Grade 12 **Physical Sciences**

MEMO **Aug 2016** **Paper 1**

Question 1

1 A✓✓

2 A

3 D

4 C

5 A

6 A

7 C

8 B

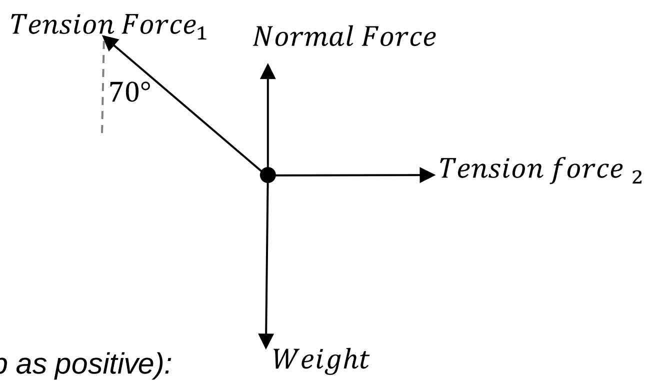
9 C

10 C **[20]**

Question 2

2.1.1 When a net force✓ acts on an object, the object will accelerate in the direction of the net force with an acceleration that is directly proportional✓ to the net force and inversely proportional✓ to the mass of the object. (3)

2.1.2



✓From a point

✓✓✓appropriate forces and labels

(4)

2.1.3 *(up as positive):*

$F_{\text{net,}} = 0$

$\vec{T}_2 - m_2 g = 0$✓

$\vec{T}_2 = m_2 g$

$\vec{T}_2 = (5)(9{,}8)$✓

$\vec{T}_2 = 49$ N up✓ **(-1 no units)** (3)

2.1.4 *right as positive*

$\vec{F}_{\text{net}} = 0$ on box mass 2kg

$T_{1x} = 49$ N to the left✓

Using trigonometry to work out T_{1y} :

$\frac{T_{1x}}{T_{1y}} = \tan\alpha$ ✓

$$T_{1y} = \frac{T_{1x}}{\tan\alpha}$$

$$T_{1y} = \frac{49}{\tan 70°}$$

$T_{1y} = 17{,}83$ N✓

Working with vertical forces (up as positive):

$\vec{F}_{\text{nety}} = 0$

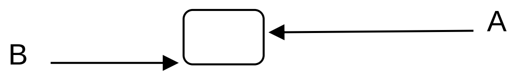
$T_{1y} + N - F_g = 0$✓

$17{,}83 + N - (2)(9{,}8) = 0$

$N = 1{,}77$N✓ i.e. the magnitude of the normal force is 1,77 N (5)

2.2.1 If body A exerts a force on body B ✓ then body B exerts an equal force on body A in the opposite direction. ✓ (2)

2.2.2 James is correct. ✓



Meaningful, labelled diagram ✓✓

A : force of man on CAR
B : force of road surface on CAR (friction)

CAR'S motion to the left is due to A being greater than B ✓✓
(NII: a net force acts on the CAR) (5)

2.2.3 Downward force would increase N ✓

$F_{f\,max} = \mu N$ so larger N results in larger $F_{f\,max}$ ✓ so car more difficult to push ✓ (3)

2.2.4 As the bucket empties, straws exert force on water ✓. According to *NIII* : the water exerts an equal and opposite force back ✓ on the straw / cup, causing it to spin 'away from' the exiting water. ✓ (3)

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Question 3

3.1.1 $a = gradient = \frac{\Delta v}{\Delta t}$ ✓ $= \frac{-2-0✓}{60-40✓} = -0,1\ m.s^{-2} = 0,1\ m.s^{-2}$ ✓ $west$ ✓

or use an equation of motion:

$v_f = v_i + a\Delta t$ ✓ $\quad -2$✓ $= 0$✓ $+ a(20$✓$)$

$a = -0,1\ m.s^{-2} = 0,1\ m.s^{-2}\ west$ ✓ (5)

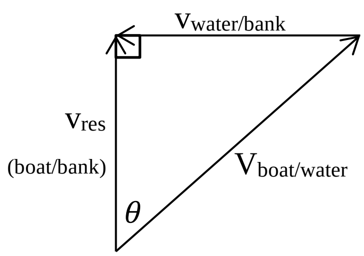
3.1.2 2.1.2 t=10-20s✓ and 30-40s✓ (2)

3.1.3 The camera's position is <u>east</u>✓ of its starting position moving <u>west</u>✓ at 60 seconds (2)

3.2.1 The <u>single vector</u> ✓ that has the <u>same effect as the original vectors acting together</u>✓ (2)

3.2.2 $v_{res}^2 = v_{c/b}^2 - v_{w/b}^2 = 3^2 - 2,5^2$ ✓✓subs

$v_{res} = 1,66\ m.s^{-1}$ ✓



✓✓✓3 marks total available:
-1 per missing arrow
-1 per missing label
No marks if incorrect triangle drawn but coe for calculation.

