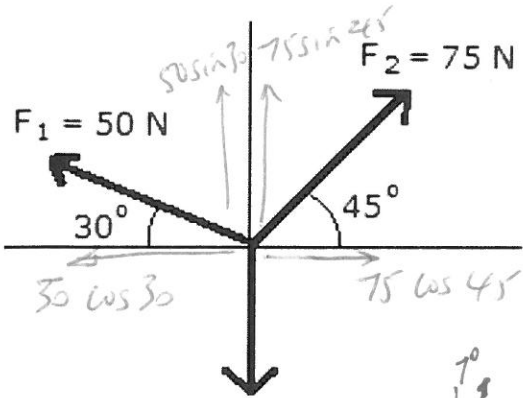


Section One: 12 Questions for a total of 50 marks.

$\theta_1, \theta_2 = 38^\circ, 67^\circ$

$x^2 = 50^2 + 75^2 - 2 \cdot 50 \cdot 75 \cdot \cos 75^\circ$
 $x = 78.6 \text{ N}$

QUESTION ONE (5 marks)



The diagram on the left shows three forces in equilibrium about a single point.

Determine the magnitude of the third force.

$\sum F_x = 75 \cos 45 - 50 \cos 30$
 $= 53.033 - 43.301$
 $= 9.732 \text{ N}$ RIGHT

$\sum F_y = 75 \sin 45 + 50 \sin 30$
 $= 53.033 + 25$

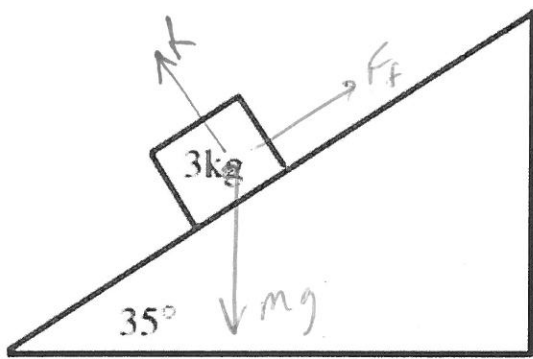
$R = \sqrt{78.033^2 + 9.732^2} = 78.033$ UP
 $= 78.6 \text{ N}$ @ 92.9°

from horizontal

79 N @ 83° 2 SF on 1?

$\tan \phi = \frac{78.033}{9.732}$
 $= 82.9^\circ$

QUESTION TWO (5 marks)



The diagram on the left shows a box of mass 3.00kg sliding down a ramp inclined at 35.0° to the horizontal, against a constant 10.0N frictional force.

a) Turn the diagram into a free body diagram. (2)

b) Determine the net acceleration of the box down the slope. (3)

$F_g = mg \sin \theta = 3 \times 9.8 \times \sin 35 = 16.863$

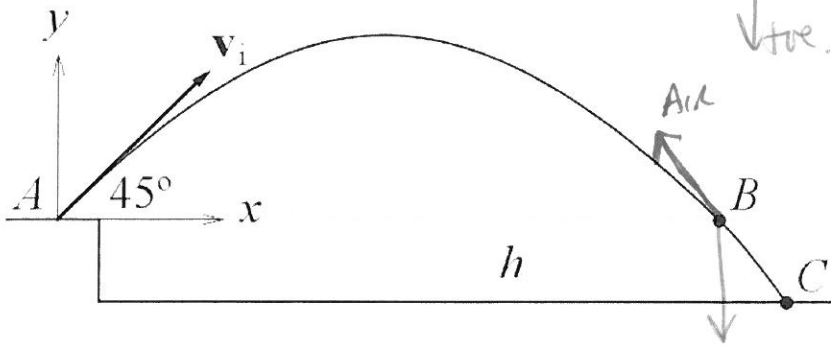
$F_n = mg \sin \theta - F_f$
 $= 16.863 - 10$
 $= 6.863 \text{ N}$

$a = \frac{F}{m} = \frac{6.863}{3}$
 $= 2.29 \text{ ms}^{-2}$

~~6.29 ms⁻²~~

QUESTION THREE

(5 marks)



A ball of mass 156g is thrown up at 45.0° from point A and is caught at point C, 2.40m vertically below A.

a) On the diagram use vectors to show the real forces acting on the ball at point B. (2) 1 ?

