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PHYS PRELIM MEMO 2017 Q 1-5

question 1

11. B ✓✓ 16. B ✓✓
 12. D ✓✓ 17. C ✓✓
 13. C ✓✓ 18. B ✓✓
 14. B ✓✓ 19. D ✓✓
 15. D ✓✓ 20. C ✓✓

[20]

question 2

1. Twice ✓ (1)

height = area

$$= \frac{1}{2} b \times h$$

$$= \frac{1}{2} (1 \times 9)$$

$$= 4.5 \text{ m} \quad (3)$$

2. rate of change of velocity (2)

$$\text{accel} = \text{gradients} = \frac{\Delta y}{\Delta x}$$

$$= -9/1$$

$$= -9.0 \text{ ms}^{-2}$$

earth: both

$$9.8 : 9$$

$$1.09 : 1$$

$$\therefore \text{ratio: } -9/-9.8 = 0.92 \times \text{earth} \quad (4)$$

$$F_{at} = m \Delta v$$

$$F(0,2) = 0.4(9 - (-9))$$

$$F = 36 \text{ N upwards} \quad (5)$$

$$F_{at} = m \Delta v$$

$$= 0.4(9 - (-9))$$

$$= 7.2$$

$$F_{app} = F_{net} - F_g$$

$$= 36 - (0.4)(9)$$

$$= 32.4 \text{ N upwards}$$

$$F_{net} = 7.2/0.2$$

$$= 36 \text{ N}$$

2.6 - yes it is an elastic collision ✓

- but wrong reasoning;

same velocity after each bounce ✓ $\therefore E_k$ conserved (3)

$$2.7 \quad s = ut + \frac{1}{2}gt^2$$

$$= (-3)(2) + \frac{1}{2}(-9)(2)^2$$

$$= -25.6 \text{ m} \quad -24 \text{ m}$$

$$\therefore \text{height} = 25.6 \text{ m} \quad (3)$$

$$2.8 \quad v = u + gt$$

$$= -3 + (-9)(2)$$

$$= -22.6 \text{ ms}^{-1}$$

$$\therefore 22.6 \text{ ms}^{-1} \text{ downwards} \quad (3)$$

don't double
penalisefor $g = 9.8$

2.9 COE 2.7

2.4 25.6 ✓ axes with units

s (m)

shape

2 ✓ t(s) (4)

question 3

$$3.1 \quad F_f = \mu F_N$$

$$= 0.9(82 \times 9.8)$$

$$= 723.14 \text{ N} \quad (4)$$

question 4

4.1 BB: $v = u + at$ B: $v = u + at$
 $= 0 + 5(3) \checkmark$ $= 6 + (4)(2) \checkmark$
 $= 15 \text{ m s}^{-1} \checkmark$ $= 14 \text{ m s}^{-1} \checkmark$ (4)

4.2 "The total linear momentum of an isolated system remains constant" (is conserved in both magnitude and direction)" (2)

4.3 $p_i = p_f \rightarrow +ve$
 $m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$
 $(1763)(15) + (1682)(-14) = (1763 + 1682) v$
 $2897 = 3445 v$
 $v = 0,84 \text{ m s}^{-1} \text{ right} \checkmark$ (5)

4.4 Barricade + hook: $p_i = p_f$
 $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$
 $(1682)(4) + 0 = (1682)(13) + (100)v$
 $v = 16,82 \text{ m s}^{-1} \checkmark$
 crane hook: $E_{k \text{ bott}} = E_{p \text{ top}}$
 $\frac{1}{2} m v^2 = mgh$
 $\frac{1}{2} (100)(16,82)^2 = (100)(9,8)h$
 $h = 14,43 \text{ m} \checkmark$ (8)

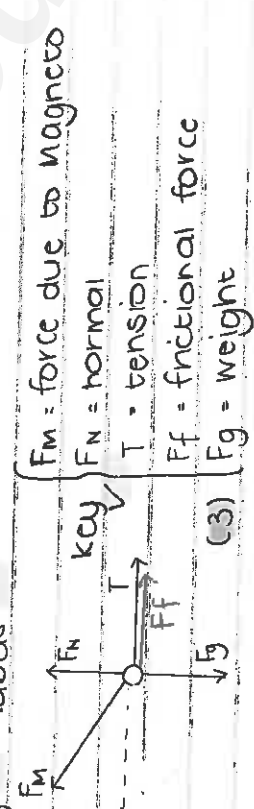
3.2 When a net force, F_{net} , is applied to an object of mass m , it accelerates in the direction of the net force. The acceleration, a , is directly proportional to the net force and inversely proportional to the mass" (3)

alternatively:

