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Education

## METRO CENTRAL EDUCATION DISTRICT

## GRADE 12

PHYSICAL SCIENCES PAPER 1 (PHYSICS) COMMON CLUSTER SEPT/OCT 2020 EXAMINATION MEMORANDUM / MARKING GUIDELINES

MARKS: 150
TIME:
3 hours

This MEMORANDUM consists of 15 pages including the cover sheet

## QUESTION 1

| 1.1 | A | $\checkmark \checkmark$ | $(2)$ |
| :--- | :--- | :--- | :--- |
| 1.2 | A | $\checkmark \checkmark$ | $(2)$ |
| 1.3 | D | $\checkmark \checkmark$ | $(2)$ |
| 1.4 | B | $\checkmark \checkmark$ | $(2)$ |
| 1.5 | C | $\checkmark \checkmark$ | $(2)$ |
| 1.6 | D | $\checkmark \checkmark$ | $(2)$ |
| 1.7 | D | $\checkmark \checkmark$ | $(2)$ |
| 1.8 | B | $\checkmark \checkmark$ | $(2)$ |
| 1.9 | A | $\checkmark \checkmark$ | $(2)$ |
| 1.10 | C | $\checkmark \checkmark$ | $(2)$ |
|  |  |  | [20] |

## QUESTION 2

2.1.1 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 $\checkmark$ and inversely proportional to the mass of the object. $\checkmark$

OR
The net force acting on an object is equal to the rate of change of momentum $\checkmark \checkmark$ of the object (in the direction of the force). (2 or 0 )
2.1.2


OR
ACCEPT the labelled free-body diagram where the applied force is resolved into horizontal and vertical components ( $\mathrm{F}_{\mathrm{ax}}$ and $\mathrm{F}_{\mathrm{ay}}$ )

### 2.1.3 For block A:

$N=F_{g}-F_{\text {ay }} \boldsymbol{V}=(15)(9,8)-120 \sin 30^{\circ} \boldsymbol{V}=147-60=87 N$
$\mathrm{F}_{\mathrm{f}}=\mu \mathrm{N}=(0,2)(87) \boldsymbol{V}=17,4 \mathrm{~N} \quad \sqrt{ }$
(4)
$\begin{array}{ll}\text { 2.1.4 } & F_{a x}=F \cos 30^{\circ}=120 \cos 30^{\circ}=103,923 \mathrm{~N} \\ & \mathrm{~F}_{\text {net }}=F_{\mathrm{ax}}+(T)+\left(F_{f}\right) \\ (15)(2,08) \checkmark=\underline{103,923-T-17,4} \checkmark \\ T=55,32 \mathrm{~N} \checkmark\end{array}$
2.2.1 Each object/body in the universe exerts a force of attraction on every other object/body. This force is directly proportional to the product of their masses $\sqrt{ }$ and inversely proportional to square of the distance between their centres $\checkmark$
2.2.2 $\quad F=\frac{G m 1 m 2}{r 2}$

$$
\begin{align*}
& =\frac{\left(6,67 \times 10^{-11}\right)\left(5,98 \times 10^{24}\right)(1200)}{\left(6,38 \times 10^{6}+3,6 \times 10^{7}\right)^{2}} \\
& =\quad 266,49 \mathrm{~N} \tag{4}
\end{align*}
$$

2.2.3 EQUAL TO

## QUESTION 3

3.1 Yes. $\checkmark$

Only force of gravity acts on the tennis ball $\checkmark$
OR
Weight is the only force acting on the tennis ball $\checkmark$
3.2.1 $\left.\begin{array}{rl}\Delta y & =v_{i} \Delta t+\frac{1}{2} a \Delta t^{2} \quad \checkmark \\ v_{i} & =12,90 \mathrm{~m} \cdot \mathrm{~s}^{-1} \quad \checkmark\end{array}\right)$

### 3.2.2 OPTION 1 POSITIVE MARKING FROM QUESTION 3.2.1

From point of projection to maximum height $X$
(a)