b) If the ball was thrown at 25.0m/s, determine its total flight time. (3)

$$V_H = V \cos 45 = 25 \cos 45 = 17.68 \text{ ms}^{-1}$$

$$V_{H'} = -V \sin 45 = -25 \sin 45 = -17.68 \text{ ms}^{-1}$$

VERTICALLY

$$V^2 = u^2 + 2as = (-17.68)^2 + 2 \times 9.8 \times 2.4$$

$$= 18.96 \text{ ms}^{-1}$$

$$t = \frac{v - u}{a} = \frac{18.96 - (-17.68)}{9.8}$$

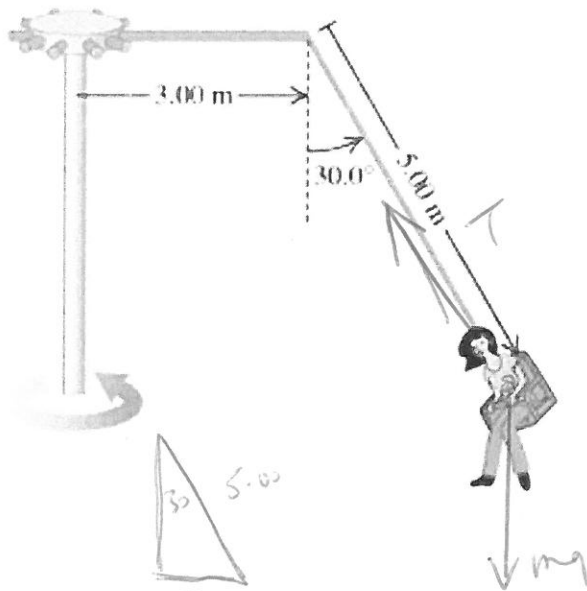
$$= 3.74 \text{ s}$$

$t_{\text{up}} = 1.80 \text{ s}$
 $t_{\text{down}} = 1.93 \text{ s}$
 $t_{\text{total}} = 3.74 \text{ s}$

$t_{A-B} = 3.60 \text{ s}$
 $t_{B-C} = 0.13 \text{ s}$
 $t_{\text{total}} = 3.74$

QUESTION FOUR

(6 marks)



The diagram to the left represents a show ground ride that revolves at 5.00rpm.

a) Using vectors, show the **real** forces acting on the rider. (2)

b) Determine the speed at which the rider moves around this horizontal circle. (4)



$$\sin 30 = \frac{6}{7} \times \frac{x}{5}$$

$$x = 5 \sin 30 = 2.5 \text{ m}$$

$$r = 3 \times 2.5 = 5.5 \text{ m}$$

$$f = 5.00 \text{ rpm} = \frac{5}{60} \text{ rps}$$

$$T = \frac{1}{f} = \frac{1}{\frac{5}{60}} = \frac{60}{5} = 12 \text{ s}$$

$$V = \frac{2\pi r}{T} = \frac{2\pi \times 5.5}{12}$$

$$= 2.88 \text{ ms}^{-1}$$

$$v^2 = rg \Rightarrow v = \sqrt{rg}$$

$$r = \frac{v^2}{g} = \frac{(15.20)^2}{9.8} = 23.81 \text{ m}$$

QUESTION FIVE (4 marks)

A GPS satellite is in orbit 1450km above the Earth's surface. Determine the **altitude** to which the satellite must be moved in order for the gravitational force it experiences to be **halved**.



$$g_1 = \frac{GM}{r^2}$$

$$g_2 = \frac{6.495}{2} = 3.247 \text{ ms}^{-2}$$

$$= \frac{6.67 \times 10^{-11} \times 5.97 \times 10^{24}}{(1450000 + 6.38 \times 10^6)^2}$$

$$= 6.495 \text{ ms}^{-2}$$

$$r^2 = \frac{GM}{g}$$

$$= \frac{6.67 \times 10^{-11} \times 5.97 \times 10^{24}}{3.247}$$

$$= 1.1074 \times 10^7 \text{ m}$$

$$- 6.38 \times 10^6$$

$$= 4.69 \times 10^6 \text{ m.}$$

$$\frac{GM}{r^2} = 2$$

$$\frac{GM}{r^2} = 2$$

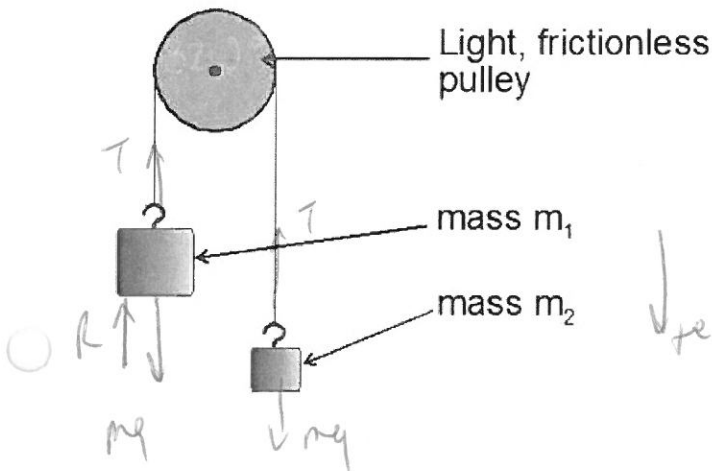
$$\frac{r^2}{r^2} = 2$$

$$r = \sqrt{2} \cdot r$$

$$= 1.107 \times 10^7 \text{ m}$$

$$\downarrow 4.69 \times 10^6 \text{ m}$$

QUESTION SIX (3 marks)



The diagram to the left shows a pulley system close to the ground. The mass of m_1 is 7.58kg and the mass of m_2 is 3.45kg.

