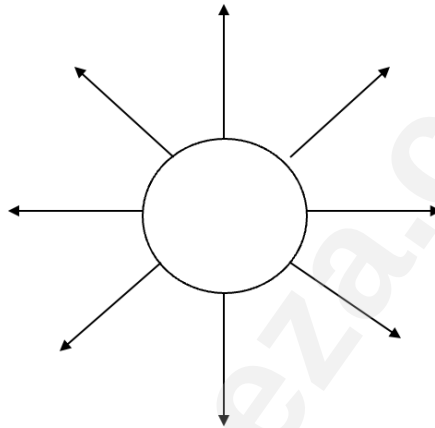
Factor of 0,11x

$$\frac{F_2}{F_1} = 0,11 ✓✓$$

[10]

QUESTION 10: Forces between Charged Objects and Electric Fields

10.1.1 In the space below, draw the electric field lines around the conducting sphere. (3)



Arrows radiating outwards from sphere. ✓

Draw perpendicular the surface. ✓

Distribution of the field lines are evenly spaced. ✓

10.1.2 State Coulomb's Law. (2)

The force between two charges is directly proportional to the product the charges
✓ and inversely proportional to the distance between the charges squared. ✓

10.1.3 Calculate the electrostatic force acting on the +60 nC sphere (PLEASE ROUND TO FOUR DECIMAL PLACES IN YOUR ANSWERS). (5)

$$F_E = k q_1 q_2 / r^2 \quad \checkmark$$

$$F_E = (9 \times 10^9) (60 \times 10^{-9}) (45 \times 10^{-9}) \checkmark / (2,5 \times 10^{-2})^2 \checkmark$$

$$F_E = 0,0388 \text{ N} \checkmark \quad \text{up} \checkmark$$

10.2.1 Define the *magnitude of an electric field at point*. (2)

The force per unit positive charge. ✓ ✓
(Part Mark = -1 for leaving "positive" out)

10.2.2 The net electric field at point is 750 N.C^{-1} to the left. Calculate the value of d. (5)

$$E_1 = k Q_1 / r^2$$

$$E_1 = (9 \times 10^9) (2 \times 10^{-6}) / 4d^2 \checkmark$$

$$E_1 = 4500/d^2 \text{ left } \checkmark$$

$$E_2 = (9 \times 10^9) (4 \times 10^{-6}) / 9d^2 \checkmark$$

$$E_2 = 4000/d^2 \text{ right } \checkmark$$

$$750 = 4500/d^2 - 4000/d^2$$

$$750 = 500/d^2$$

$$d = 0,816 \text{ m } \checkmark$$

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QUESTION 11: Magnets and Current Carrying Conductors

- 11.1 Explain why the reading of the top-pan balance decreases when the current is switched on. (4)

The conductor is producing a magnetic field ✓ that interacts with the magnetic field of the magnet ✓ that produces a force ✓.

This force acts upwards on the magnet that is resting on the top reducing the reading ✓.

or

With the force on the magnet acting up ✓, the force acting on conductor is acting down ✓ due to the interaction of the magnetic field of the conductor and the magnetic field ✓ of the magnet producing a force ✓.

- 11.2 State the direction of the force on the wire. (2)

Force acting on the wire is downwards. ✓✓

- 11.3 State the direction of the current flow in the wire. Write only left to right or right to left. (2)

Left to right. ✓✓

- 11.4 State one way, besides changing the current in the conductor, how one could increase the change of mass on the top-pan balance. (2)

Increase the strength of the magnetic field of the magnet ✓✓

Or

Increase the length of the conductor in the magnetic field of the magnet. ✓✓

- 11.5 Determine the magnetic force that is acting on the conductor when the current is 4 A. (4)

