Western Cape Government
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 ✓✓ (2)

1.2 A ✓✓ (2)

1.3 D ✓✓ (2)

1.4 B ✓✓ (2)

1.5 C ✓✓ (2)

1.6 D ✓✓ (2)

1.7 D ✓✓ (2)

1.8 B ✓✓ (2)

1.9 A ✓✓ (2)

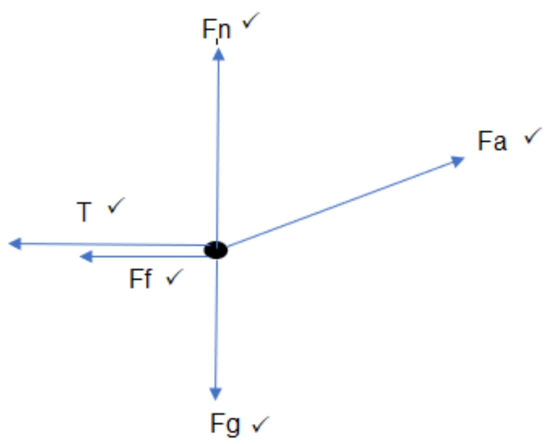
1.10 C ✓✓ (2)
[20]

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 ✓ and inversely proportional to the mass of the object. ✓ OR

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

2.1.2



(5)

OR

ACCEPT the labelled free-body diagram where the applied force is resolved into horizontal and vertical components (F_{ax} and F_{ay})

2.1.3 For block A:

$N = F_g - F_{ay}$ ✓ = (15)(9,8) - 120 sin30^0 ✓ = 147 - 60 = 87 N

$F_f = \mu N$ = (0,2)(87) ✓ = 17,4 N ✓
(4)

2.1.4 $F_{ax} = F \cos 30^0$ = 120 cos30^0 = 103,923 N

<u>F_{net} = F_{ax} + (T) + (F_f)</u> ✓

(15)(2,08) ✓ = <u>103,923 - T - 17,4</u> ✓

T = 55,32 N ✓ (4)

2.2.1 Each object/body in the universe exerts a force of attraction on every other object/body. This <u>force is directly proportional to the product of their masses</u> ✓ and <u>inversely proportional to square of the distance between their centres</u> ✓ (2)

2.2.2 $F = \frac{Gm1m2}{r2}$ ✓

$= \frac{(6,67X10^{-11})(5,98X10^{24})(1200)}{(6,38X10^{6} + 3,6X10^{7})^2}$ ✓✓

= 266,49 N ✓ (4)

2.2.3 EQUAL TO ✓ (1)

[22]

QUESTION 3

3.1 Yes. ✓

Only force of gravity acts on the tennis ball ✓

OR

Weight is the only force acting on the tennis ball ✓ (2)

3.2.1

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$-21 = v_i(3,77) + \frac{1}{2}(-9,8)(3,77)^2$ ✓

$v_i = 12,90\ m\cdot s^{-1}$ ✓ (3)

3.2.2 **OPTION 1** **POSITIVE MARKING FROM QUESTION 3.2.1**

From point of projection to maximum height X

(a) $v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = (12,9)^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = 8,49\ m$

(b) Max height = $\underline{8,49 + 21 + 0,6}$ ✓ = 30,09 m ✓ (4)

OPTION 2 **POSITIVE MARKING FROM QUESTION 3.2.1**

From point of projection to maximum height X

(a) $v_f = v_i + a\Delta t$

$0 = 12,9 + (-9,8)\Delta t$

$\Delta t = 1,316\ s$ ✓

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

$= (12,9)(1,316) + \frac{1}{2}(-9,8)(1,316)^2$ ✓

$= 8,49\ m$

(c) Max height = $\underline{8,49 + 21 + 0,6}$ ✓ = 30,09 m ✓ (4)

OPTION 3 **POSITIVE MARKING FROM QUESTION 3.2.1**

From point of projection to maximum height X

$v_f = v_i + a\Delta t$

$0 = 12{,}9 + (-9{,}8)\Delta t$

$\Delta t = 1{,}316 \text{ s}$ ✓

$\Delta y = \frac{1}{2}(v_i + v_f)\Delta t$

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

$= 8{,}49 \text{ m}$

Max height = 8,49 + 21 + 0,6 ✓ = 30,09 m ✓ (4)