If m_1 was allowed to rest on a set of bathroom scales, determine its apparent mass (in kg).

System at rest.

$$\sum F = ma = 0$$

$$mg - T = 0$$

$$T = mg = 3.45 \times 9.8$$

$$= 33.81 \text{ N}$$

$$\sum F = ma = 0$$

$$mg - T = R = 0$$

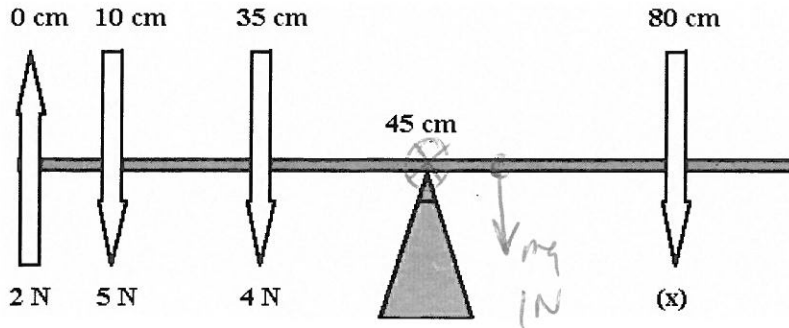
$$R = mg - T$$

$$mg = 7.58 \times 9.8 = 74.284$$

$$= 40.5 \text{ N}$$

QUESTION SEVEN

(4 marks)



The diagram to the left shows a metre ruler (weight force 1 N) at equilibrium.

Determine the weight on the right of the fulcrum required to maintain static equilibrium.

(All distance measurements have been taken from the left hand end)

TMA ⊗

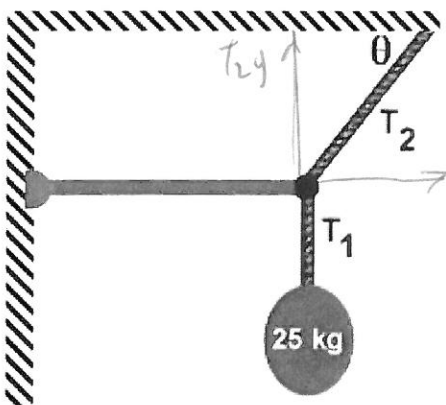
$$\sum Cwm = \sum Awm$$

$$x \times 0.35 + 1 \times 0.05 = 4 \times 0.10 + 5 \times 0.35 + 2 \times 0.45$$

$$x = \frac{1.2}{0.35} = 3.43 \text{ N} \approx \underline{3 \text{ N}}$$

QUESTION EIGHT

(3 marks)



The diagram on the left shows a heavy chandelier suspended from a wall and ceiling.

If the angle, θ , is 28° , determine the tension in both T_1 and T_2 (the horizontal supporting rod does not affect the tension in the cables).

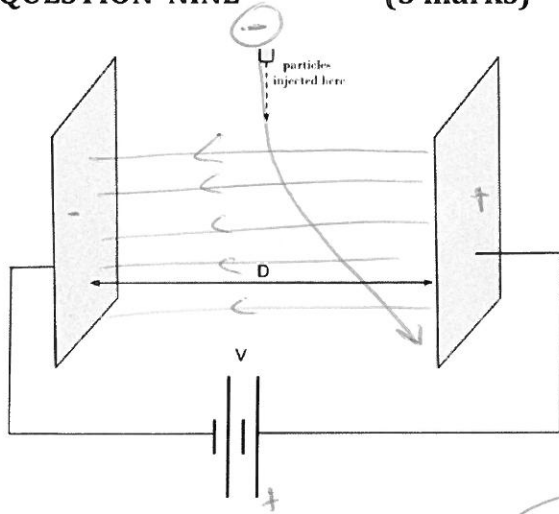
$$T_1 = mg = 25 \times 9.8 = \underline{245 \text{ N}}$$

$$\sum F_{up} = \sum F_{down} \quad T_{2y} = 245 \text{ N}$$

$$\sin \theta = \frac{T_{2y}}{T_2}$$

$$T_2 = \frac{245}{\sin 28} = 521.8 \text{ N} \approx \underline{520 \text{ N}}$$

