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Physics Trials exam 2017

Memorandum

Question 1 – Multiple choice

1.1 B ✓✓

1.2 A ✓✓

1.3 B ✓✓

1.4 C ✓✓

1.5 A ✓✓

1.6 D ✓✓

1.7 C ✓✓

1.8 A ✓✓

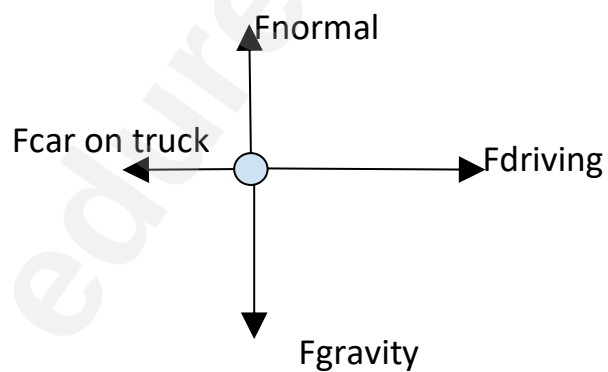
1.9 A ✓✓

1.10 C ✓✓

[10 X 2 = 20]

Question 2 – Kinematics and Newton

2.1.1



(4)

2.1.2 $F_{\text{net}} = m \times a$

$a = 2,5 \times 10^4 / 5,6 \times 10^3 \text{ kg} \checkmark \checkmark$

$= 4,46 \text{ m/s}^2 \quad \checkmark \text{ north} \checkmark$ (4)

$$\begin{aligned}
 2.1.3 \quad F_{\text{net(car)}} &= m \times a \checkmark \\
 &= 1,6 \times 10^3 \checkmark \times 4,46 \\
 &= 7143 \text{ N} \checkmark
 \end{aligned}
 \tag{3}$$

2.2.1 Constant (uniform) $\checkmark$ deceleration $\checkmark$ south $\checkmark$
 Or constantly (uniformly) $\checkmark$ decreasing velocity $\checkmark$ south $\checkmark$

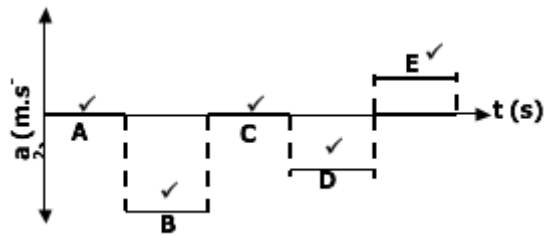
$$\begin{aligned}
 2.2.2 \quad a = \frac{\Delta v}{\Delta t} \checkmark &= \frac{-30}{6} \checkmark = \underline{-5 \text{ m.s}^{-2}} \checkmark
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 2.2.3 \quad \text{Distance} &= \text{Area A} + \text{B} \checkmark \\
 &= (30 \times 8) \checkmark + \left(\frac{1}{2} \times 6 \times 30\right) \checkmark \\
 &= \underline{330 \text{ m}} \checkmark
 \end{aligned}
 \tag{4}$$

OR A: $s = ut = (30 \times 8) \checkmark = 240 \text{ m}$
 B: (can use $v^2 = u^2 + 2as$ or $s = ut + \frac{1}{2}at^2$)
 $s = \frac{(u + v).t}{2} \checkmark = \frac{(30 + 0).6}{2} \checkmark = 90 \text{ m}$
 $s_{\text{TOTAL}} = 240 + 90 = \underline{330 \text{ m}} \checkmark$

$$\begin{aligned}
 2.2.4 \quad S_{AB} &= S_{DE} \\
 \checkmark 330 &= \left(\frac{1}{2} \times b \times 20\right) \checkmark \\
 b &= 33 \text{ s} \checkmark \\
 \text{Therefore, } t_x &= (21 + 33) = \underline{54 \text{ s}} \checkmark
 \end{aligned}
 \tag{4}$$

2.2.5



(5)

(-1 if axes not labelled)
units not needed

[30]

2.3.1 0 m✓

(1)

$$2.3.2 \quad v_f^2 = v_i^2 + 2ax \quad \checkmark$$

$$0 = 6^2 + 2(-9,8)x \quad \checkmark$$

$$x = 1,8 \text{ m} \quad \checkmark$$

(3)

$$2.3.3 \quad 2 \times 1,8 \quad \checkmark = 3,67 \text{ m} \quad \checkmark$$

(2)

