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PHYSICAL SCIENCES: PAPER I

MEMO

Question 1

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

Question 2

- 2.1 $T_{Ax} = 180\,000 \cos 10^\circ \checkmark = 177\,265\,N \checkmark$
 $T_{Ay} = 150\,000 \cos 15^\circ \checkmark = 144\,889\,N \checkmark$
- 2.2 Resultant vector is the single vector ✓ which has the same effect as the original vectors acting together. ✓
- 2.3 $F_A(\text{right}) = 177\,265 + 144\,889 \checkmark = 322\,154\,N$
 $F_f = 322\,154\,N \checkmark \text{Left} \checkmark$
- 2.4 When the angle increases, $F \cos \theta$ decreases. ✓
 F_{net} to the right decreases. ✓
 F_{net} to the right will be less than the frictional force ✓
The plane will not move. ✓

Question 3

- 3.1 Distance is the length ✓ of path travelled. ✓
- 3.2 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$
 $\Delta x = (0)(28) \checkmark + \frac{1}{2} (2,3)(28)^2 \checkmark = 901,6\,m \checkmark$
- 3.3 $v_f = v_i + at \checkmark = 0 + (2,3)(13) \checkmark = 29,9\,m \cdot s^{-1} \checkmark$
- 3.4 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
 $\Delta x = (0)(13) + \frac{1}{2} (2,3)(13)^2 \checkmark = 194\,m \checkmark$
 $\Delta x = vt = (29,9)(1,5) \checkmark = 44,85\,m \checkmark \quad \text{coe}$
 $\Delta x = 194 + 44,85 = 238,85\,m \checkmark$

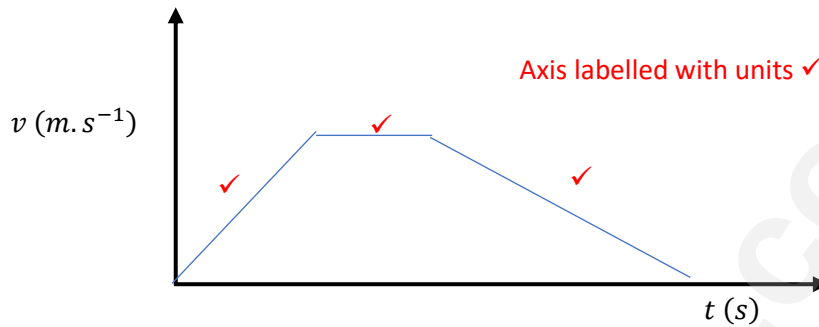
3.5 $\Delta x = 1000 - 238,85 = 761,15$ ✓

$$v_f^2 = v_i^2 + 2a\Delta x$$
 ✓

$$0^2 = 29,9^2 + 2a(761,15)$$
 ✓ coe

$$a = -0,587 \text{ m.s}^{-2} = 0,587$$
 ✓ opposite direction to the motion ✓

3.6



Question 4

4.1 Acceleration is the rate of change ✓ of velocity. ✓

4.2 $9,8 \text{ m.s}^{-2}$ ✓

4.3 $v_f^2 = v_i^2 + 2a\Delta x$

$$0^2 = (15)^2 + 2(-9,8)\Delta x$$
 ✓ $\Delta x = 11,48 \text{ m}$

$$\text{Height} = 800 + 11,48 = 811,48 \text{ m}$$
 ✓

4.4 $v_f = v_i + at$ $0 = 15 + (-9,8)t$ ✓ $t = 1,53 \text{ s}$ ✓

4.5 $\Delta x_{\text{plane}} = vt$ $100 = 50t$ $t = 2 \text{ s}$ ✓

$$\Delta x_{\text{drone}} = (15)(2) + \frac{1}{2}(-9,8)(2) = 10,4 \text{ m}$$
 ✓

$$\text{Height of drone} = 800 + 10,4 = 810,4 \text{ m}$$
 ✓

The plane will pass under the drone. ✓

Question 5

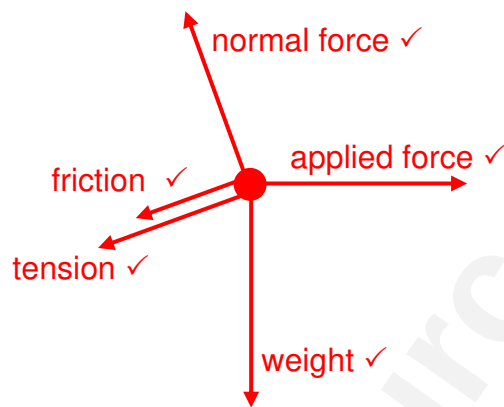
5.1 The perpendicular force ✓ exerted by a surface on an object in contact with it. ✓

5.2 $F_N = F_{g\perp} = mg \cos \theta$ ✓
 $F_N = (8,5)(9,8) \cos(36)$ ✓
 $F_N = 67,39 \text{ N}$ ✓

5.3 An object continues in a state of rest or uniform (moving with constant) velocity ✓ unless it is acted upon by a net or resultant force. ✓