OPTION 4 **POSITIVE MARKING FROM QUESTION 3.2.1**

From point of projection to roof of car

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

$= (12{,}9)(3{,}77) + \frac{1}{2}(-9{,}8)(3{,}77)^2$ ✓

$= -21{,}01 \text{ m} = 21{,}01 \text{ m down}$

(b) Max height above ground = 21,01 + 0,6 = 21,61 m

3.3

75% of 24,04 = 18,03 m·s^{-1} (speed of the tennis ball immediately after bouncing) ✓	OR	25% of 24,04 = 6,01 m·s^{-1} 24,04 – 6,01 = 18,03 m·s^{-1} (speed of the tennis ball immediately after bouncing)

$F_{net}\Delta t = \Delta p$

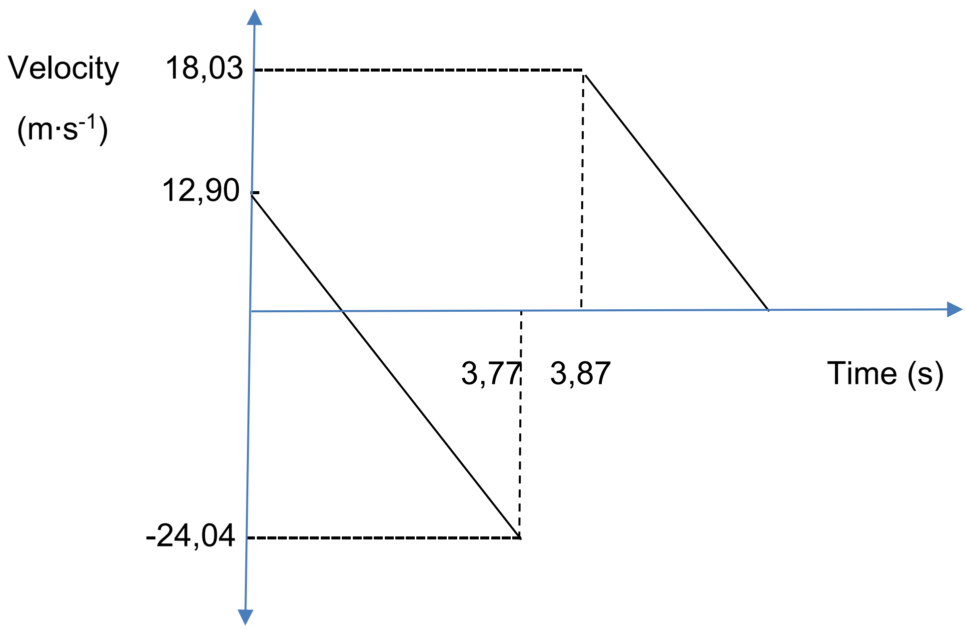
$F_{net}\Delta t = m(v_f - v_i)$ } ✓ Any ONE

$= \underline{0{,}073[18{,}03 - (-24{,}04)]}$ ✓

$= 3{,}07\ kg\cdot m\cdot s^{-1}$

$= \underline{3{,}07\ N\cdot s\ upwards}$ ✓ (4)

3.4



Criteria for graph	Marks
Time taken to reach the roof of the car and Time at which it leaves the roof of the car	✓
Velocities when thrown upwards,	✓
Velocity when it strikes the roof of the car Velocity when it bounces off the roof of the car	✓
straight lines	✓
Parallel lines	✓

(5)

[18]

QUESTION 4

4.1 gradient = $\frac{\Delta E_P}{\Delta E_K}$ ✓ = $\frac{mg(h_f - h_i)}{\frac{1}{2}m(v_f^2 - v_i^2)}$ = $\frac{mg(0 - h_i)}{\frac{1}{2}m(v_f^2 - 0)}$ ✓ = - $\frac{2gh_i}{v_f^2}$ (2)

4.2 E_{K3} ✓ (1)

4.3 tan 135^0 = - $\frac{2gh_i}{v_f^2}$ Accept: tan 45^0 = - $\frac{2gh_i}{v_f^2}$

-1 = - $\frac{(2)(9,8)h_i}{(2)^2}$ ✓

h = 0,20 m ✓ (2)

4.4 **OPTION 1**

W_g = $-mg(h_f - h_i)$ ✓

19,6 = -m(9,8)(0 – 0,2) ✓

m = 10 kg ✓

OPTION 2

W_{net} = ΔE_K

W_g = $\frac{1}{2}m(v_f^2 - v_i^2)$ ✓

19,6 = $\frac{1}{2}m(2^2 - 0^2)$ ✓

m = 9,8 kg ✓ (3)

4.5 **POSITIVE MARKING FROM QUESTION 4.4**

Σp_i = Σp_f ✓

$(mv_i)_1 + (mv_i)_2$ = $(mv_f)_1 + (mv_f)_2$

(10)(2) + (2)(0) ✓ = (10)(v_{f1}) + (2)(0,3) ✓

v_{f1} = 1,94 m·s^{-1} ; right/original direction of motion ✓ (4)

