

ARANMORE CATHOLIC COLLEGE

PHYSICS 3A3B

ASSIGNMENT #2

NAME: SOLUTIONS

MARK:

/50

1. Rubi visits a space station which is in a circular orbit at a distance of one-half an earth radius above the earth's surface.

a) What will be the acceleration due to gravity on Rubi in the station?

[4 marks]

$$g = 4.36 \text{ N kg}^{-1}$$

b) Find the speed of the station and Rubi in their circular orbit.

[3 marks]

$$V = 6.46 \text{ km s}^{-1}$$

c) How long will it take Rubi to make one complete revolution?

[2 marks]

$$T = 9.29 \times 10^3 \text{ s}$$

$$\text{or } 2.58 \text{ h.}$$

2. Modern values for the mass of the Earth and other planets have been determined by observing the motion of artificial satellites that have been launched in recent years.

- a) **Derive** an expression for the mass of a central body, for example the Earth, in terms of the orbital radius (R) and orbital period (T) of an artificial satellite. Show steps clearly. [3 marks]

$$\begin{aligned}
 F_c &= F_g & \text{sub: } v &= \frac{2\pi r}{T} \\
 \frac{mv^2}{r} &= \frac{GMm}{r^2} & M &= \frac{4\pi^2 r^3}{GT^2} \\
 \text{so } M &= \frac{v^2 r}{G}
 \end{aligned}$$

- b) One of Mars' moons, Phobos, revolves around Mars with an orbital radius of 9.35×10^3 km and with a period of 7 hours and 35 minutes. Use your expression from part (a) above to determine the mass of Mars. [4 marks]

$$M_{\text{MARS}} = 6.49 \times 10^{23} \text{ kg}$$

- c) What is the value for the acceleration due to gravity, 'g', on the surface of Mars, given that Mars has a radius of 3430 km? [4 marks]

$$g = 3.68 \text{ N kg}^{-1}$$

- d) What is the orbital speed of Phobos (in ms^{-1})? [3 marks]

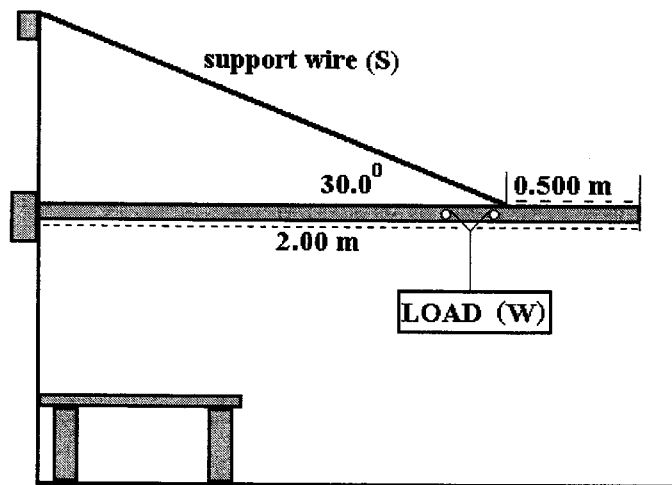
$$v = 2.15 \text{ km s}^{-1}$$

- e) Is Phobos accelerating? Explain. [2 marks]

YES - CIRCULAR MOTION

- CONSTANT SPEED, BUT DIRECTION CONSTANTLY CHANGING.

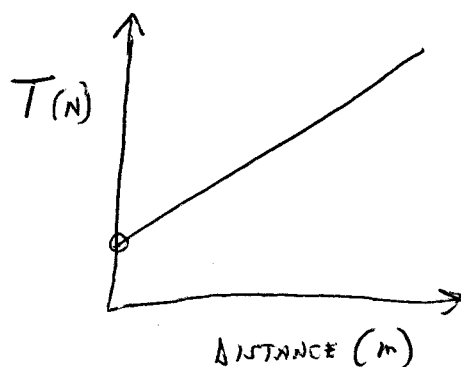
3. Derek has a wall crane illustrated below. It is designed to lift motors from cars and transfer them to a workbench using rollers. This allows Derek to shift the load from one end of the beam to the other, as shown in the diagram.



- a) If the uniform beam has a mass of 30.0 kg and the load (W) is 3.00×10^2 kg, find the force in the support wire (S) **when the load is at the outer end.** [5 marks]

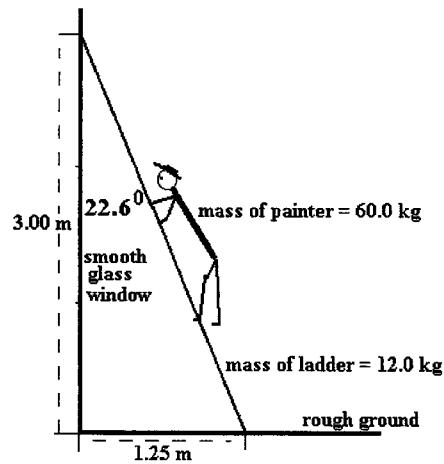
$$T = 8.23 \times 10^3 \text{ N.}$$

- b) Sketch a graph to show how the force in the wire varies as Derek moves the load in towards the wall. [3 marks]



- 1 - LABELLING AXES
- 1 - LINE
- 1 - NOT INTERSECTING AT ZERO TENSION

4. Jamaul, a painter, rests a 12.0 kg wooden extension ladder of length 3.25 m against a smooth window surface at an angle of 22.6° to the glass.



- a) What force is the ladder exerting on the glass? (Since the glass is smooth, the force will be perpendicular to the window.) [5 marks]

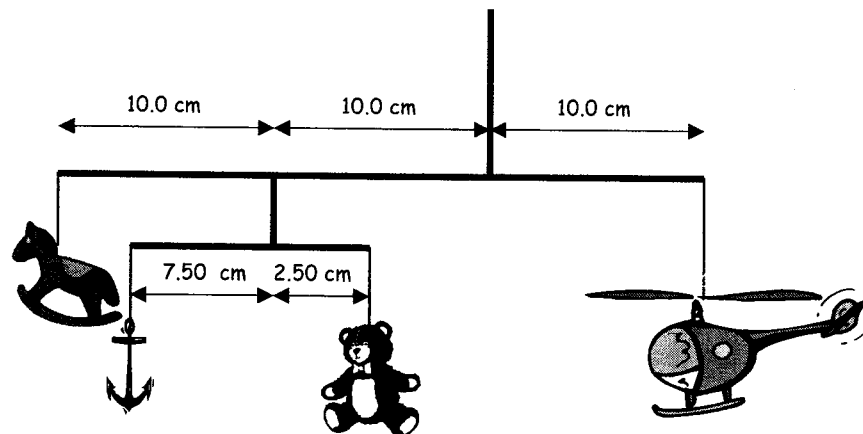
$$F_{\perp \text{ on } G} = 24.5 \text{ N.}$$

- b) The glass will break if subjected to a force greater than 170 N at the point where the ladder is resting on it. How far up the ladder can Jamaul climb before disaster strikes? [5 marks]

$$L = 1.93 \text{ m UP LADDER.}$$

5. Rahul's mobile hangs in static equilibrium above his bed, as shown in the diagram below. The mass of the horse is 180.0 g and the mass of the anchor is 80.0 g.

[7 marks]



- a) What is the mass of Rahul's hanging teddy bear?

$$m_T = 240 \text{ g}$$

- b) What is the mass of Rahul's toy helicopter?

$$m_H = 680 \text{ g}$$