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QUESTION 1

1.1 D

1.2 A

1.3 A

1.4 D

1.5 B

1.6 D

1.7 C

1.8 C

1.9 B

1.10 B

[20]

QUESTION 2

2.1.1 **Resultant vector** is the single vector which has the same effect as the original vectors acting together. ✓ (2)

2.1.2 $(4 - 1,2) = \underline{2,8 \text{ m.s}^{-1}}$ ✓ west. ✓ (2)

2.1.3 $t = \frac{s}{v} \checkmark = \frac{120}{3} \checkmark = \underline{40 \text{ s}}$ ✓ (3)

2.1.4 **Displacement** is a change in position. ✓✓ (2)

2.1.5 $s = u \times t$
 $= 2,8 \times 40 \checkmark$ c.o.e from 2.1.2 and 2.1.3.
 $= \underline{112 \text{ m}}$ ✓ west ✓ (3)

2.2.1 **PARCEL** ↓ +

$$u = 0$$

$$v = x$$

$$a = 9,8 \text{ m.s}^{-1}$$

$$s = 150 \text{ m}$$

$$t = ?$$

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

$$150 = 0 + \frac{1}{2}(9,8)t^2 \checkmark$$

$$t = 5,533 \text{ s} \checkmark$$

TRUCK

$$u = 0 \text{ m.s}^{-1}$$

$$v = x$$

$$a = ?$$

$$s = 90 \text{ m}$$

$$t = 5,533 \text{ s}$$

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

$$90 = 0 + \frac{1}{2}(a)5,533^2 \checkmark$$

$$\underline{a = 5,88 \text{ m.s}^{-2}} \checkmark$$

2.2.2 **Impulse** is the product of the net force and the contact time. ✓✓ (2)

2.2.3 The soft mattress increases the time ✓ over which the **constant change in momentum** ✓ occurs ∴ reducing the net force on the parcel. ✓ $F_{\text{net}} = \frac{\Delta p}{\Delta t} \checkmark$ (4)

[23]

QUESTION 3**3.1 Stone A**

$$a = \frac{\Delta v}{\Delta t} \checkmark$$

$$= \frac{11,2 - 4}{1,5} \checkmark$$

$$= \underline{4,8 \text{ m.s}^{-2}} \checkmark$$

(3)

$$3.2 \quad g = \frac{GM}{r^2} \checkmark$$

$$4,8 = \frac{6,7 \times 10^{-11} \times M}{(1,6 \times 10^4)^2} \checkmark$$

$$\underline{M = 1,83 \times 10^{19} \text{ kg}} \checkmark$$

(3)

$$3.3 \quad u = 12 \text{ m.s}^{-1}$$

$$v = 0$$

$$a = -4,8 \text{ m.s}^{-2}$$

$$s = x$$

$$t = ?$$

$$v = u + at \checkmark$$

$$0 = 12 - 4,8t \checkmark$$

$$\underline{t = 2,5 \text{ s}} \checkmark$$

(3)

3.4 Stone A ($\downarrow$ positive, s_A = distance $\downarrow$ from top of cliff)

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

$$s_A = 4t + \frac{1}{2}(4,8)t^2 \checkmark$$

$$s_A = 4t + 2,4t^2 \quad (1)$$

Stone B ($\uparrow$ positive, s_B is distance $\uparrow$ from bottom of cliff)

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

$$s_B = 12t + \frac{1}{2}(-4,8)t^2 \checkmark$$

$$s_B = 12t - 2,4t^2 \quad (2)$$

$$s_A + s_B = 56 \text{ m} \checkmark \text{ method}$$

$$4t + 2,4t^2 + 12t - 2,4t^2 = 56$$

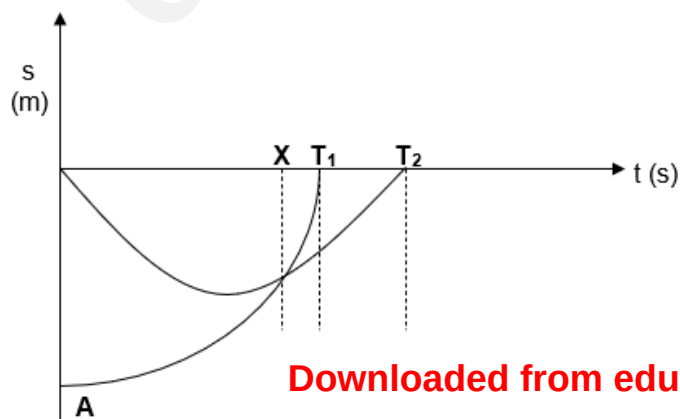
$$16t = 56$$

$$\underline{t = 3,5 \text{ s}} \checkmark$$

(5)

