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Western Cape
Government
Education

WCED Metro Central Common Paper

Physical Sciences Paper 1

September 2016

MARKING MEMORANDUM

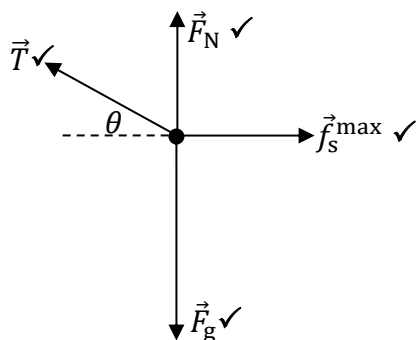
QUESTION 1

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

[20]

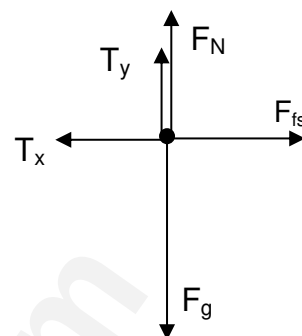
QUESTION 2

2.1



1 mark per arrow and label
subtract 1 mark for each of the following errors:

- no dot shown
- T shown with its components (unless components in dashed lines)



(4)

- 2.2 When a resultant (net) force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force ✓ and inversely proportional to the mass ✓ of the object.

OR

The resultant/net force acting on an object is equal to the rate of change of momentum of the object ✓✓ in the direction of the resultant/net force. (2 or 0)

(2)

- 2.3 $f_s^{\max} = \mu_s F_N$ ✓
 $120 = (0,34)F_N$ ✓
 $F_N = 352,9412 \text{ N}$

Vertical forces; taking up as positive

$$\vec{F}_{\text{net},y} = 0$$

$$\vec{T}_y + \vec{F}_N + \vec{F}_g = 0 \quad \checkmark$$

$$T_y + F_N - mg = 0$$

$$T_y + 352,9412 \checkmark - (50)(9,8) \checkmark = 0$$

$$T_y = 137,06 \text{ N}$$

.....(A)

(5)

- 2.4 Horizontal forces; taking left as positive

$$\vec{F}_{\text{net},x} = 0$$

$$\vec{T}_x + \vec{f}_s^{\max} = 0 \quad \checkmark$$

$$T_x - 120 = 0$$

$$T_x = 120 \text{ N} \quad \checkmark$$

..... (B)

(A) / (B):

$$\tan \theta = \frac{137,06 \dots}{120}$$

$$= 1,14215 \dots$$

$$\theta = 48,80^\circ \quad \checkmark$$

Sub into (B)

$$T \cos(48,8^\circ) = 120$$

$$T = 182,18 \text{ N} \quad \checkmark$$

OR

Subst into (A)

$$T \sin(48,8^\circ) = 137,06$$

$$T = 182,16 \text{ N}$$

(4)

- 2.5.1 DECREASES ✓

(1)

- 2.5.2 From: $T_y = T \sin \theta$. The angle (θ) increases ✓, so the vertical component of the tensional force (T_y) will increase ✓. OR

$$\text{From: } F_N + T_y = F_g$$

$$\theta \text{ increases / } T_y \text{ increases} \quad \checkmark$$

The parcel will not push as hard into the table surface ✓ so the normal force will decrease in magnitude. (2)

[18]

QUESTION 3

3.1

$$\vec{v}_f = \vec{v}_i + \vec{a}\Delta t \quad \checkmark$$

$$0 = \vec{v}_i + (-9,8)(0,6) \quad \checkmark$$

$$\vec{v}_i = 5,88 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ up}$$

+ ve

(3)

3.2

$$E_{k,\text{after/leaving}} = \frac{1}{2}mv_f^2 \quad \checkmark$$

$$= \frac{1}{2}(0,05)(5,88)^2 \quad \checkmark$$

$$= 0,8644 \text{ J}$$

5% energy loss so this represents 95% of the energy after the bounce.

$$\therefore E_{k,\text{before}} = 0,8644 \times \frac{100}{95} \quad \checkmark$$

$$= 0,90989 \dots \text{ J}$$

$$\approx 0,91 \text{ J} \quad \checkmark$$

+ ve

(4)