## OPTION 2

POSITIVE MARKING FROM QUESTION 3.2.1
From point of projection to maximum height $X$
(a) $v_{f}=v_{i}+a \Delta t$

$$
\begin{aligned}
& 0=12,9+(-9,8) \Delta t \\
& \Delta \mathrm{t}=1,316 \mathrm{~s}
\end{aligned}
$$

(b) $\Delta y=v_{i} \Delta t+\frac{1}{2} a \Delta t^{2}$

$=\quad 8,49 \mathrm{~m}$
(c) Max height
$=\stackrel{8,49+21+0,6}{ } \quad \checkmark=30,09 \mathrm{~m}$

## OPTION 3 <br> POSITIVE MARKING FROM QUESTION 3.2.1

From point of projection to maximum height $X$

$$
\begin{aligned}
& \mathrm{v}_{\mathrm{f}}=\mathrm{v}_{\mathrm{i}}+\mathrm{a} \mathrm{\Delta t} \\
& 0=12,9+(-9,8) \Delta \mathrm{t} \\
& \Delta \mathrm{t}=1,316 \mathrm{~s}
\end{aligned}
$$

$$
\Delta y=\frac{1}{2}\left(v_{i}+v_{f}\right) \Delta t
$$

$$
=\quad \underline{\frac{1}{2}}(12,9+0)(1,316)
$$

$$
=\quad 8,49 \mathrm{~m}
$$

Max height $=8,49+21+0,6 \checkmark=30,09 \mathrm{~m}$

## OPTION 4

POSITIVE MARKING FROM QUESTION 3.2.1
From point of projection to roof of car
(a) $\Delta y=v_{i} \Delta t+\frac{1}{2} a \Delta t^{2}$

$$
\begin{aligned}
& =\quad(12,9)(3,77)+\frac{1}{2}(-9,8)(3,77)^{2} \\
& =\quad-21,01 \mathrm{~m}=21,01 \mathrm{~m} \text { down }
\end{aligned}
$$

(b) Max height above ground $=21,01+0,6=21,61 \mathrm{~m}$
3.3

$$
25 \% \text { of } 24,04=6,01 \mathrm{~m} \cdot \mathrm{~s}^{-1}
$$

$$
24,04-6,01=18,03 \mathrm{~m} \cdot \mathrm{~s}^{-1}
$$

(speed of the tennis ball
immediately after bouncing)
3.4


$$
\begin{aligned}
& \\
& \left.\begin{array}{l}
\mathrm{F}_{\text {net }} \Delta \mathrm{t}=\Delta \mathrm{p} \\
\mathrm{~F}_{\text {net }} \Delta \mathrm{t}=\mathrm{m}\left(\mathrm{v}_{\mathrm{f}}-\mathrm{v}_{\mathrm{i}}\right)
\end{array}\right\} \quad \checkmark \quad \text { Any ONE } \\
& =\underline{0,073[18,03-(-24,04)]} \\
& =3,07 \mathrm{~kg} \cdot \mathrm{~m} \cdot \mathrm{~s}^{-1} \\
& =3,07 \mathrm{~N} \cdot \text { s upwards } \checkmark
\end{aligned}
$$

## QUESTION 4

4.1 gradient $=\frac{\Delta E_{p}}{\Delta E_{K}} \downarrow=\frac{\frac{m g\left(h_{f}-h_{i}\right)}{\frac{1}{2} m\left(v_{f}^{2}-v_{i}^{2}\right)}}{=\frac{m g\left(0-h_{i}\right)}{\frac{1}{2} m\left(v_{f}^{2}-0\right)}} \checkmark=-\frac{2 g h_{i}}{v_{f}^{2}}$

## 4.2 Екз

$4.3 \tan 135^{\circ}=-\frac{2 g h_{i}}{v_{f}^{2}} \quad$ Accept: $\tan 45^{\circ}=-\frac{2 g h_{i}}{v_{f}^{2}}$

$$
\begin{align*}
& \left.-1=-\frac{(2)(9,8) h_{i}}{(2)^{2}}\right] \checkmark \\
& \mathrm{h}=0,20 \mathrm{~m} \quad \checkmark \tag{2}
\end{align*}
$$

