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PRELIMINARY EXAMINATION
24 AUGUST 2020

PHYSICAL SCIENCES: PAPER I

Time: 3 hours

200 marks

MEMORANDUM

QUESTION 1

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

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QUESTION 2

2.1 2.1.1 The rate of change ✓ in velocity ✓. (2)

2.1.2 $a = \text{gradient}$ ✓

$$a = \frac{(2)-(0)}{(4)-(0)} \checkmark$$

$$a = 0,5 \text{ m} \cdot \text{s}^{-2} \checkmark \text{ right } \checkmark$$

(4)

2.1.3 $F_{\text{net}} = ma$ ✓

$$F \cos 30 = (25)(+0,5) \checkmark$$

$$F = 14,43 \text{ N} \checkmark$$

(4)

2.2 2.2.1 The length of the path travelled. ✓✓ (2)

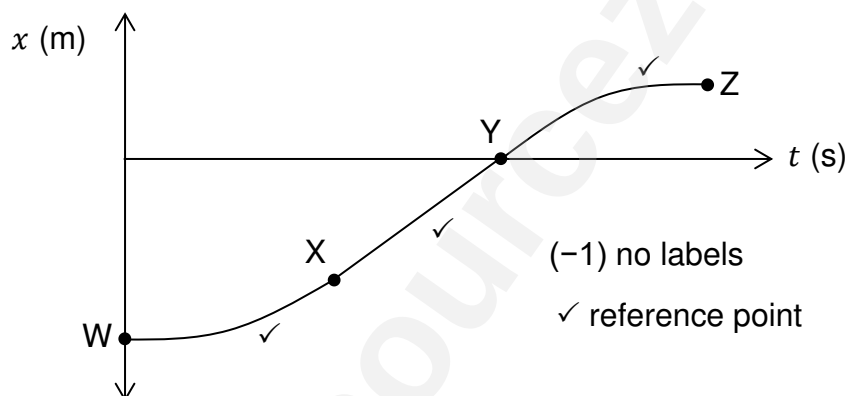
2.2.2 $\ell = \Delta x(0 - 7 \text{ s}) = \text{area}$ ✓

$$\ell = \frac{1}{2}(4)(+2) \checkmark + (3)(+2) \checkmark$$

$$\ell = 10 \text{ m} \checkmark$$

(4)

2.3



(4)

2.4 Take toward Y as positive.

Arya:

$$v_i = +3$$

$$v_f = +3$$

$$a = 0$$

$$\Delta x = +(15 - x)$$

$$\Delta t = t$$

$$\Delta x = v_i \Delta t$$

$$+(15 - x) \checkmark = (+3)t \checkmark$$

$$t = 4,32 \text{ s} \checkmark$$

Jemma:

$$v_i = 0$$

$$v_f =$$

$$a = -0,22$$

$$\Delta x = -x$$

$$\Delta t = t$$

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

$$(-x) \checkmark = 0 + \frac{1}{2} (-0,22)t^2 \checkmark$$

(6)

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QUESTION 3

3.1 The distance measured from a reference point ✓ with direction ✓. (2)

3.2 Ground ✓ (1)

3.3 25 s ✓ (1)

3.4 For the motion from A to B:

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark$$

$$\Delta x = \left(\frac{(0) + (+30)}{2} \right) (15) \quad \checkmark \checkmark$$

$$\Delta x = 225 \text{ m}$$

For the motion from B to C:

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$\Delta x = \left(\frac{(+30) + (0)}{2} \right) (10) \quad \checkmark \checkmark$$

$$\Delta x = 150 \text{ m}$$

$$h = 375 \text{ m} \quad \checkmark \quad (6)$$

3.5 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2 \quad \checkmark$

$$(-300) = 0 + \frac{1}{2} (-9,8) \Delta t^2 \quad \checkmark \checkmark$$

$$\Delta t = 7,82 \text{ s} \quad \checkmark \quad (4)$$

3.6 $v_f^2 = v_i^2 + 2a\Delta x \quad \checkmark$

$$v_f^2 = (0)^2 + 2(-9,8)(-300) \quad \checkmark \checkmark$$

$$v_f = 76,68 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ down} \quad \checkmark \quad (5)$$

3.7

3.7.1 • Moves downward ✓

• Slows down ✓

• Accelerates upward ✓ (3)

3.7.2 When object A exerts a force on object B, object B simultaneously exerts a force on object A that is equal in magnitude and opposite in direction. ✓✓ (2)

3.7.3 • According to Newton's third law

• as the engine exerts a downward force on the exhaust gases ✓

• the exhaust gases exert an upward force of equal magnitude on the engine (and thus Grasshopper) ✓