3.5.1 Bottom of cliff. $\checkmark$

(1)

3.5.2

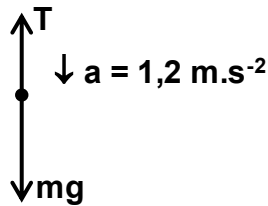
Shape $\checkmark$
 Start at 0 and end at T_2 $\checkmark$
 Intersect at X $\checkmark$

(3)

[18]

QUESTION 4

4.1.1



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

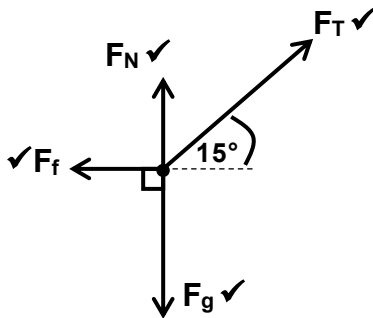
$$mg - T = ma \quad \checkmark$$

$$\checkmark (1,6 \times 9,8) - T = (1,6 \times 1,2) \quad \checkmark$$

$$T = \underline{13,76 \text{ N}} \quad \checkmark$$

(4)

4.1.2



$$F_N < F_g$$

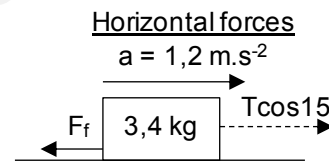
 F_T = tension F_g = weight F_f = Friction F_N = normal

(4)

4.1.3 $F_{\text{net}} = ma$

$$(13,76 \cos 15) \checkmark - F_f \checkmark = (3,4 \times 1,2) \checkmark \quad \text{c.o.e from 4.1.1}$$

$$\underline{F_f = 9,21 \text{ N}} \quad \checkmark$$

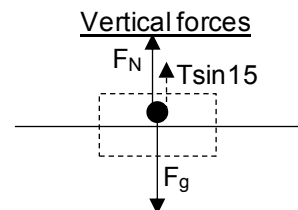


(4)

4.1.4 $F_N = F_g - F_T \sin \theta$

$$= (3,4 \times 9,8) \checkmark - 13,76(\sin 15) \checkmark \quad \text{c.o.e from 4.1.1}$$

$$= \underline{29,76 \text{ N}} \quad \checkmark$$



(3)

4.2.1 **Frictional force due to a surface** is the force that opposes the motion of an object and acts parallel to the surface with which the object is in contact. $\checkmark$

(2)

4.2.2 DECREASES.

(1)

4.2.3 $F_f = \mu \cdot F_N \checkmark \therefore F_f \propto F_N$

Normal decreases $\checkmark$ since $F_N = F_g - F_T \sin \theta$, as θ increases, the vertical component ($F_T \sin \theta$) of tension increases. $\checkmark$

(3)

4.3.1 $P = Fv \checkmark$

$$40 = (m \times 9,8) \checkmark \times 0,5 \checkmark$$

$$\underline{m = 8,16 \text{ kg}} \quad \checkmark$$

(4)

4.3.2 (a) $\uparrow + u = 0,5 \text{ m.s}^{-1}$

$$v = ?$$

$$a = -9,8 \text{ m.s}^{-2}$$

$$s = -2 \text{ m}$$

$$t = x$$

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

$$v^2 = 0,5^2 + 2(-9,8)(-2) \checkmark \checkmark$$

$$\underline{v = 6,28 \text{ m.s}^{-1}} \quad \checkmark$$

(u, a, s can all be + if consider going down from top of table.)

(4)

(b) Up and down together ↑ +

$$v = u + at \checkmark$$

$$-6,28 = 0,5 - 9,8t \checkmark \checkmark$$

$$t = 0,69 \text{ s} \checkmark$$

OR

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

$$-2 = 0,5t + \frac{1}{2}(-9,8)t^2$$

$$4,9t^2 - 0,5t - 2 = 0 \checkmark \checkmark$$

$$t = 0,69 \text{ s} \checkmark$$

OR Up only

$$v = u + at$$

$$0 = 0,5 - 9,8t$$

$$t = 0,05 \text{ s} \checkmark$$

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

$$0 = 0,5^2 + 2(-9,8)s$$

$$s = 0,0128 \text{ m} \checkmark$$

Down only

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

$$2,0128 = 0 + \frac{1}{2}(9,8)t^2$$

$$t = 0,64 \text{ s} \checkmark$$

$$\text{Total time} = 0,05 + 0,64 = 0,69 \text{ s} \checkmark$$

(4)