## $4.4 \quad$ OPTION 1

$$
\begin{aligned}
& \mathrm{W}_{\mathrm{g}}=-\mathrm{mg}\left(\mathrm{~h}_{\mathrm{f}}-\mathrm{h}_{\mathrm{i}}\right) \quad \checkmark \\
& 19,6=-\mathrm{m}(9,8)(0-0,2) \\
& \mathrm{m}
\end{aligned}
$$

## OPTION 2

### 4.5 POSITIVE MARKING FROM QUESTION 4.4


$\mathrm{V}_{\mathrm{f} 1}=1,94 \mathrm{~m} \cdot \mathrm{~s}^{-1} ;$ right/original direction of motion $\checkmark(4)$

## QUESTION 5

5.1 Trial 2 V
$\mathrm{v}^{2}$ cannot equal $0 \quad \sqrt{ }$ or
Net force must be equal to ZERO. OR
Any other valid reason
5.2

$$
\begin{align*}
\mathrm{W}_{\text {net }} & =\Delta \mathrm{E}_{\mathrm{K}}  \tag{2}\\
\mathrm{~F}_{\text {net }} \Delta \mathrm{x} \operatorname{Cos} \theta & =\frac{1}{2} \mathrm{~m}\left(\Delta \mathrm{v}^{2}\right)
\end{align*}
$$

$\Delta v^{2}$ of an object increases with increasing net force acting on an object provided the mass of the object, the displacement and the angle between the displacement and the force are kept constant.
5.3 The net/total work done $\sqrt{ }$ on an object is equal to the change in the object's kinetic energy $\sqrt{ }$. OR
The work done on an object by a net force $\sqrt{ }$ is equal to the change in the object's kinetic energy.

$$
\left.\begin{array}{rl}
\mathrm{W}_{\mathrm{net}} & =\Delta E_{K} \\
\mathrm{~F}_{\mathrm{net}} \Delta \mathrm{x} \operatorname{Cos} \theta & =\quad \frac{1}{2} \mathrm{~m}\left(\Delta \mathrm{v}^{2}\right)
\end{array}\right] \sqrt{ }
$$

In all case for this motion $\theta=0^{0}$

$$
\begin{align*}
169,41 \Delta x(1) & =\frac{1}{2}(m+30)(5,76) \\
\Delta x & =0,017(m+30) \cdots-\cdots-\cdots-\cdots \\
442,91 \Delta x(1) & =\frac{1}{2}(m+40)(13,69) \\
\Delta x & =0,01545(m+40) \cdots
\end{align*}
$$

$(1)=(2): \underline{0,017(m+30)=0,01545(m+40)} \sqrt{ }$

$$
\begin{equation*}
M=69,68 \mathrm{~kg} \quad \sqrt{ } \tag{6}
\end{equation*}
$$

## QUESTION 6

6.1 The apparent/observed (change in) frequency (or pitch) of the sound detected by a listener because the sound source and listener have different velocities relative to the medium of sound propagation. $\checkmark \checkmark$ OR

The change in the (observed) frequency when there is relative motion between the source and the observer.

## 6.2

NB: $\quad F_{L}=1,0625 . F_{S}$
$1204,16=1,0625$. $\mathrm{Fs}_{\mathrm{s}}$
$F_{s}=1133,33 \mathrm{~Hz}$

## OPTION 1

$$
\begin{aligned}
& \mathrm{f}_{\mathrm{L}}=\frac{v \pm v_{L}}{v \pm v_{s}} \mathrm{f}_{\mathrm{s}} \checkmark \quad \text { OR } \mathrm{fL}=\frac{v}{v-v_{s}} \mathrm{f}_{\mathrm{S}} \\
& 1204,16 \checkmark=\left\{\frac{340+0}{\left(340-v_{s}\right)(1133,33)}\right]_{\checkmark} \\
& 1,0625\left(340-v_{s}\right)=340 \\
& \mathrm{v}_{\mathrm{s}} \quad=20 \mathrm{~m} \cdot \mathrm{~s}^{-1} \quad \checkmark
\end{aligned}
$$

## OPTION 2

$$
\begin{align*}
\mathrm{f}_{\mathrm{L}} & =\frac{v}{v-v_{s}} \mathrm{f}_{\mathrm{s}} \\
\frac{f_{L}}{f_{s}} & =\frac{v}{v-v_{s}} \\
1,0625 \checkmark & =\frac{340}{\left(340-v_{s}\right)} \\
\mathrm{V}_{\mathrm{s}} & =20 \mathrm{~m} \cdot \mathrm{~s}^{-1} \tag{4}
\end{align*}
$$

6.3 Waves in front of the moving source are compressed.

The observed wavelength decreases
For the same speed of sound, $\checkmark$ a higher frequency or pitch will be observed.

