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# PHYS PRELIM 21

## Question 1

1.1 C ✓✓

1.6 B ✓✓

1.2 D ✓✓

1.7 C ✓✓

1.3 D ✓✓

1.8 A ✓✓

1.4 C ✓✓

1.9 D ✓✓

1.5 A ✓✓

1.10 C ✓✓

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working out:

1.2  $F_{g\parallel} = ma$

$\sin 30^\circ = o/h$

$(0,5)(9,8) \sin 30^\circ = 0,5a$

$\therefore h = 5 / \sin 30^\circ$

$\therefore a = 4,9 \text{ ms}^{-2}$

$= 10 \text{ m}$

$s = ut + \frac{1}{2}at^2$

$10 = 0 + \frac{1}{2}(4,9)t^2$

$t = 2,02 \text{ s}$

4  $p = \text{area}$

$40 = \frac{1}{2}(1)x + (4x) + \frac{1}{2}(1)x$

$\therefore x = 10$

5  $p = W/t = mgh/t$

$\therefore 240 = (100)h/2,5$

$h = 6 \text{ m}$

6  $E = kQ/r^2$  ;  $E' = k(2Q)/(2r)^2 = 2kQ/4r^2 = \frac{1}{2}kQ/r^2$

$\therefore E' = \frac{1}{2}E$

7  $R_T \downarrow I_T \uparrow V_{lost} \uparrow V \downarrow$

8  $W_0 = hf_0 = (6,6 \times 10^{-34})(4 \times 10^{14})$   
 $= 2,64 \times 10^{-19} \text{ J}$

## Question 2

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

$$-10 = u + (-9,8)(3) \quad \checkmark$$

$$u = 19,4 \text{ ms}^{-1} \quad \checkmark (3)$$

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

$$0 = 20 + (-9,8)t \quad \checkmark (2)$$

$$t = 2,04 \text{ s}$$

$$\begin{aligned} \text{height} &= \text{area} = \frac{1}{2}bh \quad \checkmark \\ &= \frac{1}{2}(2,04)(20) \quad \checkmark \\ &= 20,4 \text{ m} \quad \checkmark (3) \end{aligned}$$

$$\text{or } v^2 = u^2 + 2gs$$

$$0 = (20)^2 + 2(-9,8)s$$

$$s = 20,4 \text{ m}$$

$$4 \text{ rate of change of velocity} \quad \checkmark (1)$$

$$5 \quad v = u + gt$$

$$-18 = 20 + (-9,8)t$$

$$t = 3,88 \text{ s} \quad \checkmark$$

$$a = \frac{\Delta y}{\Delta x} \quad \checkmark$$

$$= \frac{2 - (-18)}{4} = 3,88 \quad \checkmark$$

$$= 166,67 \text{ ms}^{-2} \quad \checkmark (4)$$

$$2.6 - \text{no} \quad \checkmark$$

$$- \text{different displacements (area above - area below)} \quad \checkmark (2)$$

$$2.7 \quad T-1000 \text{ in reaction time}$$

$$s = ut = (180/3,6) \times 1$$

$$= 50 \text{ m} \quad \checkmark$$

$$s = ut + \frac{1}{2}at^2 \quad \checkmark$$

$$T-800 \text{ in rxn time}$$

$$25 \text{ m}$$

$$T-800 \quad u = 25 \text{ ms}^{-1}$$

$$T-800 : T-1000$$

$$25t + \frac{1}{2}(2,5)t^2 = (50)t + \text{distance apart} \quad (50-25)$$

$$0 = -1,25t^2 + 25t + 25$$

$$\therefore t = 20,95 \text{ s} \quad \checkmark \text{ from acceleration} \quad (6)$$

$$(t = 21,95 \text{ total})$$

$$8 \quad s = 25(20,95) + \frac{1}{2}(2,5)(20,95)^2$$

$$= 1072,38 \text{ m} + 25 \text{ m} = 1097,38 \text{ m} \quad (1)$$

9 rate of change of distance ✓ (1)