5.4 $F_T = F_{g\parallel} + F_f$
 $F_T = mg \sin \theta + F_f$
 $F_T = (8,5)(9,8) \sin(36) + (68)$ ✓✓
 $F_T = 116,96 \text{ N}$ ✓

5.5



5.6 $F_{\parallel} = F_{g\parallel} + F_f + F_T$ ✓ (method)
 $F \cos \theta = mg \sin \theta + \mu_s F_N + F_T$
 $F \cos 36$ ✓ $= (8,5)(9,8) \sin(36)$ ✓ $+ (0,4)(F \sin 36 + 67,39)$ ✓ $+ (116,96)$ ✓
 $F = 184,75 \text{ N}$ ✓ right ✓

5.7.1 Decrease ✓✓

5.7.2 Decrease ✓✓

Question 6

- 6.1 The product of the displacement ✓ and the component of the force parallel to the displacement. ✓
- 6.2.1 Force of the engine ✓ Thrust , Applied force
- 6.2.2 Friction ✓
- 6.2.3 Weight (gravitational force) ✓ and Normal force ✓
- 6.3 These forces act perpendicularly to the motion of the bike. ✓
- 6.4 Chemical potential energy ✓ (in fuel) to kinetic energy ✓ and heat and sound energy ✓
- 6.5 Work done by a net force on an object is equal to the change in the kinetic energy of the object. ✓✓

6.6 $F_{net} \cdot \Delta x = \Delta E_k$ ✓

$$(3\,500 - 850) \times (50) = E_{kf} - E_{ki}$$

$$(2\,650) \times (50) = \frac{1}{2}(150)v_f^2 - \frac{1}{2}(150)(27)^2$$

$$132\,500 = 75.v_f^2 - 54\,675$$

$$187\,175 = 75.v_f^2$$

$$v_f = 49,96 \text{ m.s}^{-1}$$

- 6.7 The total energy in a system cannot be created nor destroyed; only transformed from one form to another. ✓✓

6.8 $(E_K + E_P)_{top} = (E_K + E_P)_{bottom}$ ✓

$$\frac{1}{2}(150)(49,96)^2 + 150(9,8)10 = \frac{1}{2}(150)v^2 + 0$$

$$v = 51,88 \text{ m.s}^{-1}$$

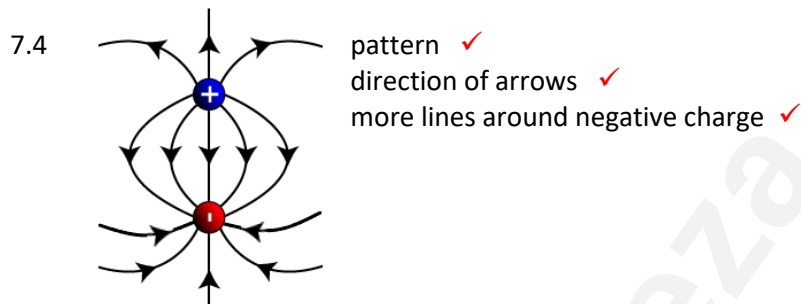
(6)

Question 7

7.1 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. ✓✓

$$\begin{aligned} 7.2 \quad F &= \frac{kq_1q_2}{r^2} \quad \checkmark \\ &= \frac{(9 \times 10^9) \cdot (3 \times 10^{-6}) \cdot (4 \times 10^{-6})}{0,03^2} \quad \checkmark \\ &= 120 \text{ N} \quad \checkmark \end{aligned}$$

7.3 A region in space in which an electric charge experiences a force. ✓✓



$$\begin{aligned} 7.5 \quad E &= \frac{kQ_1}{r^2} \quad \checkmark \\ &= \frac{(9 \times 10^9) \cdot (+3 \times 10^{-6})}{(0,04)^2} \quad \checkmark \\ &= 16875000 \text{ N.C}^{-1} \quad \checkmark \end{aligned}$$

$$\begin{aligned} E &= \frac{kQ_2}{r^2} \\ &= \frac{(9 \times 10^9) \cdot (4 \times 10^{-6})}{(0,05)^2} \quad \checkmark \\ &= 14400000 \text{ N.C}^{-1} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \tan \theta &= \frac{3}{4} \\ \theta &= 36,87^\circ \quad \checkmark \end{aligned}$$

$$\begin{aligned} \text{Horizontal component of } E_{q2} &= 14400000 \cdot \cos 36,87^\circ \\ &= 11519984,57 \text{ N.C}^{-1} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \text{Vertical component of } E_{q2} &= 14400000 \cdot \sin 36,87^\circ \\ &= 8640020,58 \text{ N.C}^{-1} \quad \checkmark \end{aligned}$$

$$\begin{aligned} E_{\text{net}} &= \sqrt{(16875000 - 11519984,57)^2 + (8640020,58)^2} \\ &= 10164946,92 \text{ N.C}^{-1} \quad \checkmark \end{aligned}$$

