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**PHYSICAL SCIENCES PAPER 1
TRIAL EXAMINATION 2021
MEMO**

Time: 3 Hours + 10 min reading time
Examiner: K. Storm

Total: 200
Moderator: N. Lock

QUESTION 1 MULTIPLE CHOICE

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

QUESTION 2

2.1.1



(2)

2.1.2

$\sin\theta = \frac{1}{2} \therefore \theta = 30^\circ \checkmark$ and **(+ 180) ✓** bearing = $210^\circ \checkmark$

(3)

2.1.3

$t = s / v \checkmark = 40 / 1,73 \checkmark = 23,12 \text{ s} \checkmark$ (OR: $40 / \sqrt{3} = 23,09 \text{ s}$)

(3)

2.1.4

$s = v \times t = 1 \checkmark \times 23,12 = 23,12 \text{ m} \checkmark$ OR $\tan 30 = s / 40 \therefore s = 23,09 \text{ m}$

(3)

2.1.5

False ✓; he would always end downstream from Y

(1)

2.2.1 $9,8 \text{ m/s}^2 \checkmark \text{downwards} \checkmark$ (2)

2.2.2 $v^2 = u^2 + 2as \quad (-3,2)^2 \checkmark = 6^2 \checkmark + 2(-9,8) s \checkmark \quad s = 1,31 \text{ m} \checkmark \text{ (i.e C is above A)}$ (4)

2.2.3 $v = u + at \quad -8 \checkmark = -0,5 \checkmark + (-9,8) t \checkmark \quad t = 0,77 \text{ s} \checkmark$ (4)

2.2.4 The work done by a net force on an object is equal to the change in the kinetic energy of the object. $\checkmark \checkmark$ (2)

2.2.5 $W_{\text{net}} = \Delta E_k = \frac{1}{2} m(v^2 - u^2) = \frac{1}{2} (0,16 \text{ conv}) ((-0,5)^2 \checkmark - (-3,2)^2 \checkmark) = -0,80 \text{ J} \checkmark$ (4)

[28]

QUESTION 3

3.1.1 $\vec{v}_f = \vec{v}_i + \vec{a}\Delta t \checkmark$ (3)

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

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

3.1.2 $E_{k,\text{after/leaving}} = \frac{1}{2} m v_f^2 \checkmark$ (4)

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

C.O.E

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

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

$$\begin{aligned} \therefore E_{k,\text{before}} &= 0,8644 \times \frac{100}{95} \checkmark \\ &= 0,90989 \dots \text{J} \\ &\approx 0,91 \text{ J} \checkmark \end{aligned}$$

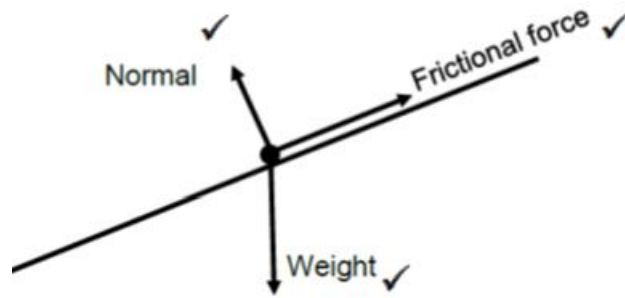
3.1.3 $(E_p + E_k)_{\text{TOP}} = (E_p + E_k)_{\text{BOTTOM}} \checkmark$ (4)

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

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

$$= 1,398 \text{ m} = 1,4 \text{ m} \checkmark$$

3.2.1



(3)

3.2.2

$$\begin{aligned}
 F_{\text{net}} &= mg \sin 20 - F_f \\
 F_{\text{net}} &= (70)(9,8) \sin 20 - 190 \quad \checkmark \checkmark \\
 F_{\text{net}} &= 234,63 - 190 \\
 F_{\text{net}} &= 44,63 \text{ N} \quad \checkmark
 \end{aligned}$$

(3)

3.2.3

$$\begin{aligned}
 F_{\text{net}} &= ma \quad \checkmark \\
 44,63 &= 70a \\
 a &= 0,64 \text{ m}\cdot\text{s}^{-2} \quad \checkmark
 \end{aligned}$$

$$v^2 = u^2 + 2as \quad \checkmark$$

$$v^2 = 4^2 + 2(0,64)(18) \quad \checkmark$$

$$v = 6,24 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

(5)

[22]

QUESTION 4

4.1 The total linear momentum of an isolated (closed) system remains constant (is conserved). (2)

4.2

Take "towards Orion" as the positive direction:

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

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

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

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

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

(4)

4.3

Take "towards Orion" as the positive direction:

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

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

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

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

(4)

4.4

$$\begin{aligned}
 F_g &= \frac{Gm_A m_B}{r^2} \checkmark \checkmark \text{ sub } G, m_A \text{ and } m_B \\
 &= \frac{(6,67 \times 10^{-11})(2,52 \times 10^{19})(1,08 \times 10^{19})}{(150 \times 10^3)^2} \checkmark \\
 &= 8,07 \times 10^{17} \text{ N} \checkmark \text{ sub converted } r
 \end{aligned}$$