[33]

QUESTION 5

5.1 The **principle of conservation of mechanical energy** states that in the absence of air resistance or any external forces, the mechanical energy of an **OBJECT** is constant. $\checkmark \checkmark$ (2)

5.2 $(E_p + E_k)_p = (E_p + E_k)_Q$ $\checkmark$ method

$$\checkmark 40 \times 9,8 \times h = \frac{1}{2} \times 40 \times 7^2 \checkmark$$

$$h = 2,5 \text{ m} \checkmark$$

(4)

5.3 The **law of conservation of linear momentum** states that the total linear momentum of an **ISOLATED SYSTEM** remains constant (is conserved). $\checkmark \checkmark$ (2)

5.4 $p \text{ Before collision} = p \text{ After collision}$ $\checkmark$

$$m_1 u_1 + m_2 u_2 = (m_1 + m_2)v$$

$$\checkmark (40 \times 7) + (30 \times 0) = (40 + 30)v \checkmark$$

$$v = 4 \text{ m.s}^{-1} \checkmark$$

(4)

$$\begin{aligned}
 5.5.1 \quad \mu &= \frac{F_f}{F_N} \\
 &= \frac{59,4}{70 \times 9,8 \cos 30} \\
 &= \underline{0,1}
 \end{aligned}$$

(4)

5.5.2 Method 1: N 2nd law and uvast

$$F_{\text{net}} = m \cdot a$$

$$mg \sin \theta - F_f = ma$$

$$(70 \times 9,8 \sin 30) - 59,4 = 70 \times a$$

$$a = 4,0514 \text{ m.s}^{-2}$$

Both formulae (method)

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

$$= 4^2 + 2(4,0514)5$$

c.o.e from 5.4

$$= \underline{7,52 \text{ m.s}^{-1}}$$

Method 2: Work energy theorem

$$W_{\text{net}} = \Delta E_k$$

$$F_{\text{net}} \times s = \frac{1}{2}m(v^2 - u^2)$$

$$(v - u)^2 \neq v^2 - u^2$$

$$(70 \times 9,8 \sin 30 - 59,4) \times 5 = \frac{1}{2} \times 70 \times (v^2 - 4^2)$$

$$\underline{v = 7,52 \text{ m.s}^{-1}}$$

(6)

Method 3: Conservation of energy

$$W_f = F_f \times s$$

$$= 59,4 \times 5 \checkmark$$

$$= 297 \text{ J}$$

$$E_k \text{ at Q} = \frac{1}{2} mv^2$$

$$= \frac{1}{2} \times 70 \times 4^2 \checkmark \quad \text{c.o.e from 5.4}$$

$$= \underline{\underline{560 \text{ J}}}$$

$$E_k \text{ at Q} = mgh$$

$$= (70 \times 9,8) \checkmark \times (5 \sin 30) \checkmark$$

$$= 70 \times 9,8 \times 2,5$$

$$= \underline{\underline{1715 \text{ J}}}$$

$$E_k \text{ at R} = (mgh + E_k)_Q - W_f$$

$$= 1715 + 560 - 297 \quad \checkmark \text{method}$$

$$= 1978 \text{ J}$$

$$\frac{1}{2} mv^2 = 1978 \text{ J}$$

$$\frac{1}{2} \times 70 \times v^2 = 1978$$

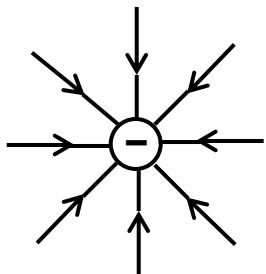
$$\underline{\underline{v = 7,52 \text{ m.s}^{-1} \checkmark}}$$

[22]

QUESTION 6

6.1 An **electric field** is a region of space in which an electric charge experiences a force. (2)

6.2 **NEGATIVE.**✓ (1)

6.3  c.o.e from 6.2
shape ✓
direction ✓ (2)

6.4 $E = \frac{KQ}{r^2}$ ✓
 $3,6 \times 10^4 = \frac{9 \times 10^9 \times Q}{0,5^2}$ ✓
 $Q = 1 \times 10^{-6} \text{ C}$ ✓ (3)

6.5.1 **POSITIVE**✓ (1)

6.5.2 $Q = 5 \times 10^{13} \times 1,6 \times 10^{-19}$ ✓
 $= 8 \times 10^{-6} \text{ C}$ ✓ (2)