3.3

$$(E_p + E_k)_{\text{TOP}} = (E_p + E_k)_{\text{BOTTOM}} \quad \checkmark$$

$$[mgh + \frac{1}{2}(0,05)(3)^2]_{\text{top}} = (0 + 0,91) \quad \checkmark \text{ (all subst)}$$

$$h = 0,685 / (0,05)(9,8)$$

$$= 1,398 \text{ m} = (0,4 \text{ m}) \quad \checkmark$$

OR

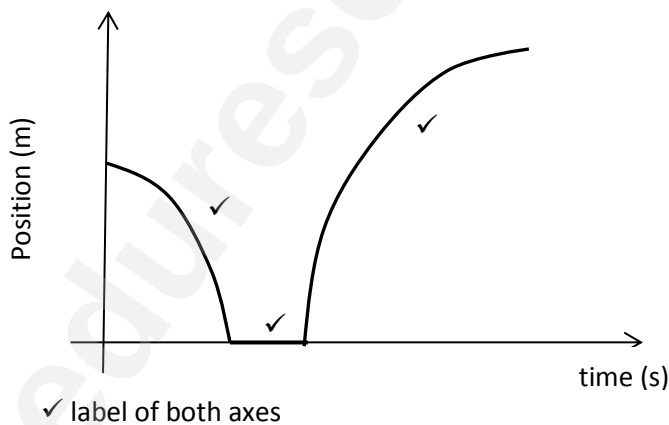
Work Energy Theorem

OR

$$W_{nc} = \Delta E_p + \Delta E_k$$

(3)

3.4



(4)

[14]

QUESTION 4

- 4.1 The total linear momentum ✓ of an isolated (closed) system remains constant ✓ (is conserved). **OR**
In an isolated system ✓ The total linear momentum before collision equals the total linear momentum after collision. ✓ (2)

4.2 Linear momentum conservation:

Take "towards Orion" as the positive direction:

$$\sum \vec{p}_i = \sum \vec{p}_f \quad \checkmark$$

$$M\vec{v}_i = m_A\vec{v}_{A,f} + m_B\vec{v}_{B,f}$$

$$(3,6 \times 10^{19})(5) \checkmark = m_A(8) \checkmark + (3,6 \times 10^{19} - m_A) \checkmark (-2) \checkmark$$

$$10 m_A = 1,8 \times 10^{20} + 7,2 \times 10^{19}$$

$$m_A = 2,52 \times 10^{19} \text{ kg}$$

Take "towards Orion" as the positive direction:

$$\sum \vec{p}_i = \sum \vec{p}_f \quad \checkmark$$

$$M\vec{v}_i = m_A\vec{v}_{A,f} + m_B\vec{v}_{B,f}$$

$$(3,6 \times 10^{19})(5) \checkmark = m_A(8) + m_B(-2) \checkmark$$

$$1,8 \times 10^{20} + 2m_B = 8m_A$$

$$m_A = 2,25 \times 10^{19} + 0,25m_B \quad \text{(A)}$$

Mass conservation:

$$m_A + m_B = M$$

$$m_A + m_B = 3,6 \times 10^{19} \text{ kg} \checkmark \quad \text{(B)}$$

sub (A) into (B):

$$2,25 \times 10^{19} + 0,25m_B + m_B = 3,6 \times 10^{19} \text{ kg}$$

$$1,25m_B = 1,35 \times 10^{19} \text{ kg}$$

$$m_B = 1,08 \times 10^{19} \text{ kg}$$

sub m_B into (B):

$$m_A + 1,08 \times 10^{19} = 3,60 \times 10^{19} \quad \checkmark$$

$$m_A = 2,52 \times 10^{19} \text{ kg}$$

Take "towards Orion" as the positive direction:

$$\sum \vec{p}_i = \sum \vec{p}_f \quad \checkmark$$

$$M\vec{v}_i = m_A\vec{v}_{A,f} + m_B\vec{v}_{B,f}$$

$$(3,6 \times 10^{19})(5) \checkmark$$

$$= m_A(8) + m_B(-2) \checkmark$$

$$1,8 \times 10^{20} + 2m_B = 8m_A$$

$$m_B = 4 m_A - 9 \times 10^{19} \quad \text{(A)}$$

Mass conservation:

$$m_A + m_B = M$$

$$m_A + m_B = 3,6 \times 10^{19} \text{ kg} \quad \checkmark \quad \text{(B)}$$

sub (A) into (B):

$$m_A + 4 m_A - 9 \times 10^{19} = 3,6 \times 10^{19}$$

$$5 m_A = 3,6 \times 10^{19} + 9 \times 10^{19} \quad \checkmark$$

$$m_A = 2,52 \times 10^{19} \text{ kg}$$

4.3

Take "towards Orion" as the positive direction:

$$\vec{F}_{\text{net}} \Delta t = \Delta \vec{p} \quad \checkmark$$

$$= m(\vec{v}_f - \vec{v}_i)$$

$$= (2,52 \times 10^{19})(8 - 5) \quad \checkmark$$

$$= 7,56 \times 10^{19} \text{ N} \cdot \text{s} / \text{kg} \cdot \text{m} \cdot \text{s}^{-1} \text{ towards Orion} \quad \checkmark \quad \text{(magnitude + direction)} \quad (3)$$

4.4

$$F_g = \frac{G m_A m_B}{r^2} \quad \checkmark$$

$$3,6 \times 10^{19} - (2,52 \times 10^{19})$$

$$= \frac{(6,67 \times 10^{-11})(2,52 \times 10^{19})(1,08 \times 10^{19}) \checkmark}{(150 \times 10^3)^2 \checkmark}$$

$$= 8,07 \times 10^{17} \text{ N} \quad \checkmark$$

(5)

(3)

(4)

[15]

QUESTION 5

- 5.1 The net (total) work done on an object ✓ is equal to the change in the object's kinetic energy. ✓ **OR**
The work done on an object by a net (resultant) force ✓ is equal to the change in the object's kinetic energy. ✓

(2)

$$\begin{aligned}
 5.2 \quad W_g &= F_g \Delta y \cos \theta \quad \checkmark \\
 &= mg \Delta y \cos \theta \\
 &= (75)(9,8)(2,4 - 1,6) \checkmark \cos 0^\circ \checkmark \\
 &= 588 \text{ J} \checkmark
 \end{aligned}$$

OR

work due to a conservative forces is equal to negative change in potential energy associated with that conservative force:

$$\begin{aligned}
 W_c &= -\Delta E_p \\
 W_g &= -mg(h_f - h_i) \quad \checkmark \\
 &= -(75)(9,8) \checkmark (1,6 - 2,4) \checkmark \\
 &= 588 \text{ J} \checkmark
 \end{aligned}$$

(4)

5.3

$$\begin{aligned}
 &W_{\text{net}} = \Delta E_k \\
 &W_f + W_g \checkmark = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \checkmark \\
 &W_f + 588 \checkmark = \frac{1}{2}(75)(3,75^2 \checkmark - 0^2 \checkmark) \\
 &W_f = -60,66 \text{ J} \quad \checkmark
 \end{aligned}$$

OR

$$\begin{aligned}
 &W_{\text{nc}} = \Delta E_p + \Delta E_k \quad \checkmark \\
 &W_f = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2) \quad \checkmark \\
 &= (75)(9,8) \checkmark ((1,6 - 2,4)) \checkmark + \frac{1}{2}(75)((3,75^2 \checkmark - 0^2) \checkmark) \checkmark \\
 &= -60,66 \text{ J} \quad \checkmark
 \end{aligned}$$

(6)

- 5.4.1 REMAINS THE SAME ✓

(1)

- 5.4.2 The gravitational force is conservative (non-contact) force ✓, so the work done by the gravitational force will not depend on the path taken. ✓ The starting and ending points are the same. Therefore the work done by the gravitational force will remain the same.