### 6.4 Increases $\checkmark$

## QUESTION 7

7.1.1 The magnitude of the electrostatic force exerted by one point charge on another point charge is directly proportional to the product of the (magnitude of the) charges $\checkmark$ and inversely proportional to the square of the distance between them.

OR
The force of attraction or repulsion between two (point) charges is directly proportional to the product of the (point) charges $\checkmark$ and inversely proportional to the square of the distance between (them) their centres.
7.1.2

7.1.3

$$
\begin{align*}
\mathrm{F} & =\frac{k Q_{1} Q_{2}}{r^{2}} \checkmark \\
\mathrm{~F}_{\text {net }} & =\mathrm{F}_{\mathrm{PR}}+\mathrm{F}_{\mathrm{SR}} \\
-1,27 \times 10^{-6} \checkmark & =\frac{\left(9 \times 10^{9}\right)\left(1,5 \times 10^{-9}\right) Q}{(0,3)^{2}} \checkmark-\frac{\left(9 \times 10^{9}\right)\left(2 \times 10^{-9}\right) Q}{(0,2)^{2}} \checkmark \\
-1,27 \times 10^{-6} & =150 \mathrm{Q}-450 \mathrm{Q} \\
\mathrm{Q} & =4,23 \times 10^{-9} \mathrm{C} \checkmark \tag{5}
\end{align*}
$$

7.2.1

$\checkmark$ Correct shape. Lines must not cross and must touch sphere
$\checkmark$ Correct direction
7.2.2

$$
\begin{gather*}
E=\frac{k Q}{r^{2}}  \tag{2}\\
3 \times 10^{7}=\frac{9 \times 10^{9} \times Q}{(0,5)^{2}} \\
\mathrm{Q}_{\mathrm{A}}=8,33 \times 10^{-14} \mathrm{C} \tag{3}
\end{gather*}
$$

7.2 .3 (a) $E_{A P}=\frac{k Q}{r^{2}}=\frac{\left(9 \times 10^{9}\right)\left(8,33 \times 10^{-14}\right)}{0,5^{2}} \checkmark=0,003 \mathrm{~N} \cdot \mathrm{C}^{-1}$, left
(b) $E_{B P}=\frac{k Q}{r^{2}}=\frac{\left(9 \times 10^{9}\right)\left(1,6 \times 10^{-14}\right)}{0,2^{2}} \quad \sqrt{ }=0,0036 \mathrm{~N} \cdot \mathrm{C}^{-1}$, right
(c) $E_{\text {net }}=E_{B P}+E_{A P}$

$$
\begin{aligned}
& =0,0036-0,003 \quad \checkmark \\
& =0,0006 \mathrm{~N} \cdot \mathrm{C}^{-1} \quad \sqrt{ }, \text { right }
\end{aligned}
$$

(5)
[19]

## QUESTION 8

8.1.1 $\mathrm{emf}(\varepsilon)=\mathrm{IR}_{\mathrm{ext}}+\operatorname{Ir} \checkmark$

When the current increases, Ir (lost volts) increases
$\operatorname{emf}(\varepsilon)$ is the same /constant
$\therefore \quad \underline{R_{\text {ext }}}$ (terminal voltage $\left./ \mathrm{pd}\right)($ voltage of the load) decreases
8.1.2 Group $2 \checkmark$
8.1.3

$$
\begin{align*}
& \text { gradient }=-\frac{\Delta V}{\Delta I}  \tag{1}\\
& \text { gradient }=-\frac{4-12}{4-0} \\
& \checkmark \\
&=2 \Omega \\
&
\end{align*}
$$

$$
\begin{align*}
\text { gradient } & =\frac{\Delta V}{\Delta I} \quad  \tag{3}\\
\text { gradient } & =\frac{4-12}{4-0} \\
& =-2 \Omega \\
-r & =-2 \Omega \\
r & =2 \Omega
\end{align*}
$$