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

3.3 W: $T - F_f = ma$ $\text{oe } 3.1$
 $T - 723,24 = 82(a) \checkmark$
 X: $F_g - T = ma$ $(104)(9,8) - T = 104(a) \checkmark$
 $295,96 = 186a$
 $a = 1,59 \text{ m s}^{-2} \text{ (6)}$

diag labels $\checkmark$



3.4 F_m = force due to magnets
 F_N = normal
 T = tension
 F_f = frictional force
 F_g = weight

3.5 W: $T_1 h - T_2 - F_f = ma$ $T_1 h - \frac{1}{2} - 600 = 82(0,4) \checkmark$
 X: $T_2 - F_g = ma$ $\frac{1}{2} - (104)(9,8) = 104(0,4) \checkmark$
 $T_1 h - 1619,2 = 74,40$
 $T_1 h = 1693,6 \text{ N}$
 $T_2 = 1060,8 \text{ N} \checkmark$
 $T_h = T \cos \theta \checkmark$
 $1693,6 = T \cos 35^\circ \checkmark$
 $T = 2067,6 \text{ N} \checkmark$ (6)

question 5

$$\begin{aligned} 5.1 \quad E_p &= mgh \\ &= (95 \times 9.8 \times 8.55) \\ &= 7960.05 \text{ J} \end{aligned}$$

$$\sin 20^\circ = \frac{x}{25}$$

$$\therefore x = 8.55 \text{ m} \quad (4)$$

$$\begin{aligned} 5.2 \quad W_f &= F_f \cdot s \\ &= 50(25) \\ &= 1250 \text{ J} \end{aligned}$$

$$E_k = E_p - W_f$$

$$= 7960.05 - 1250$$

$$= 6710.05 \text{ J}$$

$$E_k = \frac{1}{2}mv^2$$

$$6710.05 = \frac{1}{2}(95)v^2$$

$$v = 11.89 \text{ ms}^{-1} \quad (8)$$

$$(E_p + E_k)_i = (E_p + E_k)_f + W_f$$

$$7960.05 = \frac{1}{2}(95)v^2 + 1250$$

$$\therefore v = 11.89 \text{ ms}^{-1}$$

5.3 "The work done by a net force on an object is equal to the change in kinetic energy of the object." (2)

$$\begin{aligned} 5.4 \quad W_{\text{net}} &= \Delta E_k \\ \therefore \Delta E_k &= F_{\text{net}} \cdot s \\ 6710.05 &= F_{\text{net}}(15) \\ F_{\text{net}} &= 447.34 \text{ N} \quad (3) \end{aligned}$$

[17]

question 6

6.1 "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)

$$\begin{aligned} 6.2 \quad F_{FR} &= G \frac{m_1 m_2}{r^2} \\ &= (6.7 \times 10^{-11}) (54)(8 \times 10^{-3}) \\ &\quad (70 \times 10^{-2})^2 \end{aligned}$$

$$= 5.91 \times 10^{-11} \text{ N left}$$

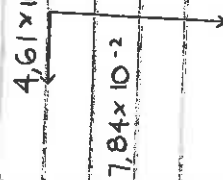
$$F_{RG} = G \frac{m_1 m_2}{r^2}$$

$$= (6.7 \times 10^{-11}) (85)(8 \times 10^{-3})$$

$$(120 \times 10^{-2})^2$$

$$= 1.30 \times 10^{-11} \text{ N right}$$

$$\begin{aligned} F_R &= mg = (8 \times 10^{-3})(9.8) \\ &= 7.84 \times 10^{-2} \text{ N down} \end{aligned}$$



$$\begin{aligned} R^2 &= (4.61 \times 10^{-2})^2 + (7.84 \times 10^{-2})^2 \\ \therefore R &= 6.15 \times 10^{-2} \\ \therefore R &= 7.84 \times 10^{-2} \text{ N} \quad (9) \end{aligned}$$

6.3 "The force per unit positive charge" (1)

$$6.4 \quad E = kq/r^2$$

$$= (9 \times 10^9) (-2 \times 10^{-9})$$

$$(9 \times 10^{-2})^2$$

$$= -2222,22 \text{ NC}^{-1} \quad \therefore 2222,22 \text{ NC}^{-1} \text{ towards ring (4)}$$

$$6.5 \quad E' = k2q/(1/2r)^2$$

$$= 2kq/1/4r^2$$

$$= 8E \quad (2)$$

$$6.6 \quad F = kq_1q_2/r^2$$

$$10 = (9 \times 10^9) (-2 \times 10^{-9}) q_2 / (5 \times 10^{-3})^2$$

$$\therefore q_2 = 1,39 \times 10^{-9} \text{ C} \quad (4)$$

6. Coulombs law (1)

[23]