(2)

[15]

QUESTION 6

6.1.1 The apparent change in frequency in sound heard due to the relative motion between listener and/or source. ✓✓ (2)

$$6.1.2 \quad f_L = \left(\frac{v \pm v_L}{v \pm v_S} \right) f_S \quad \checkmark$$

$$\therefore 0,93 \times f_S \checkmark = \left(\frac{335-0}{335+v_S} \right) f_S \quad \checkmark$$

$$\therefore 0,93(335 + v_S) = 335$$

$$\therefore 0,93v_S = 335 - 0,93 \times 335$$

$$\therefore v_S = \frac{0,07 \times 335}{0,93} = 25,22 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \quad (4)$$

6.2.1 Absorption (line spectrum) ✓ (1)

6.2.2 Red-shift ✓ (1)

6.2.3 Away from ✓ (1)

[9]

QUESTION 7

7.1 The force of attraction or repulsion between two charges is directly proportional to the product of their charges ✓ and inversely proportional to the square of the distance between them/ their centres. ✓ (2)

7.2 $F_{J \text{ on } K} = \frac{kQ_J Q_K}{r^2}$ ✓
 $= \frac{9 \times 10^9 \times 4 \times 10^{-6} \times 2 \times 10^{-6}}{(0,05)^2}$ ✓
 $= 28,8 \text{ N}$ + ve (4)



7.4 **MAGNITUDE:**
 $F_R^2 = (F_{J \text{ on } K})^2 + (F_{L \text{ on } K})^2$ ✓
 $\therefore F_R = \sqrt{28,8^2 + \left(\frac{1}{2} \times 28,8\right)^2}$ ✓
 $= 32,20 \text{ N}$ ✓

DIRECTION
 $\tan \alpha = 2,$
 $\therefore \alpha = 63,43^\circ$ ✓ Angle (show tan or other method) / BEARING $206,57^\circ$ (4)

7.5 The electric field at a point is the electrostatic force experienced per unit positive charge ✓ placed at that point. ✓ (2)

7.6 $E = \frac{F}{q}$ ✓
 $= \frac{32,20}{2 \times 10^{-6}}$ ✓
 $= 1,61 \times 10^7 \text{ N} \cdot \text{C}^{-1}$ ✓ (3)

[18]

QUESTION 8

- 8.1 emf ✓ (1)
- 8.2 Load voltage OR external voltage OR terminal voltage ✓ (1)
- 8.3 $V = IR$ ✓
 $\therefore r = \frac{V_{\text{int}}}{I} = \frac{0,9}{4,5}$ ✓
 $= 0,2 \Omega$ ✓ (3)
- 8.4 3Ω ✓
same V ✓ over each resistor and I is inversely proportional to R ✓ (3)
- 8.5 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ ✓
 $= \frac{1}{4} + \frac{1}{3} + \frac{1}{4}$ ✓ $= \frac{3+4+3}{12} = \frac{10}{12}$
 $\therefore R_p = \frac{12}{10} = 1,2 \Omega$ ✓
- $R_{\text{TOTAL}} = \frac{\varepsilon}{I} = \frac{18}{4,5} = 4 \Omega$ ✓
 $R_{\text{TOTAL}} = R + R_p + r$
 $\therefore 4 = R + 1,2 + 0,2$ ✓
 $\therefore R = 2,6 \Omega$ ✓
- $V_p = I_p R_p$
 $= (4,5)(1,2)$ ✓
 $= 5,4 \text{ V}$ ✓
- $R = V/I = 11,7 / 4,5 = 2,6 \Omega$ ✓ (7)
- 8.6 Temperature ✓ (1)
- 8.7 R_p increases when S_2 is opened
 so R_{cir} increases ✓
 so I_{cir} / current strength through ammeter decreases ✓
 so $V_{\text{int}} (= Ir)$ decreases (r constant) ✓
 so V_{ext} increases ($V_{\text{ext}} = \varepsilon - V_{\text{int}}$) ✓ (4)
- [20]