8.2.1 The battery supplies 18 J of energy $\sqrt{ }$ per coulomb of charge $\sqrt{ }$ OR The battery supplies $18 \mathrm{~J} \sqrt{\text { per unit charge }} \sqrt{ }$ OR 18 J of work is done $\sqrt{ }$ in moving 1 C of charge $\sqrt{ }$ through the battery OR

## ACCEPT:

The potential difference of the battery in an open circuit is $18 \mathrm{~V} . \checkmark \checkmark$

## OR

Maximum work done by the battery per unit charge is $18 \mathrm{~J} . \checkmark \checkmark$

## OR

Maximum energy supplied by the battery per unit charge is $18 \mathrm{~J} . \checkmark \checkmark$ (2)
8.2.2 (a) $V_{P}=V_{R 2}=I R \quad \checkmark$

$$
\begin{aligned}
& =(1,2)(10) \\
& =\quad 12 \mathrm{~V}
\end{aligned}
$$

(b) $\mathrm{PR}_{\mathrm{R} 1}=\mathrm{VI}$

$$
\begin{aligned}
& 6=\left.(12)\right|_{\mathrm{R} 1} \\
& \mathrm{IR} 1^{\mathrm{R} 1}=0,5 \mathrm{~A}
\end{aligned}
$$

(c) $V_{2}=I R$ $3,8=(0,5+1,2) X^{\checkmark}$ $X=2,24 \Omega$
(6)

## ACCEPT OTHER OPTIONS!!!!!

8.2.3. (a) INCREASES
(1)
(b) DECREASES

## QUESTION 9

### 9.1.1 (Faraday's Law) of Electromagnetic Induction

(1)
9.1.2 Mechanical energy (kinetic) is converted to electrical energy
9.1.3 Slip rings connected to brushes
(1)
9.1.4


- Shape
- Max emf for A, C \& E and Zero emf for B \& D $\downarrow$
9.2

$$
\left.\begin{array}{rl}
\text { Pave } & =\mathrm{V}_{\text {rmsIrms }} \\
& =\left(\frac{V_{\max }}{\sqrt{2}}\right)\left(I_{r m s}\right)
\end{array}\right] \quad \begin{aligned}
& \left(\frac{35,36}{\sqrt{2}}\right) \checkmark(1,22) \checkmark \\
&  \tag{4}\\
&
\end{aligned}
$$

## QUESTION 10

10.1.1 Photoelectric effect $\sqrt{ }$
10.1.2 UV light has a higher/greater frequency than the threshold frequency and energy to eject electrons from the zinc plate $\sqrt{ }$ while the frequency of white light is less than the threshold frequency and will not eject photo-electrons $\checkmark$
10.2.1 Work function is the minimum amount of energy required by a metal, before electron are ejected. $\sqrt{ } \sqrt{ }$ [2 or 0$]$
10.2.2

$$
\begin{align*}
W_{0} & =h f_{0} \\
3,36 \times 10^{-19} & =6,6 \times 10^{-34} f_{0} \\
f_{0} & =5,09 \times 10^{14} \mathrm{~Hz} \tag{3}
\end{align*}
$$

10.2.3

$$
\begin{align*}
& \left.\begin{array}{lll}
\mathrm{E} & =\mathrm{W}_{0}+\mathrm{E}_{k \max } \\
\frac{h c}{\lambda} & =\mathrm{W}_{0}+\mathrm{E}_{\mathrm{kmax}}
\end{array}\right] \quad \sqrt{ } \\
& \frac{\left(6,63 X 10^{-34}\right)\left(3 X 10^{8}\right)}{\left(400 X 10^{-9}\right)} \checkmark=3,36 \times 10^{-19}+E_{k m a x} \\
& E_{k m a x} \quad=1,6125 \times 10^{-19} \mathrm{~J} \quad \checkmark \tag{4}
\end{align*}
$$