(4)

[14]

QUESTION 5

5.1 $E_p = mgh \checkmark = 75 \times 9.8 \times 2,4 \checkmark = 1764 \text{ J} \checkmark$

(3)

5.2

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

(4)

5.3

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

OR

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

(3)

5.4.1 REMAINS THE SAME $\checkmark$

(1)

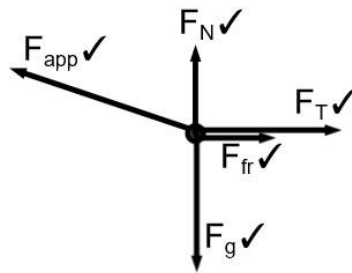
5.4.2 The starting and ending points are the same. $\checkmark$ The Work done by the force of gravity only depends on the change in height. $\checkmark$

(2)

[13]

QUESTION 6

6.1



(5)

-1 if no key

6.2.1 $F_{\text{vert}} = F \sin \theta = 60 \sin 10^\circ = 10,42 \text{ N}$

(2)

6.2.2 $F_{\text{hor}} = F \cos \theta = 60 \cos 10^\circ = 59,09 \text{ N}$

(2)

6.3

(3)

When a net force is applied to an object of mass m , it accelerates in the direction of the net force. ✓ The acceleration is directly proportional to the net force ✓ and inversely proportional to the mass. ✓

OR The net force acting on an object is equal to the rate of change of momentum.

6.4 $F_N = F_g - F_{\text{vert}} = (5 \times 9,8) - 10,42 = 38,58 \text{ N}$

(3)

6.5 $F_{\text{fr}} = \mu F_N = 0,5 \times 38,58 = 19,29 \text{ N}$

(3)

6.6

(6)

For 5 kg block: $(59,09 - T - 19,29) = 5a \quad \therefore \quad 39,8 - T = 5a$

For 2 kg block: $T - (2 \times 9,8) = 2a \quad \therefore \quad T - 19,6 = 2a$

Solve simultaneously: $39,8 - (2a + 19,6) = 5a \quad \therefore$

$20,2 = 7a \quad \therefore$

$a = 2,89 \text{ m/s}^2$

$T = 2(2,89) + 19,6 = 25,37 \text{ N}$

[24]

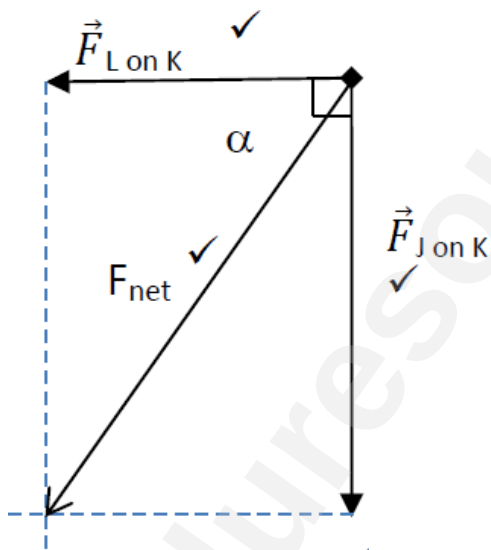
QUESTION 7

7.1.1 *Two point charges in free space or air exert forces on each other. The force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charges* (2)

7.1.2 Calculate the magnitude of the electrostatic force between charges J and K. (4)

$$\begin{aligned}
 F_{J \text{ on } K} &= \frac{kQ_J Q_K}{r^2} \quad \checkmark \\
 &= \frac{9 \times 10^9 \times 4 \times 10^{-6} \times 2 \times 10^{-6}}{(0,05)^2} \quad \checkmark \\
 &= 28,8 \text{ N} \quad \checkmark
 \end{aligned}$$

7.1.3 (3)



7.1.4 (6)

MAGNITUDE:

$$\begin{aligned}
 F_R^2 &= (F_{J \text{ on } K})^2 + (F_{L \text{ on } K})^2 \quad \checkmark \\
 \therefore F_R &= \sqrt{28,8^2 + \left(\frac{1}{2} \times 28,8\right)^2} \quad \checkmark \checkmark \\
 &= 32,20 \text{ N} \quad \checkmark
 \end{aligned}$$

DIRECTION

$$\begin{aligned}
 \tan \alpha &= 2, \quad \checkmark \\
 \therefore \alpha &= 63,43^\circ \quad \checkmark
 \end{aligned}$$

