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 ✓✓

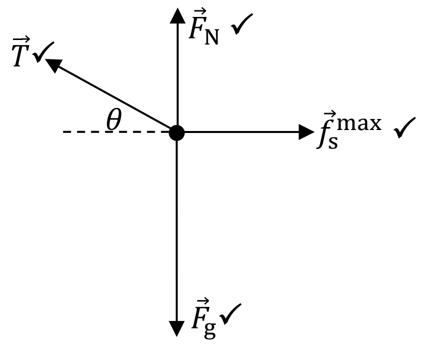
1.9 D ✓✓

1.10 C ✓✓

**[20]**

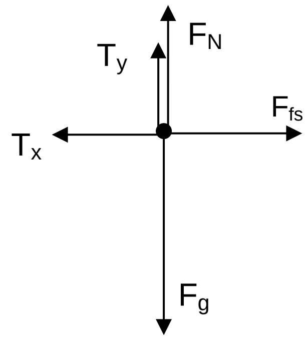
**QUESTION 2**

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 <u>resultant (net) force</u> acts on an object, the object will accelerate in the direction of the force. <u>This acceleration is directly proportional to the force</u> ✓ and <u>inversely proportional to the mass</u> ✓ of the object.

**OR**

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

(2)

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

Vertical forces; taking up as positive
$\vec{F}_{net,y} = 0$
$\vec{T}_y + \vec{F}_N + \vec{F}_g = 0$ ✓
$T_y + F_N - mg = 0$
$T_y + 352{,}9412$ ✓ $- (50)(9{,}8)$ ✓ $= 0$
$T_y = 137{,}06\ N$ ………**(A)** (5)

2.4 Horizontal forces; taking left as positive
$\vec{F}_{net,x} = 0$
$\vec{T}_x + \vec{f}_s^{max} = 0$ ✓
$Tx - 120 = 0$
$Tx = 120\ N$ ✓ ……….. **(B)**

**(A) / (B):**

$\tan\theta = \frac{137{,}06\ldots}{120}$
$= 1{,}14215\ldots$
$\theta = 48{,}80°$ ✓

**Sub into (B)**
$T\cos(48{,}8°) = 120$
$T = 182{,}18\ N$ ✓

**OR**

**Subst into (A)**
$T\sin(48{,}8°) = 137{,}06$
$T = 182{,}16\ N$ (4)

2.5.1 DECREASES ✓ (1)

2.5.2 From: $T_y = T\sin\theta$ . The angle <u>$(\theta)$ increases</u> ✓, so the vertical component of the tensional force <u>$(T_y)$ will increase</u> ✓. **OR**
From: $F_N + T_y = F_g$
θ increases/ $T_y$ increases ✓
<u>The parcel will not push as hard into the table surface</u> ✓ so the normal force will decrease in magnitude. (2)

**[18]**

**QUESTION 3**

3.1

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

$0 = \vec{v}_i + (-9{,}8)(0{,}6)$ ✓

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

+ ve (3)

3.2

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

$= \frac{1}{2}(0{,}05)(5{,}88)^2$ ✓

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

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

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

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

+ ve $\approx 0{,}91\ \text{J}$ ✓ (4)

3.3

$(E_P + E_K)_{TOP} = (E_P + E_K)_{BOTTOM}$ ✓

$[mgh + ½(0{,}05)(3)^2]_{top} = (0 + 0{,}91)$ ✓ (all subst)

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

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

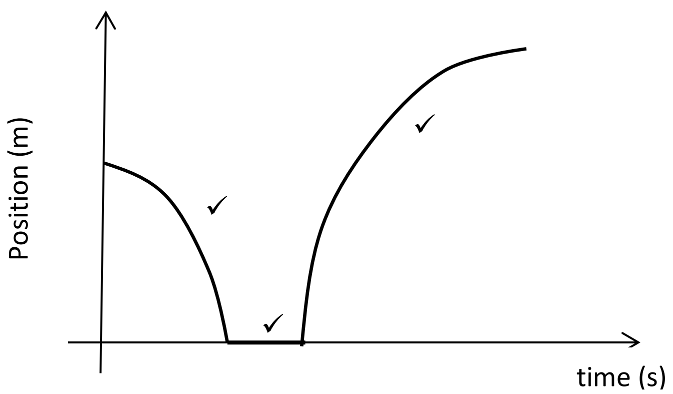
**OR**

Work Energy Theorem

**OR**

$W_{nc} = \Delta E_p + \Delta E_k$ (3)