(6)

3.2.3 $\sin\theta = \frac{2,5}{3}$ ✓✓linked ratio and subs coe from 2.2.2 diagram

$\theta = 56,44^o$

thus he must paddle his canoe 56,44° E of N ✓coe from diagram (or 33,56° N of E, or 33,56° to the riverbank upstream; or bearing of 56,44°) (NE not accepted) (3)

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Question 4

4.1.1 The only force acting on an object is the gravitational force. (1)

4.1.2 Down. (1)

4.1.3 *Take up as positive*

$\Delta\vec{y} = \vec{v}_i\Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$✓

$(1{,}3) = \vec{v}_i(0{,}08) + \frac{1}{2}(-9{,}8)(0{,}08)^2$✓✓subs

$\vec{v}_i = 16{,}642\ \mathrm{m\cdot s^{-1}}$ up ✓ (-1 no direction) (4)

4.1.4 *Taking up as positive*

$\vec{v}_f^2 = \vec{v}_i^2 + 2\vec{a}\cdot\Delta\vec{y}$✓

$0^2 = (16{,}642)^2 + 2(-9{,}8)\cdot\Delta\vec{y}$✓

$\Delta\vec{y} = 14{,}13041 \ldots \mathrm{m}$✓

$\Delta\vec{y} = 14{,}13\ \mathrm{m}$ from the bottom of the window

$\Delta\vec{y} = 14{,}13 + 4{,}5$

$\Delta\vec{y} = 18{,}63\ \mathrm{m}$ from the ground✓

$\Delta\vec{y} = 18{,}63 - 1{,}9$

$\Delta\vec{y} = 16{,}73\ \mathrm{m}$ from the point of release✓ (5)

4.2.1 Displacement. (1)

4.2.2 t = 9h10mins = 33000s✓

S = 10.5 x 500 = 5250km = 5250 000m✓

Average velocity = s/t = 5250000/33000 = 159ms^{-1} ✓ (3)

4.2.3 more (1)

4.2.4 the speed is given by distance✓ divided by time. Since the distance is more the ratio will be more. ✓ (2)

4.2.5 s_{total} = 1500m t_{total} = 2 x 60 = 120s

From standstill till he reaches his top speed:

u = 0

v = 22ms^{-1}

$a = 0,25ms^{-2}$

$v^2 = u^2 + 2as$

$22^2 = 0 + 2(0,25)(s)$

$484 = 0,5(s)$

S = 968m ✓

$v = u + at$

$22 = 0 + 0,25(t)$

t = 88s✓

time left before light changes = 120 - 88 = **32s**✓

distance left to cover = 1500 – 968 = **532m**✓

speed = $22ms^{-1}$ and is now constant

v = s/t   22 = s/32✓

Distance he can cover before light green is 704m✓

Yes he manages to get through the green light. (6)

4.2.6 $F_{net} = ma$

$F_{net} = 95(0,12) = 11,4N$✓

$F_{net} = F_{applied}$ –Friction-mg sinθ✓

11,4 = 241 – Friction – 95(9,8)(sin15)

Friction = -11.36N ✓ ie in the opposite direction to the motion. ✓ (4)

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Question 5

5.1 The total linear momentum of an isolated✓ system is constant (is conserved) ✓ (2)

5.2 $\sum \vec{p}_{\mathrm{i}} = \sum \vec{p}_{\mathrm{f}}$ ✓

$m_1\vec{v}_{1,\mathrm{i}} + m_2\vec{v}_{2,\mathrm{i}} = m_1\vec{v}_{1,\mathrm{f}} + m_2\vec{v}_{2,\mathrm{f}}$

$(0{,}80)(4{,}5) + (0{,}65)(0) = (0{,}80)(0{,}5) + (0{,}65)\vec{v}_{2,\mathrm{f}}$ ✓✓$subs$

$v_{2,\mathrm{f}} = 4{,}92307\ldots\ \mathrm{m \cdot s^{-1}}$

$\approx 4{,}92\ \mathrm{m \cdot s^{-1}}$ ✓ (4)