6.6 $E = \frac{F}{q}$ ✓
 $F = Eq$ ✓
 $= 3,6 \times 10^6 \times 8 \times 10^{-6}$ ✓ c.o.e from 6.5.2
 $= 0,29 \text{ N}$ ✓ **towards A (LEFT)** ✓

OR $F = \frac{k q_1 q_2}{r^2}$ ✓
 $= \frac{9 \times 10^9 \times 1 \times 10^{-6} \times 8 \times 10^{-6}}{0,5^2}$ ✓ co.e from 6.4 and 6.5.2
 $= 0,29 \text{ N}$ ✓ **towards A** ✓ **(LEFT)** (4)

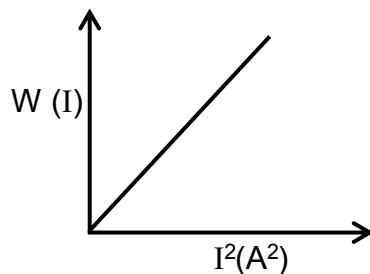
6.7 To the left of sphere A.✓✓ (2)

[17]

QUESTION 7

7.1.1 Energy (W) ✓ (1)

7.1.2



Heading ✓

Points ✓

Scale ✓

Labels ✓✓

Line ✓

(6)

7.1.3 gradient = $\frac{\Delta y}{\Delta x}$ ✓

$$= \frac{155 - 90}{0,175 - 0,1} \quad \checkmark$$

$$= \underline{866,67} \quad \checkmark \underline{\text{J} \cdot \text{A}^{-2}} \quad \checkmark$$

Points shown on graph ✓

(Check points and allow range)

(5)

7.1.4 $W = I^2 R t$

$$\frac{W}{I^2} = R t$$

$$\therefore \text{gradient} = R t \quad \checkmark$$

$$\checkmark 866,67 = R \times 60 \quad \checkmark \text{ conversion } \quad \text{c.o.e from 7.1.3}$$

$$\underline{R = 14,44 \Omega} \quad \checkmark$$

(4)

7.2.1 **Emf** is the total energy supplied per coulomb of charge ✓ by the cell. ✓ (2)7.2.2 $\varepsilon = I(R + r)$ ✓

$$24 = 3(7,2 \checkmark + r) \quad \checkmark$$

$$\underline{r = 0,8 \Omega} \quad \checkmark$$

$$R_p = \frac{18 \times 12}{18 + 12}$$

$$= 7,2 \Omega$$

(4)

7.2.3 Ratio 12 : 18
2 : 3 (5 PARTS)

$$I = \frac{3}{5} \checkmark \times 3 \text{ A} = \underline{1,8 \text{ A}} \quad \checkmark$$

$$\begin{aligned} \text{OR } I &= \frac{V}{R} \\ &= \frac{24 - (0,8 \times 3)}{12} \quad \text{OR } I = \frac{7,2 \times 3}{12} \\ &= \underline{21,6} \quad \checkmark \\ &\quad 12 \quad \checkmark \\ &= \underline{1,8 \text{ A}} \quad \checkmark \end{aligned}$$

(3)

7.2.4 (a) Increases ✓ (1)

(b)

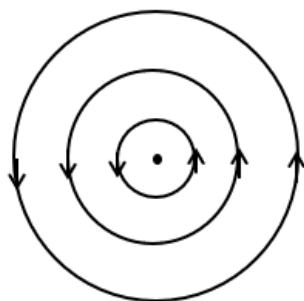
- R has increased
- I through battery has decreased ✓ $I = (\varepsilon / R + r)$
- Less energy used (volts lost) ✓ moving smaller current through **INTERNAL RESISTANCE** of battery. ✓ ($V_1 = \varepsilon - \text{lost } V$ or $V_1 = \varepsilon - I \cdot r$)

(3)

[29]

QUESTION 8

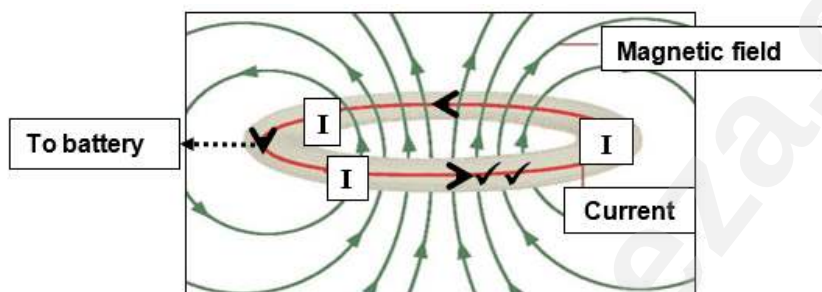
8.1.1



Concentric circles ✓
Further apart ✓
Direction ✓

(3)