$$102,45 - 101,06 = 1,39 \text{ g} ✓$$

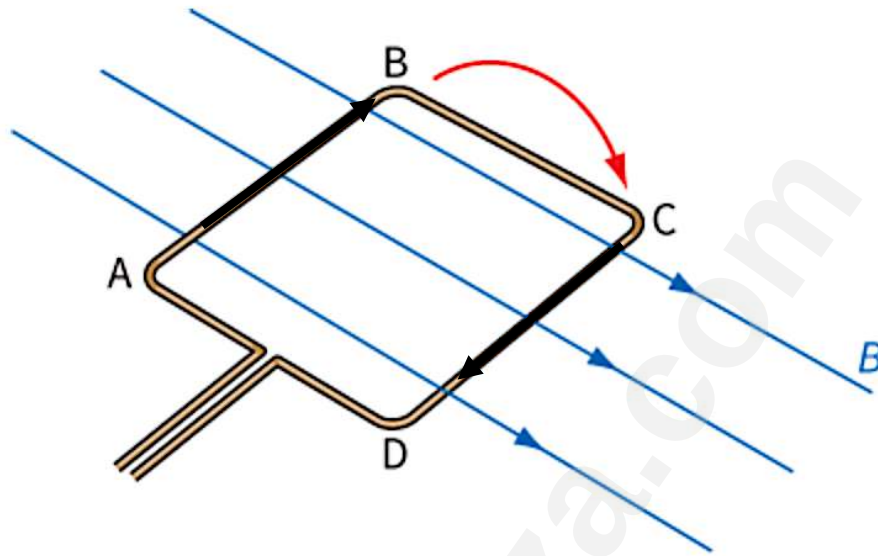
$$1,39 / 1000 = 1,39 \times 10^{-3} \text{ kg}$$

$$F_M = 1,39 \times 10^{-3} \times 9,8 ✓$$

$$F_M = 0,0136 \text{ N} ✓ \text{ downwards} ✓$$

[14]

QUESTION 12: Generators



- 12.1 On the diagram, using arrow heads, show the direction of the induced current caused by the induced emf. ✓✓ (2)

A to B to C to D

- 12.2 State Faraday's Law of electromagnetic induction. (2)

The emf induced is directly proportional to the rate of change of magnetic flux. ✓✓
(AON)

- 12.3 Define magnetic flux linkage. (2)

The product of the number of turns on the coil and the flux through the coil. ✓✓
(AON)

- 12.4 Explain why an emf is induced when the coil rotates. (2)

The coil is rotating through the magnetic lines of flux ✓ which causes there to be a change in the magnetic flux inducing an emf ✓.

- 12.5 State two ways in which the induced emf of this generator can be increased without changing the rate of the coil.

(2)

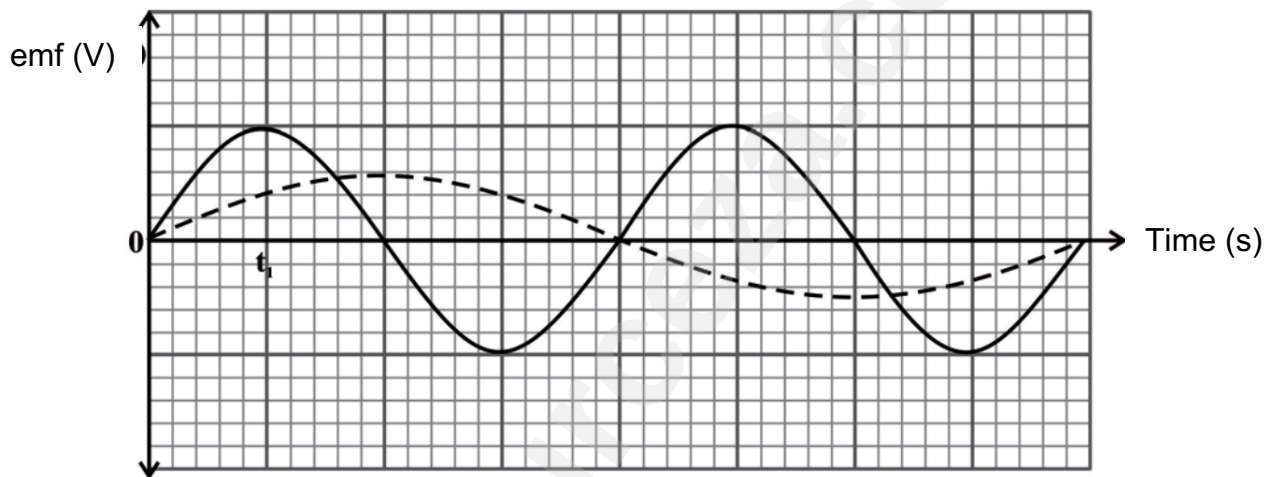
Increase the strength of the magnetic field. ✓

Increase the number of number of turns of the coil. ✓

Increase area of the coil ✓

(any two suitable answers)

The graph below shows the changes in the induced emf against time for two complete cycles of this generator.