3.4




✓ label of both axes

(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 moment after collision. ✓ (2)

4.2 **Linear momentum conservation:**

Take "towards Orion" as the positive direction:

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

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

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

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

Take "towards Orion" as the positive direction:

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

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

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

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

**Mass conservation:**

$m_A + m_B = M$

$m_A + m_B = 3,6 \times 10^{19}$ kg✓ **(B)**

**sub (A) into (B):**

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

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

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

**sub $m_B$ into (B):**

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

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

Take "towards Orion" as the positive direction:

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

$(3,6 \times 10^{19})(5)$✓

$= m_A(8) + m_B(-2)$✓

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

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

**Mass conservation:**

$m_A + m_B = M$

$m_A + m_B = 3,6 \times 10^{19}$ kg ✓ **(B)**

**sub (A) into (B):**

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

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

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

(5)

4.3 Take "towards Orion" as the positive direction:

$\vec{F}_{net}\Delta t = \Delta\vec{p}$ ✓

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

$= (2,52 \times 10^{19})(8 - 5)$ ✓

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

4.4 $F_g = \frac{Gm_Am_B}{r^2}$ ✓

$= \frac{(6,67\times10^{-11})(2,52\times10^{19})(1,08\times10^{19})✓}{(150\times10^3)^2 ✓}$

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

$= 8,07 \times 10^{17}$ N ✓

(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)

5.2 $W_g = F_g \Delta y \cos\theta$ ✓
$= mg\Delta y \cos\theta$
$= (75)(9{,}8)(2{,}4 - 1{,}6)$ ✓ $\cos 0°$ ✓
$= 588 \text{ J}$ ✓

***OR***

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

$W_c = -\Delta E_p$
$W_g = -mg(h_f - h_i)$ ✓
$= -(75)(9{,}8)$ ✓ $(1{,}6 - 2{,}4)$ ✓
$= 588 \text{ J}$ ✓

(4)

5.3

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

***OR***

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

(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 $f_L = (\frac{v \pm v_L}{v \pm v_S}) f_S$ ✓

$\therefore 0{,}93 \text{ x } f_s$ ✓ $= (\frac{335-0}{335+v_S}) f_S$ ✓

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

$\therefore 0{,}93 v_S = 335 - 0{,}93 \text{ x } 335$

$\therefore v_S = \frac{0{,}07 \text{ x } 335}{0{,}93} = 25{,}22 \text{ m·s}^{-1}$ ✓ (4)

6.2.1 Absorption (line spectrum) ✓ (1)

6.2.2 Red-shift ✓ (1)

6.2.3 Away from ✓ (1)

**[9]**

**QUESTION 7**

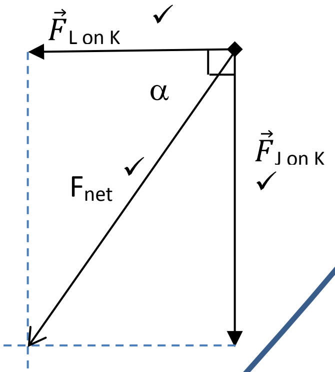
7.1 The force of attraction or repulsion between two charges is directly proportional to the product of their charges ✓ and inversely proportional to the square of the distance between them/ their centres.✓ (2)

7.2 $F_{J\,on\,K} = \frac{kQ_JQ_K}{r^2}$ ✓

$= \frac{9 \times 10^9 \times 4 \times 10^{-6} \times 2 \times 10^{-6}}{(0,05)^2}$ ✓

$= 28,8\ N$ ✓ + ve (4)

7.3




(3)

7.4 **MAGNITUDE:**

$F_R^2 = (F_{J\,on\,K})^2 + (F_{L\,on\,K})^2$ ✓

$\therefore F_R = \sqrt{28,8^2 + \left(\frac{1}{2} x\ 28,8\right)^2}$ ✓

$= 32,20\ N$ ✓

**DIRECTION**

tan α = 2,

∴ α = 63,43° ✓Angle (show tan or other method) / BEARING 206,57°

(4)