$$10 \quad \text{speed} = \frac{\text{dist}}{\text{time}} \quad \checkmark$$

$$= 8500 / 26 \times 60 \quad \checkmark$$

$$= 5,45 \text{ ms}^{-1} \quad \checkmark \quad (2)$$

$$11 \quad \text{speed} = \frac{\text{dist}}{\text{time}} \quad \checkmark$$

$$= 1500 / 4 \times 60 \quad \checkmark$$

$$= 6,25 \text{ ms}^{-1} \quad \checkmark \quad (2)$$

$$12 \quad v = u + at \quad \checkmark$$

$$6,25 = 5,45 + (0,3)t \quad \checkmark$$

$$t = 2,675 \quad \checkmark \quad (3)$$

3 - no ✓  
- same  $F_{\text{net}}$  ( $F_{g1}$ ) ∴ same acceleration ✓ (2)

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### Question 3

3.1 Newton's first law : an object continues in a state of rest or uniform velocity unless it is acted upon by a net or resultant force ✓ (2)

$$3.2 \quad T - F_g = ma \quad \checkmark$$

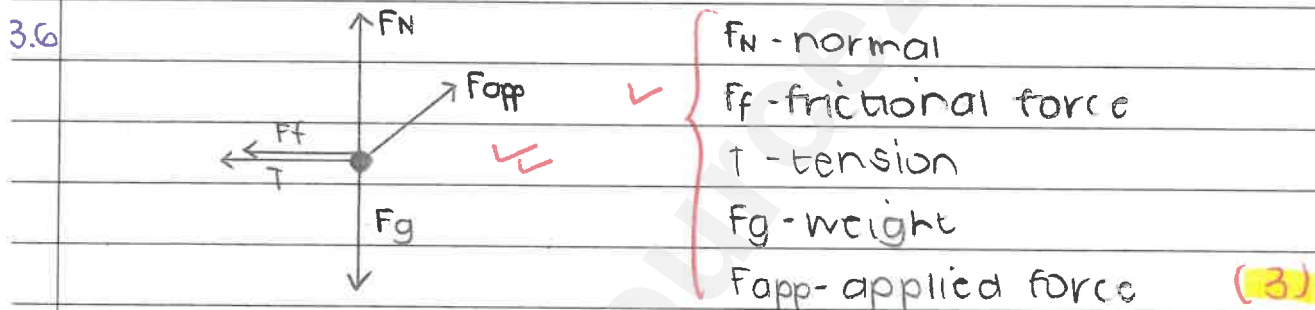
$$T - (816 + 100)(9,8) = (816 + 100)(1,5) \quad \checkmark$$

$$T = 10350,8 \text{ N} \quad \checkmark \quad (3)$$

3.3  $m: T - F_{g\parallel} = ma$  Downloaded from eduresourceza.com  $T - mg \sin 30^\circ = ma$  } ✓  
 $2m: F_g - T = ma$  ✓  $2mg - T = 2ma$  } ✓  
 $2mg - 0.5mg = 3ma$  } ✓  
 $1.5mg = 3ma$  } ✓  
 $1.5g = 3a$  } ✓  
 $\therefore a = \frac{1}{2}g$  (4)

3.4 the perpendicular force exerted by a surface on an object in contact with it ✓ (1)

3.5  $F_f = \mu F_N = \mu F_g \cos \theta$  ✓  
 $= (0.35)(100)(9.8) \cos 22^\circ$  ✓  
 $= 318.02 \text{ N}$  ✓ (3)



3.7  $F_f = \mu F_N$   
 $= \mu (F_g - F_{appv})$  ✓  
 $= \mu (F_g - F_{app} \sin 15^\circ)$  (1)

3.8 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 ✓ (2)