• Which is the cause of the thrust ✓ (3)

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QUESTION 4

- 4.1 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. ✓✓ (2)
- 4.2 Horizontally right **applied force** ✓
Vertically down **weight** ✓
Friction down the slope ✓
Normal force perpendicularly away from slope ✓ (4)
- 4.3 35° ✓ (1)
- 4.4 4.4.1 The perpendicular force ✓ exerted by a surface on an object in contact with it. ✓ (2)
- 4.4.2 $F_{app\perp} = 25 \sin 35$ ✓
 $F_{app\perp} = 14,34 \text{ N}$ ✓ (2)
- 4.4.3 $F_N = F_{g\perp} + F_{app\perp}$ ✓
 $F_N = (1,5 \times 9,8 \times \cos 35) + (14,34)$ ✓✓
 $F_N = 26,38 \text{ N}$ ✓ (4)
- 4.5 $F_f + F_{g\parallel} = F_{app\parallel}$
 $F_f = (25 \cos 35) - (1,5 \times 9,8 \times \sin 35)$ ✓
 $F_f = 12,05 \text{ N}$ ✓ **down the slope** ✓ (4)
- 4.6 $F_{fs}^{\max} = \mu_s F_N$ ✓
 $F_{fs}^{\max} = (0,75) (1,5 \times 9,8 \times \cos 35)$ ✓
 $F_{fs}^{\max} = 9,05 \text{ N}$ ✓
 $F_{g\parallel} = 8,43 < F_{fs}^{\max}$ so **block will not move** ✓ (5)

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QUESTION 5

5.1 5.1.1 The work done by a net force on an object ✓ is equal to the change in the kinetic energy of the object ✓. (2)

$$\begin{aligned}
 5.1.2 \quad W_{net} &= \Delta E_K \quad \checkmark \\
 W_{app} + W_g + W_f &= \Delta E_K \\
 W_{app} + F_g \Delta x \cos \theta + F_f \Delta x \cos \theta &= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \\
 W_{app} + (80 \times 9,8)(25) \cos(110) \checkmark + (70)(25) \cos(180) \checkmark &= \frac{1}{2} (80)(5)^2 - \frac{1}{2} (80)(2)^2 \checkmark \checkmark \\
 \mathbf{W_{app} = 9\,293,59\,J} \quad \checkmark & \quad (6)
 \end{aligned}$$

$$\begin{aligned}
 5.1.3 \quad W_{app} &= F_{app} \Delta x \cos \theta \quad \checkmark \\
 (9293,59) &= F_{app} (25) \cos 30 \quad \checkmark \checkmark \\
 \mathbf{F_{app} = 429,25\,N} \quad \checkmark & \quad (4)
 \end{aligned}$$

5.2 5.2.1 The rate ✓ at which work is done (OR energy transferred) ✓. (2)

$$\begin{aligned}
 5.2.2 \quad P &= \frac{W}{\Delta t} \quad \checkmark \\
 P &= \frac{(9293,59)}{(7,14)} \quad \checkmark \checkmark \\
 \mathbf{P = 1\,301,62\,W} \quad \checkmark & \quad (4)
 \end{aligned}$$

$$\begin{aligned}
 5.2.3 \quad \% \text{ efficiency} &= \frac{P_{out}}{P_{in}} \times 100 \\
 \% \text{ efficiency} &= \frac{(1301,62)}{(2000)} \times 100 \quad \checkmark \checkmark (\text{conv}) \\
 \% \text{ efficiency} &= \mathbf{65,08\, \%} \quad \checkmark \quad (3) \\
 & \quad \mathbf{[21]}
 \end{aligned}$$

QUESTION 6

6.1 The force per unit positive charge. ✓✓ (2)

6.2 $E_M = \frac{kQ_M}{r^2}$ ✓
 $E_M = \frac{(9 \times 10^9)(4 \times 10^{-9})}{(15 \times 10^{-3})^2}$ ✓✓
 $E_M = 1,6 \times 10^5 \text{ N} \cdot \text{C}^{-1}$ ✓ **east** ✓ (5)

6.3 Take east as positive.
 $\vec{E}_{net} = \vec{E}_M + \vec{E}_N$ ✓
 $(+2 \times 10^5) = (+1,6 \times 10^5) + \vec{E}_N$ ✓
 $\vec{E}_N = 4 \times 10^4 \text{ N} \cdot \text{C}^{-1}$