Half the amplitude. ✓✓

Double the wavelength. ✓✓

- 12.6 On the graph above, draw the curve of the emf vs time when the speed of the bicycle wheel is halved.

(4)

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QUESTION 13

- 13.1 Explain why, if the transformer is connected to a steady (direct current) supply on the primary coil, no emf is induced in the secondary coil. (2)

For a DC supply, the magnetic flux is constant (uniform) ✓, therefore there is no change in the magnetic flux with respect to time ✓, therefore no emf is induced in the secondary coil.

Or

AC input causes a change in the magnetic flux with respect to time ✓ ✓ which is detected by the secondary coil. ✓

- 13.2 The primary coil has 100 turns and the secondary coil 3333 turns. Calculate the output voltage of the secondary coil. (3)

$$N_s / N_p = V_s / V_p \quad \checkmark$$

$$V_s = (3333/100) / (12 \times 10^3) \quad \checkmark$$

$$V_s = 39990 \text{ V} \quad \checkmark$$

- 13.3 Using a suitable formula, explain why the electrical transmission from the power station to the substation requires this higher voltage and a smaller current. (3)

$P = I^2 R$ ✓; the power dissipated from a resistor is dependent on I^2 and R ✓; the smaller the current the smaller the energy loss in electrical energy is transmitted ✓.

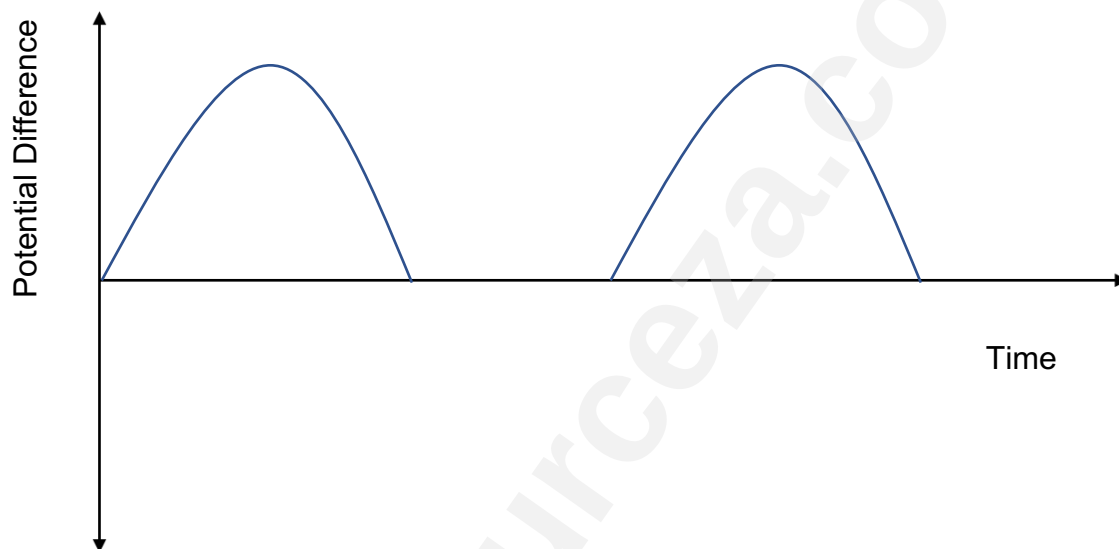
- 13.4 Define a diode. (2)

A component that only allows current to flow in one direction. ✓✓
(AON)

- 13.5 On the graph below, sketch what the potential difference vs time graph across the resistor for two full cycles. (3)

Two cycles ✓✓

$\frac{1}{2}$ cycle rectified ✓



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