3.9 A:  $F_h - T - F_f = ma$  ✓  $F \cos 15^\circ - T - 0,35 [(150 \times 9,8) - F \sin 15^\circ] = 150(2)$   
 B:  $T - F_f - F_{g_{||}} = ma$  ✓  $T - 318,02 - (100 \times 9,8) \sin 22^\circ = 100(2)$  ✓  
 $F \cos 15^\circ - 514,5 - 0,35 F \sin 15^\circ$   
 $- 318,02 - 367,12 = 500$   
 $0,97F - 0,091F - 1199,64 = 500$   
 $\therefore 0,875F = 1699,6$   
 $F = 1942,45 \text{ N}$  ✓

(6)

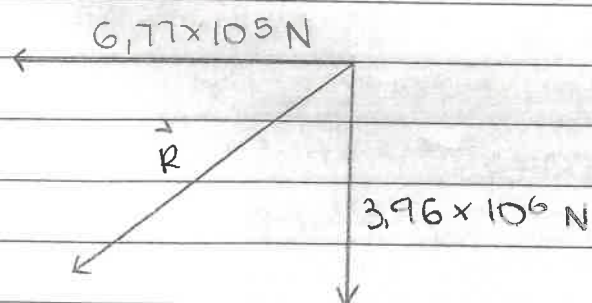
[25]

## Question 4

1  $v = s/t \therefore s = v \times t$   
 $= 20 \text{ km} \cdot \text{s}^{-1} \times (2 \times 365 \times 24 \times 60 \times 60)$   
 $= 1,26 \times 10^9 \text{ km}$  ✓ (1)

2 Every particle with mass 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 ✓ (1)

3  $F_{TE} = G m_1 m_2 / r^2$  eq ✓  $F_{SE} = G m_1 m_2 / r^2$   
 $= (6,7 \times 10^{-11}) (1,3 \times 10^{23}) (1820 \times 10^3) / (2 \times 10^3 \times 10^3)^2$  ✓  $= (6,7 \times 10^{-11}) (5 \times 10^{26}) (1820 \times 10^3) / (3 \times 10^5 \times 10^3)^2$   
 $= 3,96 \times 10^6 \text{ N}$  ✓  $= 6,77 \times 10^5 \text{ N}$  ✓



$R^2 = (6,77 \times 10^5)^2 + (3,96 \times 10^6)^2$   
 $\therefore R = 4,02 \times 10^6 \text{ N}$  ✓

(1)

4.4 a region in space where a mass will experience a force ✓ (1)

4.5  $F_g = mg$

$$8000 = m(9,8)$$

$$m = 816,32 \text{ kg} \quad \checkmark$$

$$g' = G(95M)/(9R)^2 \quad \checkmark$$

$$= 95/81 GM/R^2$$

$$= 95/81 g \quad \checkmark$$

$$= 11,49 \text{ ms}^{-2} \quad \checkmark$$

$$\therefore F_{g'} = (816,32 \times 11,49)$$

$$= 9379,52 \text{ N} \quad \checkmark \quad (5)$$

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### Question 5

5.1 the total linear momentum of an isolated system remains constant ✓ (1)

5.2  $p_i = p_f$

$$(m_1 + m_2)u = m_1 v_1 + m_2 v_2 \quad \checkmark$$

$$0 = (0,680)v + (10,2 \times 10^{-3} \times 290)$$

$$v = -4,35 \text{ ms}^{-1}$$

$$\therefore 4,35 \text{ ms}^{-1} \text{ (backwards)} \quad \checkmark \quad (5)$$

5.3 - no ✓

- not action-reaction pairs ✓

- not same force  $\therefore$  not same impulse ✓ (3)

5.4

$$p_i = p_f$$

$$m_1 u_1 + m_2 u_2 + m_3 u_3 + m_4 u_4 = (m_1 + m_2 + m_3) v + m_4 v_4 \quad (2)$$

5.5 - no ✓

- elastic collisions mean both momentum and kinetic energy must be conserved ✓ (2)

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## Question 6

5.1

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

$$0 = (10)^2 + 2a(40 \times 10^{-2})$$

$$a = -125 \text{ ms}^{-2} \quad \checkmark$$

$$F_{\text{net}} = ma$$

$$= (220)(125)$$

$$= 275 \times 10^4 \text{ N} \quad \checkmark$$

$$F_{\text{net}} = F_{\text{pole}} - F_g$$

$$2,75 \times 10^4 = F_{\text{pole}} - (220)(9,8)$$

$$F_{\text{pole}} = 26956 \text{ N}$$

(5)