2.3.4 No✓, if you travelled in a straight line✓

in one direction then the distance = x✓

(3)

$$2.3.5 \quad v_f^2 = v_i^2 + 2ax \quad \checkmark$$

$$= 6^2 + 2(-9,8)(0,7) \quad \checkmark$$

$$= 22,28$$

$$v_f = 4,72 \text{ m.s}^{-1} \quad \checkmark$$

$$v_f = v_i + at$$

$$-4,72 = 6 + (-9,8)t \quad \checkmark$$

$$t = 1,09 \text{ s} \quad \checkmark$$

or use the quadratic formula

(5)

2.4.1 $x = v_i t + \frac{1}{2} a t^2$ ✓

$= 6(1,53) + \frac{1}{2}(-9,8)(1,53)^2$ ✓

$= -2,29 \text{ m}$

$h = 2.29 \text{ m}$ ✓ (3)

2.4.2 $v_f = v_i + a t$ ✓

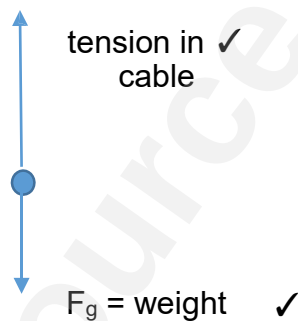
$= 6 + (-9,8)(1,53)$ ✓

$= -8,99 \text{ m.s}^{-1}$ ✓ (3)

[50]

Question 3 - Newton

3.1



labels

$T > W$ ✓

(3)

3.2 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 m (3)

3.3 $F_{\text{net}} = m a$ ✓

$T - F_g = m a$

$T - (800 \times 9,8)$ ✓ $= 800 \times 2$ ✓

$T = 9440 \text{ N}$ ✓ (4)

3.4 $T_{\max} = 18\,000\text{ N} \checkmark$

$$18\,000 - m_{\max}(9,8) = m_{\max}(2) \checkmark$$

$$18\,000 = 2m + 9,8m$$

$$18\,000 = 11,8m \checkmark$$

$$m_{\max} = 1525,42\text{ kg} \checkmark$$

therefore max CARGO = $1525,42 - 800 = 725,42\text{ kg} \checkmark$ (5) [15]

Question 4 - Momentum

4.1.1 $F_{\text{net}} \times \Delta t = \Delta p \checkmark$

$$(F_a - F_f) \times 0,5 = m(v - u)$$

$$(20 - 0,39) \checkmark \text{ N} \times 0,5 = 0,16 \checkmark (v - 0) \checkmark$$

$$v = 61,28\text{ m/s} \checkmark \quad (5)$$

4.2.1 The total linear momentum in an isolated system remains constant in magnitude and direction. (2)

4.2.2

$$\text{Total } p \text{ before} = \text{Total } p \text{ after}$$

$$mu + mu = mv + mv \checkmark$$

$$(0,16 \times 12) + 0 \checkmark = (0,16 \times -1,5) + (580/1000) \times v \checkmark$$

$$v(\text{stick}) = 3,72\text{ m/s} \checkmark \text{ in the initial direction of the ball} \checkmark$$

(5)

4.2.3

$$E_{k \text{ initial}} = \frac{1}{2} mv^2 \text{ (stick is stationary)}$$

$$= \frac{1}{2} (0.16) \times 12^2 \checkmark$$

$$= 11.52 \text{ J } \checkmark$$

$$E_{k \text{ final}} = \frac{1}{2} mv^2 + \frac{1}{2} mv^2$$

$$= \frac{1}{2} \times 0.16 \times 1.5^2 + \frac{1}{2} \times 0.58 \times 3.72^2 \checkmark$$

$$= 0.18 + 4.01$$

$$= 4.19 \text{ J } \checkmark$$

Therefore, inelastic collision because $E_{k(i)} \neq E_{k(f)}$ $\checkmark$ (5)

[17]

Question 5 - Energy

5.1.1 The E_m is an isolated system will remain constant (or the sum of E_p & E_k will be conserved in an isolated system). $\checkmark \checkmark$ (2)