[12]

QUESTION 5

5.1 Trial 2 ✓

v^2 cannot equal 0 ✓ or

Net force must be equal to ZERO. OR

Any other valid reason (2)

5.2 $W_{net} = \Delta E_K$

$F_{net}\Delta x\cos\theta = \frac{1}{2}m(\Delta v^2)$ ✓

Δv^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. ✓ (2)

5.3 The <u>net/total work done</u>✓ on an object is <u>equal to the change in the object's kinetic energy</u>✓. OR
The <u>work done on an object by a net force</u> ✓ is <u>equal to the change in the object's kinetic energy.</u> ✓ (2)

5.4 $W_{net} = \Delta E_K$

$F_{net}\Delta x\cos\theta = \frac{1}{2}m(\Delta v^2)$ ✓

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

$169{,}41\Delta x(1) = \frac{1}{2}(m + 30)(5{,}76)$ ✓

$\Delta x = 0{,}017(m + 30)$ ---------------- (1)

$442{,}91\Delta x(1) = \frac{1}{2}(m + 40)(13{,}69)$ ✓

$\Delta x = 0{,}01545\,(m + 40)$ ------------- (2) ✓

(1) = (2): <u>0,017(m + 30) = 0,01545 (m + 40)</u> ✓

M = 69,68 kg ✓ (6)

[12]

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. ✓✓ OR

The change in the (observed) frequency when there is relative motion between the source and the observer. ✓✓ (2)

6.2

NB: $F_L = 1{,}0625.\ F_S$

$1204{,}16 = 1{,}0625.\ F_S$

$F_S = 1133{,}33$ Hz

<u>OPTION 1</u>

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \ ✓ \quad \text{OR} \quad f_L = \frac{v}{v - v_s} f_s$$

$$1204{,}16 \ ✓ = \left\{\left(\frac{340+0}{340-v_s}\right)(1133{,}33)\right\} \ ✓$$

$$1{,}0625(340 - v_s) = 340$$

$$v_s = 20 \text{ m.s}^{-1} \ ✓$$

<u>OPTION 2</u>

$$f_L = \frac{v}{v - v_s} f_s \ ✓$$

$$\frac{f_L}{f_s} = \frac{v}{v - v_s}$$

$$1{,}0625 \ ✓ = \left(\frac{340}{340 - v_s}\right) \ ✓$$

$$v_s = 20 \text{ m.s}^{-1} \ ✓$$ (4)

6.3 Waves in front of the moving source are compressed.

The observed <u>wavelength decreases</u> ✓

For the <u>same speed of sound</u>,✓ a higher frequency or pitch will be observed. (2)

6.4 Increases ✓ (1)

[9]

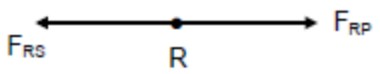
QUESTION 7

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 ✓ 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 ✓ and inversely proportional to the square of the distance between (them) their centres. ✓ (2)

7.1.2

✓  ✓ (2)

7.1.3

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

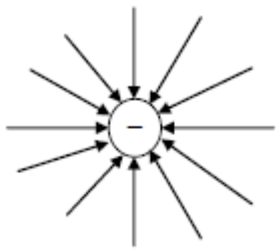
$$F_{net} = F_{PR} + F_{SR}$$

$$-1{,}27 \times 10^{-6} \checkmark = \frac{(9\times10^9)(1{,}5\times10^{-9})\,Q}{(0{,}3)^2} \checkmark - \frac{(9\times10^9)(2\times10^{-9})\,Q}{(0{,}2)^2} \checkmark$$

$$-1{,}27 \times 10^{-6} = 150\,Q - 450\,Q$$

$$Q = 4{,}23 \times 10^{-9}\ \text{C} \checkmark$$ (5)

7.2.1



✓ Correct shape. Lines must not cross and must touch sphere

✓ Correct direction (2)

7.2.2

$$E = \frac{kQ}{r^2} \checkmark$$

$$3 \times 10^7 = \frac{9\times10^9 \times Q}{(0{,}5)^2} \checkmark$$

$$Q_A = 8{,}33 \times 10^{-14}\ \text{C} \checkmark$$ (3)

7.2.3 (a) $E_{AP} = \frac{kQ}{r^2} = \frac{(9 \times 10^9)(8,33 \times 10^{-14})}{0,5^2}$ ✓ = 0,003 N·C^{-1} , left ✓

(b) $E_{BP} = \frac{kQ}{r^2} = \frac{(9 \times 10^9)(1,6 \times 10^{-14})}{0,2^2}$ ✓ = 0,0036 N·C^{-1} , right