5.2 the sum of the gravitational potential energy and kinetic energy at a point ✓ (1)

6.3

$$E_{\text{m bottom}} = \frac{1}{2}mv^2$$

$$= \frac{1}{2}(500)(10)^2$$

$$= 2,5 \times 10^4 \text{ J} \quad \checkmark$$

formulae ✓

$$E_{\text{m @ 3,9m}} = \frac{1}{2}mv^2 + mgh$$

$$= \frac{1}{2}(500)(7)^2 + (500)(9,8)(3,9)$$

$$= 1,225 \times 10^4 + 1,911 \times 10^4$$

$$= 3,14 \times 10^4 \text{ J}$$

$$(31360)$$

$$\therefore \Delta E_{\text{m}} = 6360 \text{ J} \quad \checkmark$$

(5)

4 the work done by a net force on an object is equal to the change in kinetic energy of the object ✓ (1)

6.5  $W_{\text{net}} = \Delta E_k$  ✓

$$F_{\text{net}, 6} = 2,5 \times 10^4 - 1,225 \times 10^4$$

$$F_{\text{net}}(7,8) = 1,275 \times 10^4 \text{ ✓}$$

$$F_{\text{net}} = 1634,62 \text{ N ✓ (3)}$$

6.6 A ✓ (2)

6.7 in the absence of air resistance or any external forces, the mechanical energy of an object is constant ✓ (1)

6.8 speed needed:  $v = \sqrt{gR}$   
 $= \sqrt{(9,8)(20)}$   
 $= 14 \text{ ms}^{-1} \text{ ✓}$

at point D:  $E_m = E_p + E_k$

$$mgh = mgh + \frac{1}{2}mv^2 \text{ ✓}$$

$$(500)(9,8)(60) = (500)(9,8)(40) + \frac{1}{2}(500)v^2 \text{ Sub ✓}$$

$$2,94 \times 10^5 = 1,96 \times 10^5 + 250v^2$$

$$\therefore v = 19,80 \text{ ms}^{-1} \text{ ✓}$$

$\therefore$  does meet requirements ✓ (6)

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## Question 7

7.1 the force per unit positive charge ✓ (1)

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$$\# e^- = Q/q_e = 20 \times 10^3 / 1,6 \times 10^{-19} \\ = 1,25 \times 10^{23} e^- \quad \checkmark \quad (1)$$

$$3 \quad E_1 = E_2 \quad \checkmark \\ KQ/r^2 = KQ/r^2$$

$$\frac{(9 \times 10^9) Q}{(7)^2} = \frac{(9 \times 10^9)(20 \times 10^3)}{(15)^2} \quad \checkmark$$

$$\therefore Q = 4355,56 \text{ C} \quad \checkmark \quad (4)$$

4 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 ✓ (1)

$$5 \quad F = Kq_1 q_2 / r^2 \quad \checkmark$$

$$= \frac{(9 \times 10^9)(4355,56)(20000)}{(15 + 7)^2} \quad \checkmark$$

$$= 1,62 \times 10^{15} \text{ N} \quad \checkmark \quad (4)$$

[11]

### Question 8

1 the rate at which work is done ✓ (1)

$$2 \quad P = I^2 R \quad \checkmark$$

$$40 = (2)^2 R \quad \checkmark$$

$$R = 10 \Omega \quad \checkmark \quad (3)$$

$$3 \quad \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \quad \checkmark$$

$$= \frac{1}{10} + \frac{1}{20} \quad \checkmark$$

$$\therefore R_p = 6,67 \Omega \quad \checkmark \quad (3)$$

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3.4  $I_b = I_t \times R_p / R_b$

$$2 = \frac{I_t \times 6,67}{10}$$

$$I_t = 3,00 \text{ A} \quad (3)$$

3.5  $V = IR$  }  $13 = 5 + 6,67 + R$   
 $39 = 3R$  }  $\therefore R = 1,33 \Omega \quad (3)$   
 $R = 13 \Omega$