$$5.1.2 \quad E_p = m \times g \times h \checkmark$$

$$= 75 \times 9.8 \times 4 \checkmark$$

$$= 2940 \text{ J } \checkmark \quad (3)$$

$$5.1.3 \quad E_m(A) = E_m(B) \checkmark$$

$$\text{Therefore, } E_k = \frac{1}{2} mv^2$$

$$2940 = \frac{1}{2} 75 \times v^2 \checkmark$$

$$v = 8.85 \text{ m.s}^{-1} \checkmark \quad (3)$$

$$\begin{aligned}
 5.2.1 \quad W_{Ff} &= F_f \times \Delta x \times \cos \theta \checkmark \\
 &= 84 \text{ N} \times 9,75 \times \cos 180^\circ \checkmark \\
 &= -819 \text{ J (negative sign not necessary)} \checkmark \text{ (c.o.e)} \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 5.2.2 \quad W_{\text{net}} &= \Delta E_k \\
 F_{\text{net}} \times \Delta x &= \frac{1}{2} m v^2 - \frac{1}{2} m v^2 \checkmark \\
 -819 \text{ J} &= \frac{1}{2} (75) (v^2) \checkmark - 2940 \text{ J} \checkmark \\
 2121 \text{ J} &= \frac{1}{2} (75) (v^2) \\
 v &= \sqrt{56,56} \\
 &= 7,52 \text{ m.s}^{-1} \checkmark \quad (4)
 \end{aligned}$$

[15]

Question 6 - Electrostatics + "G"

$$\begin{aligned}
 6.1 \quad F_{\text{attraction}} &= F_g \text{ (paper)} = 0.5 \times 10^{-3} \checkmark \times 9.8 = 0.0049 \text{ N} \checkmark \\
 F &= k Q_1 Q_2 / r^2 \checkmark \quad (\text{no c.o.e. to answer}) \\
 0.0049 &= (9 \times 10^9 \times 1 \times 10^{-9} \checkmark \times 20 \times 10^{-9}) / r^2 \\
 r &= 0.0061 \text{ m or } 6.1 \text{ mm} \checkmark \quad (5)
 \end{aligned}$$

$$\begin{aligned}
 6.2 \quad F &= G m_1 m_2 / r^2 \checkmark \\
 &= (6.7 \times 10^{-11} \times 0.5 \times 10^{-3} \checkmark \times 40 \times 10^{-3}) / (1 \times 10^{-2} \checkmark)^2 \checkmark \\
 &= 1.34 \times 10^{-11} \text{ N} \checkmark \quad (4)
 \end{aligned}$$

$$\begin{aligned}
 6.3 \quad \text{new charge on both} &= (20 - 1) / 2 = 9.5 \text{ nC} \checkmark \\
 \Delta Q &= 20 - 9.5 = 10.5 \text{ nC} \checkmark \\
 n_e &= 10.5 \times 10^{-9} / 1.6 \times 10^{-19} \checkmark = 6.56 \times 10^{10} \text{ electrons} \checkmark \quad (4)
 \end{aligned}$$

$$6.4 \quad g = GM / r^2 \checkmark = (6.7 \times 10^{-11} \times 6 \times 10^{23}) \checkmark / (3.5 \times 10^6)^2 \checkmark$$

$$= 3.28 \text{ m.s}^{-2} \checkmark \quad (4)$$

$$6.5 \quad F_g \text{ less} \checkmark \therefore \text{less } F_{\text{elec}} \text{ required} \checkmark \therefore \text{distance greater} \checkmark \quad (3)$$

[26]

Question 7 – Electricity

7.1 The total energy supplied $\checkmark$ per coulomb of charge by the cell. $\checkmark$ (2)

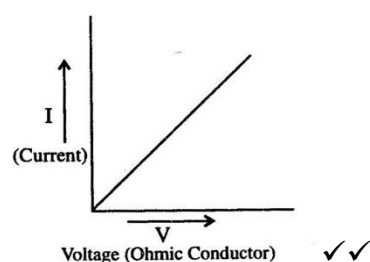
7.2.1 $\frac{1}{4}$ of 12 = 3V $\checkmark \checkmark$ (2)

7.2.2 $P = I^2 R \checkmark$ Same current flows through both $\therefore$ bulb with greater resistance will be brighter $\checkmark$ i.e. 3R $\checkmark$ (3)

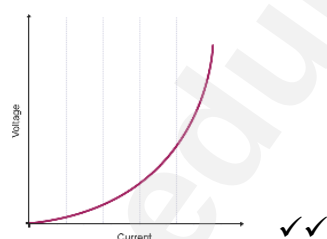
7.3.1 Current through a conductor is directly proportional to potential difference across the conductor $\checkmark$ at constant temperature. $\checkmark$ (2)

7.3.2

Ohmic conductor



Light bulb



(4)

7.4.1 Less current flows through each, so they last longer. $\checkmark$

Total internal resistance is less. $\checkmark$ (2)