(c) $E_{net} = E_{BP} + E_{AP}$

= 0,0036 – 0,003 ✓

= 0,0006 N·C^{-1} ✓, right

(5)

[19]

QUESTION 8

8.1.1 emf (ε) = IR_{ext} + Ir ✓
When the current increases, Ir (lost volts) increases ✓
emf (ε) is the same /constant ✓
∴ IR_{ext} (terminal voltage/pd)(voltage of the load) decreases (3)

8.1.2 Group 2 ✓ (1)

8.1.3

gradient = $-\frac{\Delta V}{\Delta I}$ ✓ gradient = $-\frac{4-12}{4-0}$ ✓ = 2 Ω ✓	gradient = $\frac{\Delta V}{\Delta I}$ ✓ gradient = $\frac{4-12}{4-0}$ ✓ = - 2 Ω -r = - 2 Ω r = 2 Ω ✓

(3)

8.2.1 The battery supplies 18 J of energy✓ per coulomb of charge ✓ **OR**
The battery supplies 18 J ✓ per unit charge ✓ **OR**
18 J of work is done ✓ in moving 1 C of charge ✓ through the battery

OR

ACCEPT:
The potential difference of the battery in an open circuit is 18 V. ✓✓

OR

Maximum work done by the battery per unit charge is 18 J. ✓✓

OR

Maximum energy supplied by the battery per unit charge is 18 J. ✓✓
(2)

8.2.2 (a) V_P = V_{R2} = IR ✓

= (1,2)(10) ✓

= 12 V

(b) P_{R1} = VI ✓

6 = (12)I_{R1} ✓

I_{R1} = 0,5 A

(c) V_2 = IR

3,8 = (0,5 + 1,2)X ✓

X = 2,24 Ω ✓

(6)

ACCEPT OTHER OPTIONS!!!!!

8.2.3. (a) INCREASES ✓

(1)

(b) DECREASES ✓ (1)

[17]

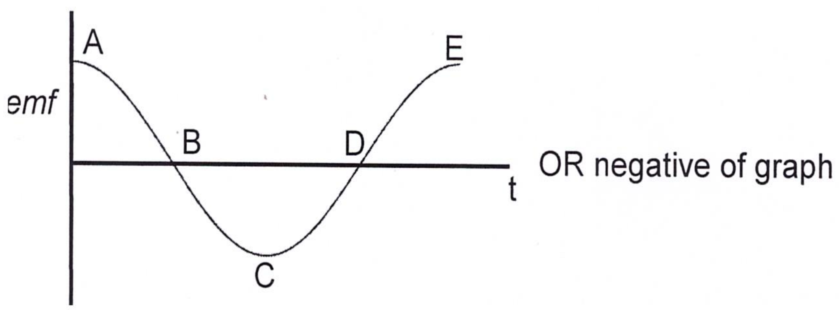
QUESTION 9

9.1.1 (Faraday's Law) of Electromagnetic Induction ✓
(1)

9.1.2 Mechanical energy (kinetic) is converted to electrical energy ✓
(1)

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 ✓ (2)

9.2 $P_{ave} = V_{rms}I_{rms}$

$= (\frac{V_{max}}{\sqrt{2}})(I_{rms})$ ✓

$= (\frac{35,36}{\sqrt{2}})$ ✓ $(1,22)$ ✓

$= 30,50\ W$ ✓ (4)

[9]

QUESTION 10

10.1.1 Photoelectric effect ✓ (1)

10.1.2 UV light has a higher/greater frequency than the threshold frequency and energy to eject electrons from the zinc plate ✓ while the frequency of white light is less than the threshold frequency and will not eject photo-electrons ✓ (2)

10.2.1 Work function is the minimum amount of energy required by a metal, before electron are ejected. ✓✓ [2 or 0] (2)

10.2.2

$W_0 = hf_0$ ✓

$3{,}36 \times 10^{-19} = 6{,}6 \times 10^{-34} f_0$ ✓

$f_0 = 5{,}09 \times 10^{14} Hz$ ✓ (3)

10.2.3

$E = W_0 + E_{kmax}$

$\frac{hc}{\lambda} = W_0 + E_{kmax}$ ✓

$\frac{(6{,}63 X 10^{-34})(3 X 10^{8})}{(400 X 10^{-9})}$ ✓ $= 3{,}36 X 10^{-19} + E_{kmax}$ ✓

$E_{kmax} = 1{,}6125 X 10^{-19}$ J ✓ (4)

[12]

ACCEPT OTHER OPTIONS!!!!!!