8.6  $W = I^2 R t$  ✓ sub  
 $= (3)^2 5 (60 \times 60)$   
 $= 1,62 \times 10^5 \text{ J} \quad (3)$

8.7 the total energy supplied per coulomb of charge by the cell ✓ (1)

8.8  $V_{lost} = Ir$  ✓  $\text{emf} = I(R+r)$   
 $(45 - 39) = 3r$  ✓  $45 = 3(13 + r)$   
 $r = 2 \Omega \quad (3) \quad r = 2 \Omega$

8.9 a component that only allows current to flow in one direction ✓ (1)

3.10 - no effect ✓  
 - diode is reverse-biased  $\therefore$  no current flows in the branch ✓ (2)

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### Question 9

9.1 mutual induction ✓ (1)

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12 battery is DC  $\therefore$  no change in magnetic flux ✓ (1)

13 power same across both coils

$$\therefore P = VI \quad \checkmark$$

$$100 = 12(I) \quad \checkmark$$

$$I = 8.33A \quad \checkmark (3)$$

14 step up ✓ (1)

5 the induced emf is directly proportional to the rate of change of magnetic flux ✓ (1)

6 sound waves cause coil to move across magnets  $\therefore$  induced current ✓ (1)

7 - stronger magnet ✓

- more turns on the coil ✓ (1)

8 Lenz's law ✓ (1) the induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux

9 Y  $\rightarrow$  X ✓ (1)

10 Y- split-ring commutator ✓

Z- armature ✓ (2)

11 reverses the direction of the current in the loop every half-rotation ✓ (1)

12 electrical  $\rightarrow$  mechanical ✓ (1)

13 X ✓ (1)

14 when the armature is vertical ✓ (1)

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## Question 10

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10.1  $E = hc/\lambda$  ✓

$$= \frac{(6,6 \times 10^{-34}) (3 \times 10^8)}{486 \times 10^{-9}}$$

$$= 4,07 \times 10^{-19} \text{ J} \quad \text{✓} \quad (3)$$

10.2 lower ✓ (1)

10.3  $c = f\lambda$  ✓

$$3 \times 10^8 = f(10 \times 10^{-6}) \quad \text{✓}$$

$$f = 3 \times 10^{13} \text{ Hz} \quad \text{✓} \quad (3)$$

0.4 photon - discrete packet of light energy ✓

photoelectron:  $e^-$  released from metal surface due to the photoelectric effect ✓ (2)

0.5 the minimum amount of energy needed to emit an  $e^-$  from the surface of a metal ✓ (1)

0.6  $W_0 = hf_0$  ✓

$$3 \times 1,6 \times 10^{-19} = 6,6 \times 10^{-34} (f_0) \quad \text{✓}$$

$$f_0 = 7,27 \times 10^{14} \text{ Hz} \quad \text{✓}$$

$$3 \times 10^{13} < 7,27 \times 10^{14} \quad \text{✓} \quad (4)$$

Or:  $E = hf$

$$= (6,6 \times 10^{-34}) (3 \times 10^{13})$$

$$= 1,98 \times 10^{-20} \text{ J}$$

$$= 0,12 \text{ eV}$$

$$0,12 \text{ eV} < 3,00 \text{ eV}$$

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10.7

$$E = W_0 + E_k$$

$$hf = W_0 + E_k$$

$$(6,6 \times 10^{-34})(3 \times 10^{15}) = (3 \times 1,6 \times 10^{-19}) + E_k$$

$$1,98 \times 10^{-18} = 4,8 \times 10^{-19} + E_k$$

$$\therefore E_k = 1,5 \times 10^{-18} \text{ J}$$

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

$$1,5 \times 10^{-18} = \frac{1}{2}(9,1 \times 10^{-31})v^2$$

$$v = 1,82 \times 10^6 \text{ ms}^{-1}$$

(5)

10.8 stay the same (1)

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