$E_N = \frac{kQ_N}{r^2}$
 $(4 \times 10^4) = \frac{(9 \times 10^9)Q_N}{(45 \times 10^{-3})^2}$ ✓✓
 $Q_N = 9 \times 10^{-9} \text{ C}$ ✓ (5)

6.4 Negative ✓ (1)

6.5 $E_{net} = \frac{F_{net}}{q}$ ✓
 $(2 \times 10^5) = \frac{F_{net}}{(1,6 \times 10^{-19})}$ ✓
 $F_{net} = 3,2 \times 10^{14} \text{ N}$ ✓ **west** ✓ (4)
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QUESTION 7

7.1 The total energy supplied per coulomb of charge by the cell. ✓✓ (2)

7.2 $I_T = \frac{V_2}{R_3}$ ✓
 $I_T = \frac{(15)}{(1,5)}$ ✓
 $I_T = 10 \text{ A}$ ✓ (3)

7.3 $V_1 = V_T = emf - I_T r$ ✓
 $V_1 = (35) - (10)(0,3)$ ✓✓
 $V_1 = 32 \text{ V}$ ✓ (4)

7.4 A material's opposition to the flow of electric current. ✓✓ (2)

7.5 $V_{||} = V_T - V_2$
 $V_{||} = (32) - (15)$ ✓
 $V_{||} = 17 \text{ V}$ ✓
 $R_{||} = \frac{V_{||}}{I_T}$
 $R_{||} = \frac{(17)}{(10)}$ ✓
 $R_{||} = 1,7 \Omega$ ✓
 $\frac{1}{R_{||}} = \frac{1}{R_1} + \frac{1}{R_2}$
 $\frac{1}{(1,7)} = \frac{1}{R_1} + \frac{1}{(8)}$ ✓
 $R_1 = 2,16 \Omega$ ✓ (6)

7.6 $I_2 = \frac{V_{||}}{R_2}$
 $I_2 = \frac{(17)}{(8)}$ ✓✓
 $I_2 = 2,13 \text{ A}$ ✓ (3)

7.7 $P_r = I_T^2 r$ ✓
 $P_r = (10)^2 (0,3)$ ✓✓
 $P_r = 30 \text{ W}$ ✓ (4)

7.8 7.8.1 Decrease ✓✓ (2)

7.8.2 • From the equation $V_2 = I_T R_3$ we get $V_2 \propto I_T$ ✓ as R_3 is constant ✓
 • The current has decreased
 • So, V_2 also decreases ✓ (3)

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QUESTION 8

8.1 A representation of the magnitude and direction of the magnetic field. ✓✓ (2)

8.2

8.2.1 • As the rod is pulled to the left, the area of the loop exposed to the magnetic field decreases (changes) ✓
 • This causes the magnetic flux through the loop to decrease (change) ✓
 • According to Faraday's law ✓
 • This change in magnetic flux causes an emf to be induced ✓
 • Because, the loop is closed (closed circuit), this emf causes a current to be induced ✓ (5)

8.2.2 Out of the page ✓✓ (2)

8.2.3 Up ✓✓ (2)

8.3 $3I$ ✓✓ (2)

8.4 $\frac{1}{4}I$ ✓✓ (2)

8.5

8.5.1 The motor effect ✓ (1)

8.5.2 Left ✓✓ (2)

8.5.3 Out of the page ✓✓ (2)

[20]

QUESTION 9

9.1

9.1.1 $E = (-1,51) - (-13,6) \checkmark$

$E = 12,09 \text{ eV} \checkmark$

$E = 1,93 \times 10^{-18} \text{ J} \checkmark$

(3)

9.1.2 $E = \frac{hc}{\lambda} \checkmark$

$(1,93 \times 10^{-18}) = \frac{(6,6 \times 10^{-34})(3 \times 10^8)}{\lambda} \checkmark \checkmark$

$\lambda = 102,59 \text{ nm} \checkmark$

(4)

9.2

9.2.1 The minimum amount of energy needed to emit an electron from the surface of a metal. $\checkmark \checkmark$

(2)

9.2.2 $E = W_0 + E_K^{\text{max}} \checkmark$

$hf = W_0 + \frac{1}{2}mv_{\text{max}}^2 \checkmark$

$(6,6 \times 10^{-34})(1,2 \times 10^{15}) \checkmark = (6,9 \times 10^{-19}) \checkmark + \frac{1}{2}(3,1 \times 10^{-31})v_{\text{max}}^2 \checkmark$

$v_{\text{max}} = 8,11 \times 10^5 \text{ m} \cdot \text{s}^{-1} \checkmark$

(6)

9.2.3 Increase $\checkmark$

(1)

[16]**Total: 200 marks**