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

+ ve

7.6 $E = \frac{F}{q}$ ✓

$= \frac{32,20}{2 \times 10^{-6}}$ ✓

$= 1,61 \times 10^7\ N \cdot C^{-1}$ ✓ (3)

**[18]**

**QUESTION 8**

8.1 emf ✓ (1)

8.2 Load voltage OR external voltage OR terminal voltage ✓ (1)

8.3 $V = IR$ ✓

$\therefore r = \frac{V_{int}}{I} = \frac{0{,}9}{4{,}5}$ ✓

$= 0{,}2\ \Omega$ ✓ (3)

8.4 3 Ω ✓

same V ✓ over each resistor and I is inversely proportional to R ✓ (3)

8.5 $\frac{1}{R_P} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$ ✓

$= \frac{1}{4} + \frac{1}{3} + \frac{1}{4}$ ✓ $= \frac{3+4+3}{12} = \frac{10}{12}$

$\therefore R_P = \frac{12}{10} = 1{,}2\ \Omega$ ✓

$R_{TOTAL} = \frac{\varepsilon}{I} = \frac{18}{4{,}5}$ ✓ $= 4\ \Omega$ ✓

$R_{TOTAL} = R + R_P + r$

$\therefore 4 = R + 1{,}2 + 0{,}2$ ✓

$\therefore R = 2{,}6\ \Omega$ ✓

OR

$V_P = I_P R_P$

$= (4{,}5)(1{,}2)$ ✓

$= 5{,}4\ V$ ✓

18 – (0,9 + 5,4) ✓

R = V/I = 11,7/ 4,5 = 2,6 Ω ✓ (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 $V_{int}$ (= Ir) decreases (r constant) ✓

so $V_{ext}$ increases ($V_{ext} = \varepsilon - V_{int}$) ✓ (4)

**[20]**

**QUESTION 9**

9.1 0,10 s ✓ (1)

9.2 $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$

$= \frac{84,8}{\sqrt{2}}$

$= 60\text{ V}$ (2)

9.3.1 $P_{\text{avg}} = V_{\text{rms}}^{\ 2}$

$\therefore 40 = \frac{100^2}{R}$

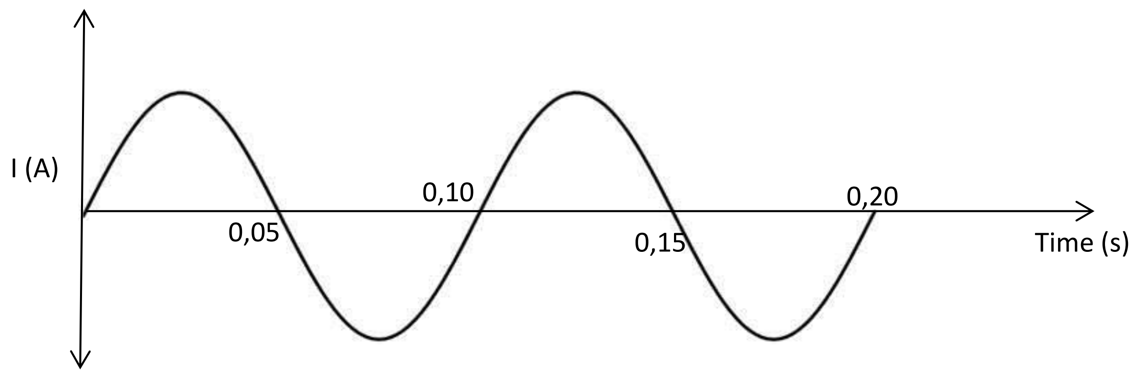
$\therefore R = 250\ \Omega$ (3)

9.3.2 TOO DIM✓

$V_{rms}$ for bulb = 100 V

BUT $V_{rms}$ of generator – 60 V. ✓ (2)

9.4




(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

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

(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

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

OR

$$E = W_o + E_k$$
$$E_k = E - W_o$$
$$\tfrac{1}{2} mv^2 = hf - W_o \quad ✓$$
$$\tfrac{1}{2}(9{,}11 \times 10^{-31})\ v^2\ ✓ = (6{,}63 \times 10^{-34})(5 \times 10^{15}) - (9{,}282 \times 10^{-19})\ ✓$$
$$v = 2{,}29 \times 10^6\ \text{m}\cdot\text{s}^{-1}\ ✓$$

OR

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

(4)

**[12]**