QUESTION NINE (5 marks)



The diagram on the left shows a pair of metal plates separated by a distance, D , which is 14.5cm. The voltage applied across the plates is 245V, and the field established between the plates is uniform.

a) Neatly sketch lines showing the field between the two plates (2)

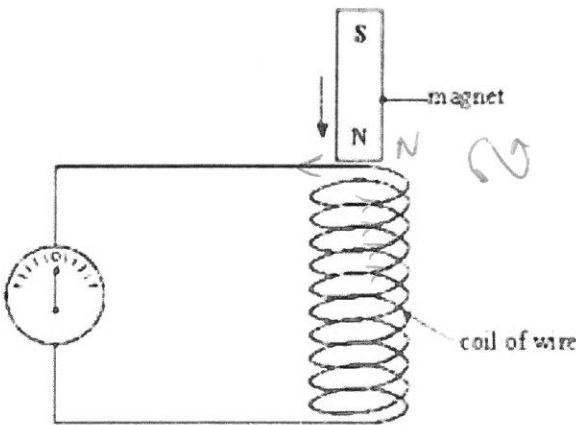
b) Sketch in the path that a slow moving negative ion, injected from the top of the diagram, would describe. (1)

c) Determine the intensity of the uniform field between the plates. (2)

Handwritten: $E = \frac{V}{a}$ or data sheet?

Handwritten: $= \frac{245}{0.145} = 16896 = \underline{1690 V}$

QUESTION TEN (3 marks)



The diagram on the left shows a bar magnet about to fall through a coil of wire.

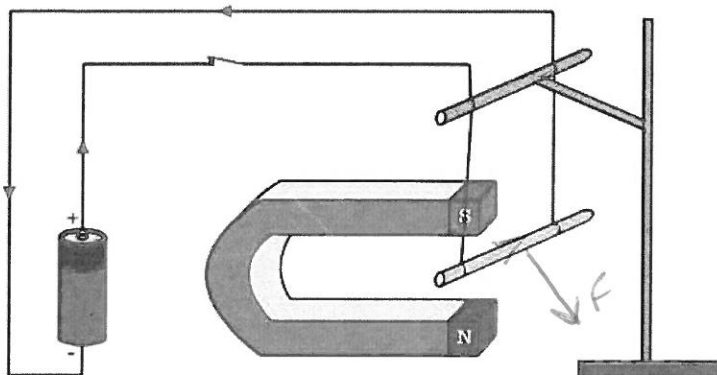
a) Show on the horizontal wires the direction of current flow as the magnet approaches the coil (as shown). (1)

BETTER WAY TO SHOW
b) Explain how the needle on the meter on the left on the diagram will behave as the magnet enters the top, moves through and then leaves the coil. (2)

- Needle move to left as magnet approaches
 - Back to 0 while magnet is in middle
 - Needle moves to right as N pole leaves coil
- LENZ'S LAW

QUESTION ELEVEN

(3 mark)



The diagram on the left shows a metal rod carrying a current of 0.560A, in a uniform magnetic field of 0.0540T. The uniform field extends along 13.5cm of the metal rod. The wooden retort stand on the right of the diagram has a horizontal wooden bar designed to hold the wires away from the magnet.

a) Use a vector diagram to show the force the metal rod experiences. (1)

b) Determine the magnitude of the electro-magnetic force the metal rod experiences. (2)

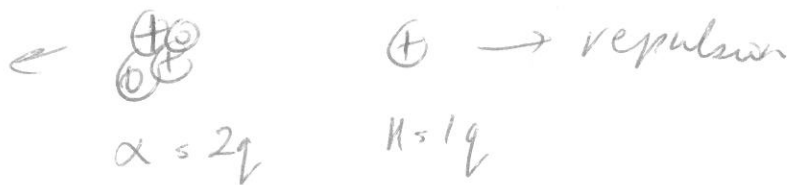
$$\begin{aligned}
 F &= BIl \\
 &= 0.0540 \times 0.560 \times 0.135 \\
 &= \cancel{0.408} \text{ N} \\
 &= 4.08 \times 10^{-3} \text{ N}
 \end{aligned}$$

QUESTION TWELVE

(4 marks)

An alpha particle approaches to within of 4.55μm of a hydrogen ion.

Determine the magnitude and direction of the force between these two particles.



$$\begin{aligned}
 F &= k \frac{q_1 q_2}{r^2} = \frac{1}{4\pi \times 8.85 \times 10^{-12}} \times \frac{(2 \times 1.6 \times 10^{-19})(1.6 \times 10^{-19})}{(4.55 \times 10^{-6})^2} \\
 &= 2.22 \times 10^{-17} \text{ N}
 \end{aligned}$$

REPULSION