7

question 7

7.1 2C of charge pass a point per second (2)

$$7.2 \quad \text{emf} = I(R+r)$$

$$12 = 2(R+0,33)$$

$$\therefore R = 5,67 \Omega \quad (3)$$

$$7.3 \quad V = IR \quad \text{or} \quad V_{\text{lost}} = Ir \quad \therefore 12 - 0,66 = 2(5,67) \\ = 11,34 \text{ V} \quad (3) \quad = 2(0,33) = 0,66 \text{ V} \\ = 11,34 \text{ V}$$

$$7.4 \quad V_{30} = IR \quad \therefore V_2 = 11,34 - 6 = 2(3) = 6 \text{ V} \quad (4) \\ = 5,34 \text{ V}$$

$$7.5 \quad V_{RP} = V_{R_1} + V_{R_2} \quad V = IR \\ = 2(2,67) = 5,34 \text{ V} \\ \therefore R_P = 2,67 \Omega \quad (4)$$

alternatively:

$$R = V/I \\ = 5,34/2$$

$$V_{RP} = V_{R_1} + V_{R_2}$$

$$= 2,67 \Omega \quad 2,67 = V_{3+R_x} + V_4$$

$$\therefore R_{oc} = 5 \Omega$$

$$\begin{aligned}
 1.6 \quad Q &= It \quad - \\
 &= (1.34)(10) \quad - \\
 &= 13.4C \quad - (5) \\
 I_b &= I_b \times P_b / P_b \\
 &= 2 \times 2.67 / 4 \quad - \\
 &= 1.34A \quad -
 \end{aligned}$$

- 1.7 - total external resistance would increase $\checkmark$
 - total current would $\therefore$ decrease $\checkmark$
 - lost volts $\therefore$ decrease $\checkmark$
 - reading on V_1 would increase $\checkmark$ (4)

[25]

question 8

8.1 electrical to mechanical $\checkmark$ (1)

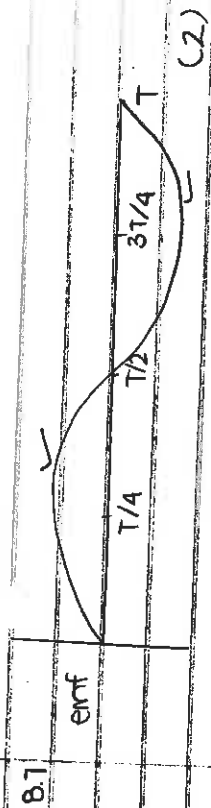
8.2 split-ring commutator $\checkmark$ (1)

8.3 4-3-2-1 $\checkmark$ (2)

- 8.4 - replace the DC input with a mechanical input $\checkmark$
 - replace the split-ring commutator with
 elip rings $\checkmark$ (2)

8.5 "The induced emf is directly proportional to
 the rate of change of magnetic flux" (2)

- 8.6 - stronger magnets $\checkmark$
 - more loops on coil $\checkmark$
 - faster rotation $\checkmark$ (3)



8.8 allows current to only flow in 1 direction $\checkmark$ (1)

8.9 graph A: full wave rectification $\checkmark$

- current flows through either D_1 and D_2
 or D_3 and D_4 to complete the circuit $\checkmark$
- in either option the current through the
 load resistor is in the same direction $\checkmark$ (2)

8.10 step-up $\checkmark$ (1)

8.11

$$\begin{aligned}
 N_p / N_s &= I_s / I_p \quad - \\
 20 / 80 &= I_s / 5 \quad -
 \end{aligned}$$

$$\therefore I_s = 1.25A \quad - (3)$$

8.12 - zero voltage in secondary coil

- emf only induced if there is a changing
 magnetic flux $\therefore$ needs AC not DC $\checkmark$ (2)

$$\begin{aligned}
 8.13 \quad P &= VI \quad - \quad P_p = P_s \\
 &= (12)(5) \quad - \\
 &= 60W \quad - (3)
 \end{aligned}$$

question 9

9.1 minimum frequency of incident radiation at which electrons will be emitted from a particular metal $\sim (2)$

9.2 - incoming photons (with sufficient energy) will cause electrons to be ejected $\therefore$ completing the circuit $\sim (3)$

$$\begin{aligned} 9.3 \quad W_0 &= hf_0 \\ &= 6,6 \times 10^{-34} (4 \times 10^{14}) \\ &= 2,64 \times 10^{-19} \text{ J} \quad \sim (3) \end{aligned}$$

$$\begin{aligned} 9.4 \quad E &= W_0 + E_{K \max} \\ hc/\lambda &= hf_0 + E_K \\ (6,6 \times 10^{-34}) (3 \times 10^8) &= 2,64 \times 10^{-19} + E_K \\ E_K &= 1,56 \times 10^{-19} \text{ J} \\ &= 800 \times 10^{-19} \end{aligned}$$

$$\begin{aligned} &\sim 1,396 \times 10^{-18} = 2,64 \times 10^{-19} + E_K \\ &2,48 \times 10^{-19} \text{ J} \quad E_K \sim 1,32 \times 10^{-19} \text{ J} \quad \text{incoming } E < W_0 \\ &\therefore \text{no } e^- \text{ ejected} \end{aligned}$$

$$\begin{aligned} E_K &= \frac{1}{2} mv^2 \\ 1,32 \times 10^{-19} &= \frac{1}{2} (9,1 \times 10^{-31}) v^2 \\ \therefore v &= 5,39 \times 10^5 \text{ ms}^{-1} \quad \sim (1) \end{aligned}$$

9.5 greater intensity means more photons $\therefore$ more photoelectrons $\sim$ same velocity $\sim (4)$ [19]