Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

(a) Draw a ray diagram for an astronomical refracting telescope in normal adjustment.
Your diagram should show the paths of **three** non-axial rays passing through both lenses.
Label the principal foci of the two lenses.

(3)

(b) The Treptow Giant Telescope in Berlin is the longest moveable refracting telescope on Earth.
Some of its properties are summarised below:

distance between the objective lens and eyepiece lens = 21 m

angular magnification = 210

objective lens diameter = 0.68 m

(i) Calculate the focal lengths of the eyepiece lens and objective lens of the Treptow Giant Telescope.

eyepiece lens focal length _____ m

objective lens focal length _____ m

(2)

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(ii) Early telescopes had very small diameter objective lenses. State **two** advantages of using an astronomical telescope that has a large diameter objective lens when making observations.

Advantage 1 _____

_____

_____

Advantage 2 _____

_____

_____

(2)

(c) The images formed by refracting telescopes can suffer from chromatic aberration.

Draw a labelled diagram to show how a converging lens causes chromatic aberration.

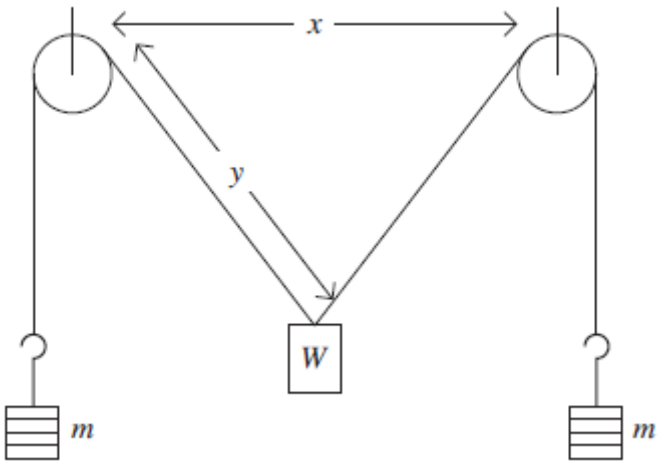
(1)

(Total 8 marks)

Q2.

In an experiment an unknown load, of weight, W, was supported by two strings kept in tension by equal masses, m, hung from their free ends, with each string passing over a frictionless pulley. The arrangement was symmetrical and is shown in **Figure 1**.

Figure 1



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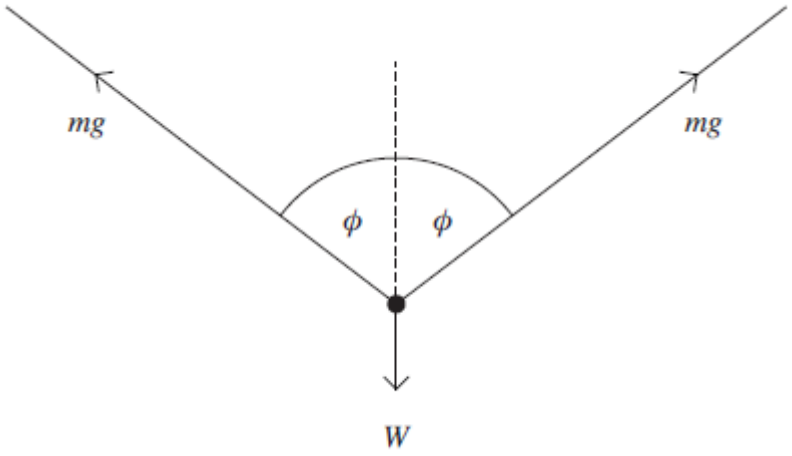
The distance x was kept constant throughout the experiment. The length y was measured for different values of m.

The distance between the strings at the pulleys, x = 0.500m

(a) **Figure 2** shows the three forces acting through the point at which the strings are attached to the load. The weight of the load is W and the tension in each string is mg, where g is gravitational field strength.

Figure 2



(i) By resolving the forces vertically show that $m = \frac{W}{2g\cos\phi}$

where φ is the angle between each string and the vertical.

_____

_____

_____

_____

(1)

(ii) Draw the line of best fit through the points plotted on the graph.