BEARING $206,57^\circ$ ✓

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 (2)

$$7.2.2 \quad F = \frac{G m_1 m_2}{r^2} \quad \checkmark \quad (4)$$

$$= \frac{6,7 \times 10^{-11} \times 6,42 \times 10^{23} \times 5,98 \times 10^{24}}{(2,25 \times 10^8 \times 10^3)^2} \quad \checkmark$$

$$= 5,08 \times 10^{15} \text{ N} \quad \checkmark$$

$$7.2.3 \quad g = \frac{G m_1}{r^2} \quad \checkmark \quad (4)$$

$$= \frac{6,7 \times 10^{-11} \times 6,42 \times 10^{23}}{(3380 \times 1000)^2} \quad \checkmark$$

$$= 3,77 \text{ m.s}^{-2} \quad \checkmark$$

$$7.2.4 \quad F = mg \quad \checkmark = 500 \times 3,77 \quad \checkmark = 1882,55 \text{ N} \quad \checkmark \quad (3)$$

[28]

QUESTION 8

8.1 A material's opposition to the flow of electric current ✓✓ (2)

8.2.1 voltage $V_1:V_2$ 2:1 ✓✓ (2)

8.2.2 current $A_1:A_2$ 2:1 ✓✓ (2)

8.2.3 power $P_P:P_Q$ 4:1 ✓✓ (2)

8.3.1 $I_{\text{MIXER}} = V/R \quad \checkmark = 220/110 \quad \checkmark = 2 \text{ A} \quad \checkmark \quad (3)$

8.3.2 $I_{\text{OVEN}} = P/V = 1320/220 = 6 \text{ A} \quad \checkmark$
 $I_{\text{TOT}} = 2 + 6 + 4 \quad \checkmark = 12 \text{ A} \quad \checkmark < 15 \text{ A, Yes} \quad \checkmark \quad (4)$

8.3.3 $W = P \times t = VIt = (220 \times 4)/1000 \quad \checkmark \times 2 \quad \checkmark = 1,76 \text{ kWh}$
 $\text{Cost} = 1,76 \times 116,63 \quad \checkmark = \text{R } 2,05 \quad \checkmark \quad (4)$

8.4.1 $V_{\text{lost}} = 45 - 43,5 = 1,5 \text{ V} \quad \checkmark \quad (1)$

8.4.2 $V_{\text{lost}} = IR \therefore 45 - 43,5 = I(0,5) \quad \checkmark \therefore I = 3 \text{ A} \quad \checkmark \quad (2)$

8.4.3 $V_{12} = IR = 3(12) \quad \checkmark = 36 \text{ V} \quad \checkmark$
 $V_{\parallel} = 43,5 - 36 = 7,5 \text{ V} \quad \checkmark$
 $I = V / R = 7,5 / 10 \quad \checkmark = 0,75 \text{ A} \quad \checkmark \quad (5)$

8.4.4 $I_R = 3 - 0,75 = 2,25 \text{ A} \quad \checkmark$
 $R = V / I = 7,5 / 2,25 \quad \checkmark = 3,33 \Omega \quad \checkmark \quad (3)$

8.4.5 From $E = IR + Ir$ (4)

$$R \uparrow \checkmark \quad I \downarrow \checkmark \quad V_{\text{lost}} \downarrow \checkmark \quad V_{\text{ext}} \uparrow \checkmark$$

8.5 $Q = 1.6 \times 10^{-19} \checkmark \times 10^{18} = 0,16 \text{ C}$

$$I = Q/t = 0,16 / 10 = 0,016 \text{ A } \checkmark \checkmark$$

$$V = IR = 0,016 \times 20 = 0,32 \text{ V } \checkmark \checkmark \quad (5)$$

[39]

QUESTION 9

9.1 Planck's constant $\checkmark$ (1)

9.2 *the minimum frequency of incident radiation at which electrons will be emitted from a particular metal* (2)

9.3 $W_o = hf_o$
 $= 6,6 \times 10^{-34} \times 1,4 \times 10^{15}$
 $= 9,24 \times 10^{-19} \text{ J}$ (3)

9.4.1 - increase the number $\checkmark$ of photoelectrons (1)

9.4.2 no effect on their kinetic energies / Remain the same $\checkmark$ (1)

9.5 (4)

$$E_{k,\text{max},E} = \frac{1}{2} m_e v_{\text{max},E}^2 \checkmark$$

$$2,4 \times 10^{-18} \checkmark = \frac{1}{2} (9,11 \times 10^{-31}) \checkmark v_{\text{max},E}^2$$

$$v_{\text{max},E} = 2,3 \times 10^6 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OR

$$\left. \begin{aligned} E &= W_o + E_k \\ E_k &= E - W_o \\ \frac{1}{2} mv^2 &= hf - W_o \end{aligned} \right\} \checkmark$$

$$\frac{1}{2} (9,11 \times 10^{-31}) v^2 \checkmark = (6,63 \times 10^{-34})(5 \times 10^{15}) - (9,282 \times 10^{-19}) \checkmark$$

$$v = 2,29 \times 10^6 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OR

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

[12]

TOTAL: 200