Question 8

$$8.1 \quad R_1 = \frac{V_1}{I_2} \quad \checkmark$$

$$(12) = \frac{V_1}{(1.5)} \quad \checkmark$$

$$V_1 = 18 \text{ V} \quad \checkmark$$

8.2 24 V $\checkmark$. The voltmeter reads the emf when no current is flowing $\checkmark$.

$$8.3 \quad emf = V + Ir \quad \checkmark$$

$$(24) = (18) + (2)r \quad \checkmark$$

$$r = 3 \text{ } \Omega \quad \checkmark$$

8.4 Reading across R_2 :

$$R_2 = \frac{V}{I}$$

$$(8) = \frac{V}{0.5} \quad \checkmark \checkmark$$

$$V = 4 \text{ V} \quad \checkmark$$

V_2 :

$$V_1 = V + V_2 \quad \checkmark$$

$$(18) = (4) + V_2 \quad \checkmark$$

$$V_2 = 14 \text{ V} \quad \checkmark$$

$$8.5 \quad P = I^2 R \quad \checkmark$$

$$P = (0.5)^2 (8) \quad \checkmark \checkmark$$

$$P = 2 \text{ W} \quad \checkmark$$

- 8.6
- ♦ Breaking at X effectively increases the total resistance (by removing a parallel resistor) $\checkmark$
 - ♦ An increase in resistance causes a decrease in the current $\checkmark$
 - ♦ A decrease in the current results in less lost volts $\checkmark$
 - ♦ The reading on voltmeter V_1 will increase $\checkmark$

Question 9

- 9.1 Mechanical energy ✓ to electrical energy. ✓
- 9.2 Sliprings ✓ (Carries the current in and out of the coil /completes the circuit)
- 9.3 (Carbon) Brushes. ✓ Carries the current (from the rings) ✓ to the external circuit ✓
- 9.4 There is **change in magnetic flux (linkage)** ✓ between the coil and the magnets as the coil spins which induces an emf in the coil. ✓

OR magnetic field (lines) cutting through conductor / coil.

- 9.5 LKMN ✓

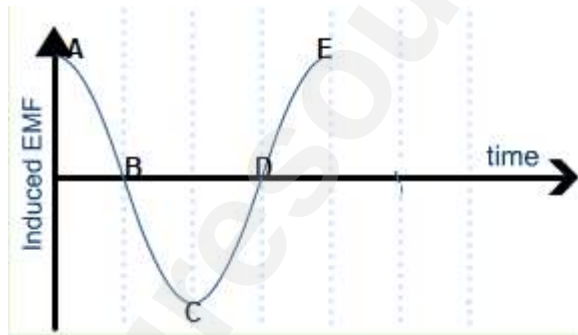
- 9.6 The emf induced is directly proportional to the rate of change of magnetic flux ✓✓

- 9.7 Bulb burns brighter ✓

$$emf = -N \frac{\Delta \Phi}{\Delta t} \quad \checkmark$$

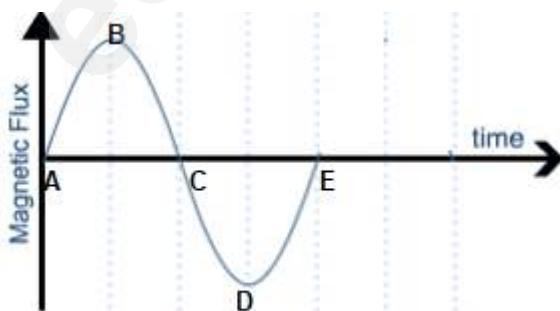
coil turns faster greater **rate** of change of magnetic flux (linkage) ✓
less time ✓ thus greater emf / current

- 9.8.1



Shape ✓
Max emf for A, C & E ✓
Zero emf for B & D ✓
Graph can also be in opposite direction

- 9.8.2



Shape ✓
A, C & E at magnetic flux zero ✓
Maximum magnetic flux at B & D ✓
Graph can also be in opposite direction

Question 10

10.1 $6,5 \times 10^{14} \text{ Hz}$ ✓✓

10.2 Work function (W_0) as the minimum amount of energy needed to emit an electron from the surface of a metal and know that the work function is material specific. ✓✓

10.3 $W_0 = h \cdot f_0$ ✓
 $= (6,6 \times 10^{-34}) \cdot (6,5 \times 10^{14})$ ✓coe
 $= 4,29 \times 10^{-19} \text{ J}$ ✓

10.4 $4,95 \times (1,6 \times 10^{-19})$ ✓ = $7,92 \times 10^{-19} \text{ J}$ ✓

10.5 $E = \frac{hc}{\lambda}$ ✓
 $7,92 \times 10^{-19} = \frac{(6,6 \times 10^{-34}) \cdot (3 \times 10^8)}{\lambda}$ ✓coe
 $\lambda = 2,5 \times 10^{-7} \text{ m}$ ✓

10.6 $E = W_0 + E_k$ ✓
 $(7,92 \times 10^{-19}) = 4,29 \times 10^{-19} + \frac{1}{2} \cdot (9,1 \times 10^{-31}) \cdot v^2$ ✓coe
 $v = 893197,74 \text{ m.s}^{-1}$ ✓