7.4.2 Opposition to the flow of electric current $\checkmark$ inside a battery. $\checkmark$ (2)

$$7.4.3 \quad R_{//} = 300 / 40 = 7.5\Omega \checkmark \quad r_{//} = 1 / 2 = 0.5\Omega \checkmark$$

$$I = \varepsilon / (R + r) \checkmark = 1.6\checkmark / 8 = 0.2 \text{ A} \checkmark \quad (5)$$

$$7.4.4 \quad V = IR_{\text{ext}} \checkmark = 0.2 (7.5) \checkmark = 1.5 \text{ V} \checkmark \quad (3)$$

$$7.4.5 \quad R \text{ increases; } \checkmark I \text{ decreases; } \checkmark V_{\text{lost}} \text{ decreases; } \checkmark V_{\text{ext}} \text{ increases} \checkmark \quad (4)$$

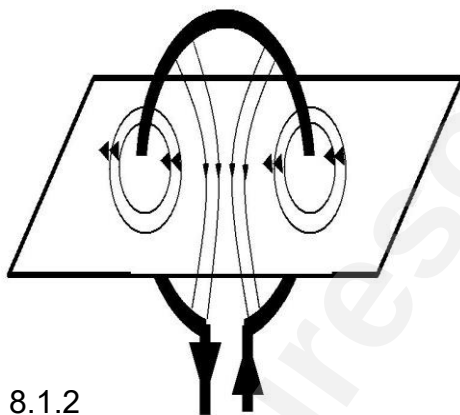
[29]

Question 8 - Electrodynamics

8.1.1

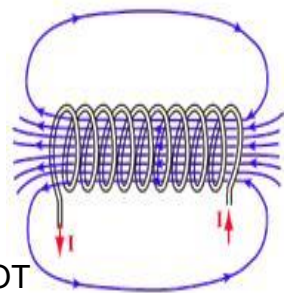
- o Circular magnetic field around conductors. $\checkmark$ (use ampere's right hand rule for each side of coil)
- o Lines showing stronger field through centre of coil. $\checkmark$ (This was NOT shown in most of the answers.)
- o Direction correct. $\checkmark$

(3)



8.1.2

- o North on left. $\checkmark$ (use right hand rule – fingers in current direction and thumb points to North)
- o Low density of field lines outside coil. $\checkmark$
- o Fields lines concentrated inside coil. $\checkmark$ (This was NOT shown in most of the answers.)
- o Direction of lines from N to S. $\checkmark$ (Lines come out of North and go towards South on outside of coil but run through centre of coil from South to North)



(4)

8.1.3 Iron core (bar) $\checkmark$

(1)

8.2.1 Use a stronger magnet/increase current. $\checkmark \checkmark$

(2)

8.2.2 **Newton's third law:** When object A exerts a force on object B, object B

simultaneously exerts

an oppositely directed force ✓ of equal magnitude on object A. ✓ (2)

8.2.3 Reading will **decrease**. ✓

The magnetic field exerts a force downwards on conductor (given in question)
∴ the conductor

will exert an **upwards** force on the magnet. ✓✓ (∴ less force on balance). (3)

8.3.1 **Faraday's law of electromagnetic induction**: the emf induced is directly proportional ✓ to the rate of change of magnetic flux ✓ (2)

8.3.2 There is a **CHANGE in magnetic flux** ✓✓ in the coil as the magnetised string vibrates. (2)

[19]

Question 9 – Photons + Electrons

9.1 The photoelectric effect ✓ (1)

9.2 Electroscope ✓ (1)

9.3 The minimum frequency of incident radiation at which electrons will be emitted from a particular metal. ✓✓ (2)

9.4 $W_0 = hf_0$ ✓
 $(3,1 \times 1,6 \times 10^{-19}) = (6,6 \times 10^{-34})f_0$ ✓
 $f_0 = 7,52 \times 10^{14} \text{ Hz}$ ✓ (4)

9.5	$c = \lambda f$	OR	$E = \frac{hc}{\lambda}$
	$(3 \times 10^8) = (340 \times 10^{-9})f$ ✓		$E = \frac{(6,6 \times 10^{-34})(3 \times 10^8)}{(340 \times 10^{-9})}$ ✓
	$f = 8,82 \times 10^{14} \text{ Hz}$ ✓		$E = 5,82 \times 10^{-19} \text{ J} = 3,64 \text{ eV}$ ✓
	$f > f_0$ ✓		$E > W_0$ ✓
	Therefore, electrons will be emitted (3)		Therefore, electrons will be emitted

9.6 $E = W_0 + E_K^{\max}$ ✓
 $\frac{hc}{\lambda} = W_0 + E_K^{\max}$
 $\frac{(6,6 \times 10^{-34})(3 \times 10^8)}{(340 \times 10^{-9})} = (3,1 \times 1,6 \times 10^{-19}) + E_K^{\max}$ ✓✓
 $E_K^{\max} = 8,64 \times 10^{-20} \text{ J}$ ✓ (4)

[15]

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