5.3 $\sum E_{\mathrm{k,i}} = \frac{1}{2}m_1v_{1,\mathrm{i}}^2 + \frac{1}{2}m_2v_{2,\mathrm{i}}^2$ ✓

$$\sum E_{\mathrm{k,i}} = \frac{1}{2}(0{,}80)(4{,}5)^2 + \frac{1}{2}(0{,}65)(0)^2 \checkmark$$

$$\sum E_{\mathrm{k,i}} = 8{,}1\ \mathrm{J} \checkmark$$

$$\sum E_{\mathrm{k,f}} = \frac{1}{2}m_1v_{1,\mathrm{f}}^2 + \frac{1}{2}m_2v_{2,\mathrm{f}}^2$$

$$\sum E_{\mathrm{k,f}} = \frac{1}{2}(0{,}80)(0{,}5)^2 + \frac{1}{2}(0{,}65)(4{,}92307\ldots)^2 \checkmark$$

$$\sum E_{\mathrm{k,f}} = 7{,}97692\ldots\ \mathrm{J}$$

$$\sum E_{\mathrm{k,f}} \approx 7{,}98\ \mathrm{J} \checkmark$$

$$\sum E_{\mathrm{k,i}} > \sum E_{\mathrm{k,f}}$$

The collision is inelastic because the system lost kinetic energy. ✓ (6)

5.4 Conservation of mechanical energy:

$mgh_{\mathrm{i}} + \frac{1}{2}mv_{\mathrm{i}}^2 = mgh_{\mathrm{f}} + \frac{1}{2}mv_{\mathrm{f}}^2$ ✓

Dividing by m and solving for h_{f}:

$h_{\mathrm{f}} = h_{\mathrm{i}} + \frac{v_{\mathrm{i}}^2 - v_{\mathrm{f}}^2}{2g}$ ✓

$= 0 + \frac{(4{,}92307\ldots)^2 - 0^2}{(2)(9{,}8)}$ ✓

$= 1{,}23656\ldots\ \mathrm{m} \approx 1{,}24\ \mathrm{m}$ ✓

OR

Substitute first then solve for h_{f}:

$(0{,}65)(9{,}8)(0) + \frac{1}{2}(0{,}65)(4{,}92307\ldots)^2 = (0{,}65)(9{,}8)h_{\text{f}} + \frac{1}{2}(0{,}65)(0)^2$ ✓ ✓

$h = 1{,}23656\ldots\ \text{m}$

$\approx 1{,}24\ \text{m}$ ✓ (4)

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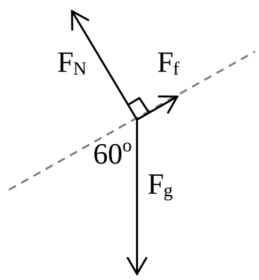
Question 6

6.1



F_g = gravitational force or weight

F_N = Normal force

F_f = frictional force

Orientation

(4)

6.2 $F_{||}$ = W sin30° ✓ = (70)(9,8) ✓ sin30° = 343 N ✓ (3)

6.3 $W_{net} = F_{net}\Delta x$ ✓ = $(F_{||} - F_f)\Delta x$ = (343✓coe – 150✓)(120✓) = 23160 J ✓ (5)

6.4 The work done by a <u>net force</u> ✓on an object is equal to the <u>change in the kinetic energy</u>✓ of the object. (2)

6.5 $W_{net} = \Delta E_k$ ✓= ½ mv_f^2 – ½ mv_i^2

23160✓coe = ½ (70✓)v_f^2 - 0✓

v_f = 25,72 $m.s^{-1}$ ✓ (4)

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Question 7

7.1.1 $F_g = mg$ ✓ = 3×10^{-3} (9,8) ✓ = 0,029 N ✓ (3)

7.1.2 F_e = 0,029 N ($2{,}94\times10^{-2}$) ✓ (1)

7.1.3 The force between 2 charged bodies ✓ is directly proportional to the product of the charges ✓ and inversely proportional to the distance between the charges squared ✓ (3)

7.1.4 $F = \frac{kQQ}{r^2}$ ✓

$Q^2 = 4{,}18\times10^{-13}$ ✓✓ (for substitution)

$Q = 6{,}47\times10^{-7}$ C ✓✓ (647 nC) (4)

7.1.5 indep variable : charge on ball B ✓ (1)

7.1.6 see graph :
- heading ✓
- Y axis title and unit ✓
- x axis title and unit ✓
- Scale (correct and >1/2 grid) ✓
- Plotted points ✓✓
- LOBF ✓ (7)

7.1.7 r much smaller than expected.
Perhaps balls discharged slightly, ✓✓ so force between them was reduced
OR mistake in measuring distance ✓ (1/2) (2)

7.1.8 r^2 is directly proportional to Q_B ✓✓ when F and Q_A are kept constant. (2)

7.2.1 Every particle in the universe attracts every other particle with a force✓ which is directly proportional to the product of their masses✓ and inversely proportional to the square of the distance✓ between their centres. (3)

7.2.2 $F_{m/e} = \frac{GMm}{r^2}$ ✓ $= \frac{6{,}67\times10^{-11} \times 6\times10^{24} \times 6\times10^{22}}{(3{,}84\times10^{8})^2}$ ✓ ✓