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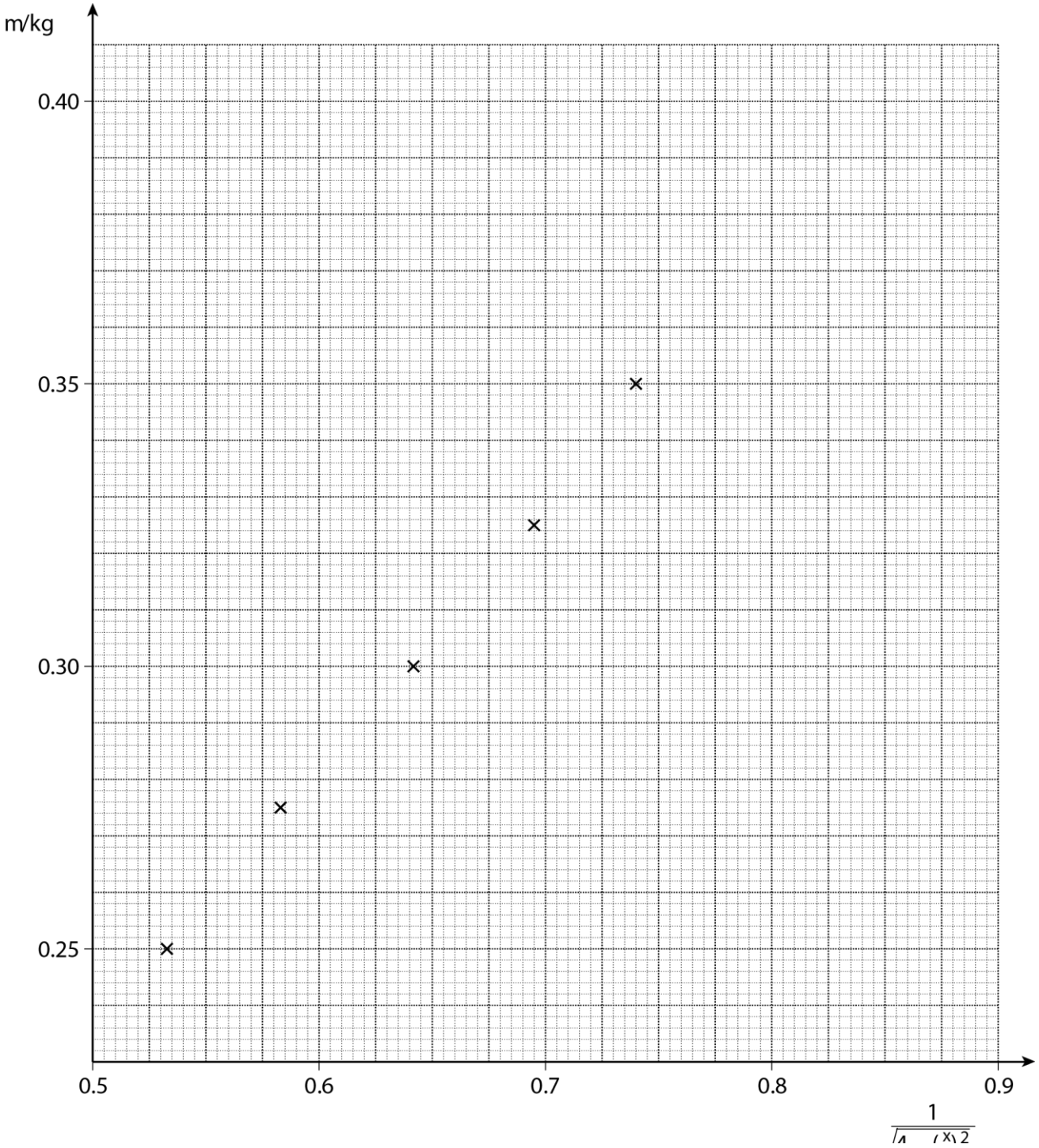

(1)

(b) (i) Determine the gradient of your graph.

(3)

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(ii) The equation for the straight line is $m = \frac{W}{g} \times \frac{1}{\sqrt{4 - \left(\frac{x}{\quad}\right)^2}}$

Given that g = 9.81Nkg^{-1}, determine a value for W.

(2)

(c) When m was 0.300 kg, y was 0.400 m.

Calculate the percentage uncertainty in $\left(\frac{x}{y}\right)^2$ for m = 0.300 kg.

(3)

(d) (i) Explain the term *systematic error*.

(1)

(ii) In practice, there may be a systematic error in this experiment because of friction in the pulleys.
When the measurements were taken, increasing values of m were used. State and explain how friction in the pulleys would have affected the measured values of y.

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_____

_____

_____

(2)

(Total 13 marks)

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