8.1.2



(2)

8.1.3



(3)

(a) On diagram ✓

(1)

(b) On diagram ✓

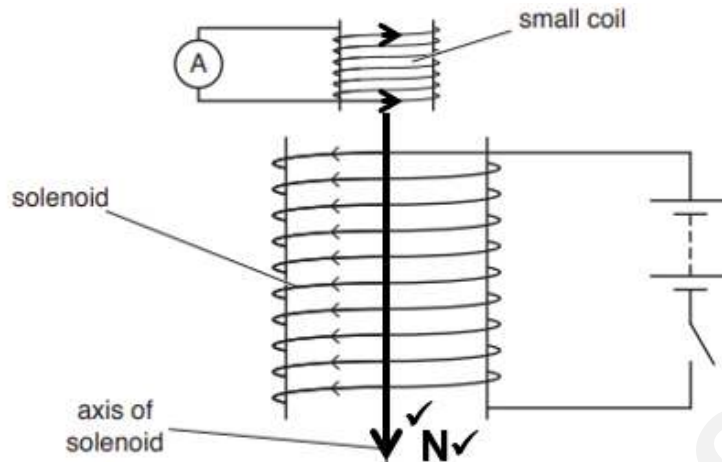
(1)

Use **stronger magnets.** ✓

Pass a **stronger current** through conductor. ✓

(2)

8.2.1 (1) and 8.2.2 (1) on this diagram.



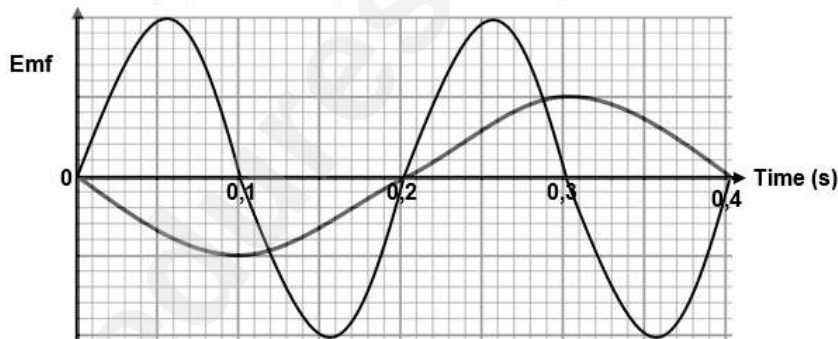
8.2.3 The induced current flows in a direction so as to set up a magnetic field ✓ to oppose the change in magnetic flux. ✓ (2)

8.2.4 On the diagram. (2)

8.2.5 There is a change in flux ✓ in the small coil ✓ ∴ there is an induced emf in the small coil and hence an induced current. (2)

8.2.6 The magnetic field set up by the solenoid remains constant ✓ ∴ rate of change of flux is zero. ✓ (2)

8.3.1 Slip rings. ✓ (1)



8.3.2 Horizontal. ✓ (1)

8.3.3 Peak emf 2x greater. ✓
Frequency doubled ∴ period halved. ✓
Reflect graph about x – axis. ✓
(see graph) (3)

[23]

QUESTION 9

9.1.1 **Threshold (cut-off) frequency** is the minimum frequency of incident radiation✓ at which electrons will be emitted from a particular metal.✓ (2)

9.1.2 Greater than. (1)

9.1.3 There is a reading on the ammeter✓ which indicates electrons must have been emitted from the metal plate.✓ (2)

9.2.1 $E = \frac{hc}{\lambda}$ ✓
 $= \frac{6,6 \times 10^{-34} \times 3 \times 10^8}{280 \times 10^{-9}}$ ✓ conversion
 $= \underline{7,07 \times 10^{-19} \text{ J}}$ ✓ (4)

9.2.2 $E = W_0 + \Delta E_{k \text{ max}}$ ✓
 $\checkmark 7,07 \times 10^{-19} - 3,78 \times 10^{-19} \checkmark = \frac{1}{2} \times 9,1 \times 10^{-31} \checkmark \times v^2$
 $\underline{v = 8,50 \times 10^5 \text{ m.s}^{-1}}$ ✓
 (850339,30 m.s⁻¹) (5)

[14]**TOTAL: 200**