$= \frac{2{,}4 \times 10^{37}}{1{,}47 \times 10^{17}}$

$= 1{,}63 \times 10^{20}$ N ✓ (4)

7.2.3 If the F_{res} on the moon = 0 then $F_{earth\ on\ moon} = F_{sun\ on\ moon}$ ✓

$1{,}63 \times 10^{20} = \frac{6{,}67\times10^{-11} \times 1{,}9\times10^{30} \times 6\times10^{22}}{r^2}$ ✓

$r^2 = \frac{7{,}6 \times 10^{42}}{1{,}63 \times 10^{20}}$ ✓

$r^2 = 4{,}7 \times 10^{22}$

$r = 2{,}2 \times 10^{11}$ m ✓ [4]

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Question 8

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

8.2 **Series resistance calculation**

$R = R_{3\Omega} + R_{2\Omega}$

$R = 3 + 2$ ✓

$R = 5\ \Omega$✓

Working with emf and internal resistance

$\varepsilon = I(R + r)$

$6 = (1{,}091)(5 + r)$ ✓

$r = 0{,}4995\ \ldots \Omega$

$r \approx 0{,}5\ \Omega$ ✓ (4)

8.3 **Using modified emf formula**

$V_{\text{load}} = \varepsilon - Ir$

$V_{\text{load}} = 6 - (1{,}846)(0{,}4995\ \ldots)$ ✓✓

$V_{\text{load}} = 5{,}07792\ \ldots\ \text{V}$

$V_{\text{load}} \approx 5{,}08\ \text{V}$ ✓

OR Long version! Starting with parallel resistance

$$\frac{1}{R_{\text{p}}} = \frac{1}{R_{1\Omega}} + \frac{1}{R_{3\Omega}}$$

$$\frac{1}{R_p} = \frac{1}{1} + \frac{1}{3}$$

$$\frac{1}{R_p} = \frac{4}{3}$$

$$\therefore R_{\text{p}} = \frac{3}{4} = 0{,}75\ \Omega$$ ✓

Equivalent resistance

$R_{\text{eq}} = R_{\text{p}} + R_{2\Omega}$

$R_{eq} = 0{,}75 + 2$

$R_{eq} = 2{,}75\ \Omega$ ✓

Using Ohm's Law in the external circuit

$V_{\text{load}} = IR_{\text{ext}}$

$V_{\text{load}} = (1{,}846)(2{,}75)$

$V_{\text{load}} = 5{,}0765\text{ V}$

$V_{\text{load}} \approx 5{,}08\text{ V}$ ✓ (3)

8.4.1 Increases (1)

8.4.2 Another resistor is added in parallel so external resistance (R) and hence total resistance ($R + r$) decreases. ✓From $\varepsilon = I(R + r)$, total current will increase. ✓From $V_{\text{internal resistance}} = Ir$, more energy is used up to overcome internal resistance. This energy is released as heat which will increase the temperature of the the battery. ✓ (3)

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Question 9

9.1.1 $\frac{V_p}{N_p} = \frac{V_s}{N_s}$ ✓ $\therefore N_s = \frac{(1000)(36)}{240}$ ✓✓ = 150 turns ✓ (4)

9.1.2 $P_p = P_s$ ✓
or $V_pI_p = P_s$
$(240)(I_p)$✓ = 500 ✓
$\therefore I_p$ = 2,08 A (3)

9.1.3 0,5 x 3✓*method* = 1,5 kWh
1,5 x 1,30 ✓ *method* = R1,95 ✓ (3)

9.2.1 mechanical energy to electrical energy ✓ (1)

9.2.2 According to Faraday's law (of electromagnetic induction) ✓ the magnet must rotate to cause a <u>changing magnetic flux</u> ✓ over time ✓(or rate ✓of change of magnetic flux✓) (3)

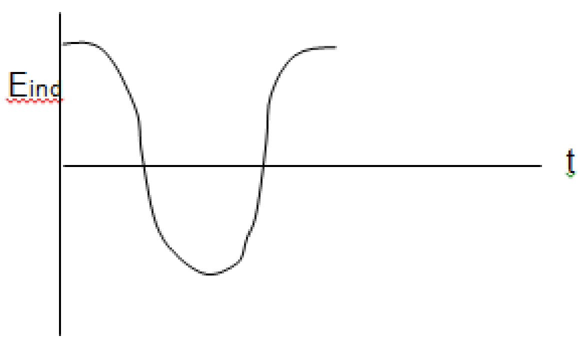
9.2.3 (iii) ✓ (1)

9.2.4 FDGHAE ✓✓ (2)

9.2.5 pedal faster ✓ *concept* (1)

9.3.1 alternating current ✓ : SLIP RINGS ✓ in contact with brushes (2)

9.3.2



Shape✓✓ (3)
+ or -✓

[23]