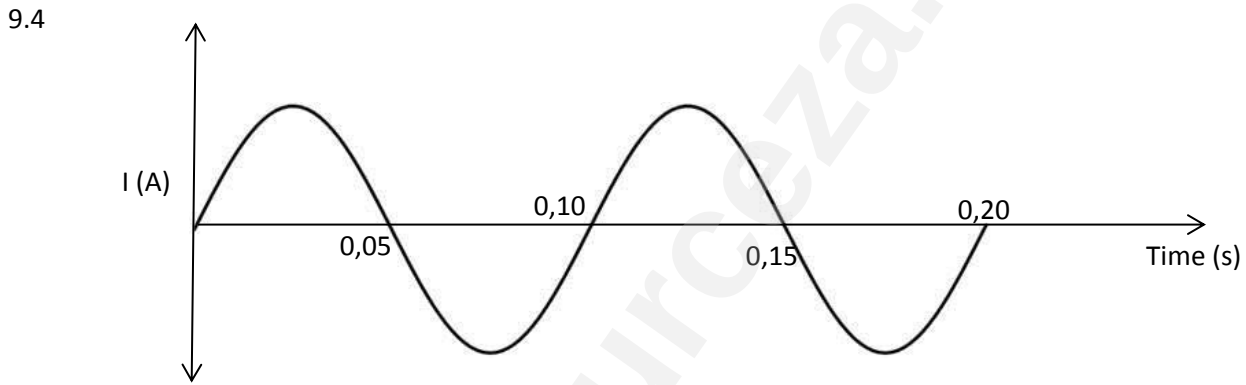
QUESTION 9

9.1 0,10 s ✓ (1)

$$\begin{aligned}
 9.2 \quad V_{\text{rms}} &= \frac{V_{\text{max}}}{\sqrt{2}} \\
 &= \frac{84,8}{\sqrt{2}} \\
 &= 60 \text{ V}
 \end{aligned}
 \quad (2)$$

$$\begin{aligned}
 9.3.1 \quad P_{\text{avg}} &= V_{\text{rms}}^2 \\
 \therefore 40 &= \frac{100^2}{R} \\
 \therefore R &= 250 \, \Omega
 \end{aligned}
 \quad (3)$$

9.3.2 TOO DIM ✓
 V_{rms} for bulb = 100 V
 BUT V_{rms} of generator = 60 V. ✓ (2)



(2)
[10]

QUESTION 10

10.1 Planck's constant ✓ (1)

10.2 *Threshold frequency* (f_0) is the minimum frequency of light ✓ needed to emit (eject) electrons ✓ from the surface of a certain metal / material. (2)

10.3

$$\begin{aligned}
 W_0 &= hf_0 \checkmark \\
 &= (6,63 \times 10^{-34})(1,4 \times 10^{15}) \checkmark \\
 &= 9,282 \times 10^{-19} \text{ J}
 \end{aligned}$$

(3)

10.4.1 The greater brightness would:
- increase the number ✓ of photoelectrons

10.4.2 - but would have no effect on their kinetic energies / Remain the same ✓ (2)

10.5

$$\begin{aligned}
 E_{k,\max,E} &= \frac{1}{2} m_e v_{\max,E}^2 \checkmark \\
 2,4 \times 10^{-18} \checkmark &= \frac{1}{2} (9,11 \times 10^{-31}) \checkmark v_{\max,E}^2 \\
 v_{\max,E} &= 2,3 \times 10^6 \text{ m} \cdot \text{s}^{-1} \checkmark
 \end{aligned}$$

OR

$$\begin{aligned}
 E &= W_0 + E_k \\
 E_k &= E - W_0 \\
 \frac{1}{2} m v^2 &= hf - W_0 \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \\
 \frac{1}{2} (9,11 \times 10^{-31}) v^2 \checkmark &= (6,63 \times 10^{-34})(5 \times 10^{15}) - (9,282 \times 10^{-19}) \checkmark \\
 v &= 2,29 \times 10^6 \text{ m} \cdot \text{s}^{-1} \checkmark
 \end{aligned}$$

OR

Learners can calc the gradient of the graph which = $6,67 \times 10^{-34}$ and then use above method.

(4)
[12]