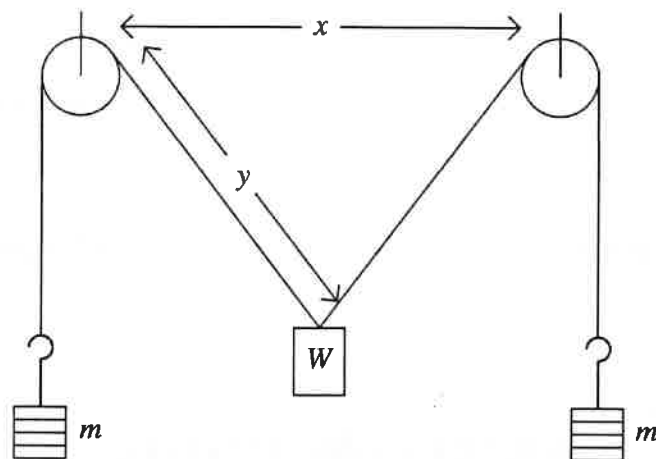


2

In an experiment similar to the one you performed in Stage 1 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



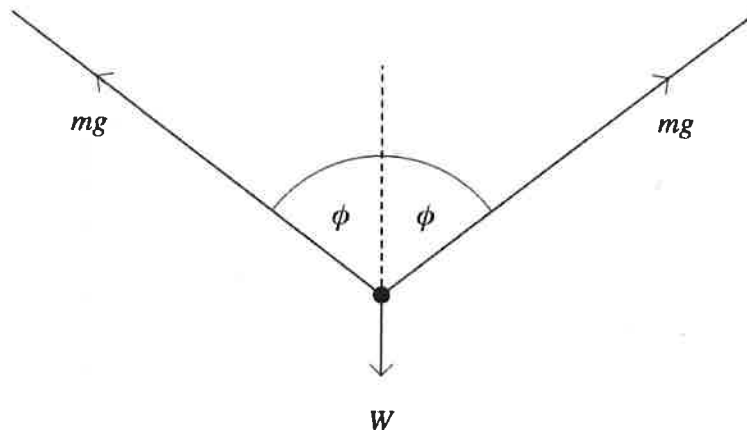
The distance x was kept constant throughout the experiment. The length y was measured for different values of m . The results are shown in the table.

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

m/kg	y/m	$(\frac{x}{y})^2$	$\frac{1}{\sqrt{4 - (\frac{x}{y})^2}}$
0.250	0.736	0.462	0.532
0.275	0.484	1.067	0.584
0.300	0.400	1.563	0.641
0.325	0.360	1.929	0.695
0.350	0.339	2.175	0.740
0.375	0.322	2.411	0.793
0.400	0.308	2.635	0.856

- 2 (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



- 2 (a) (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.

$$m = \frac{W}{2g\cos\phi} \quad 2mg\cos\phi = W$$

$$\phi = \cos^{-1}\left(\frac{W}{2mg}\right)$$

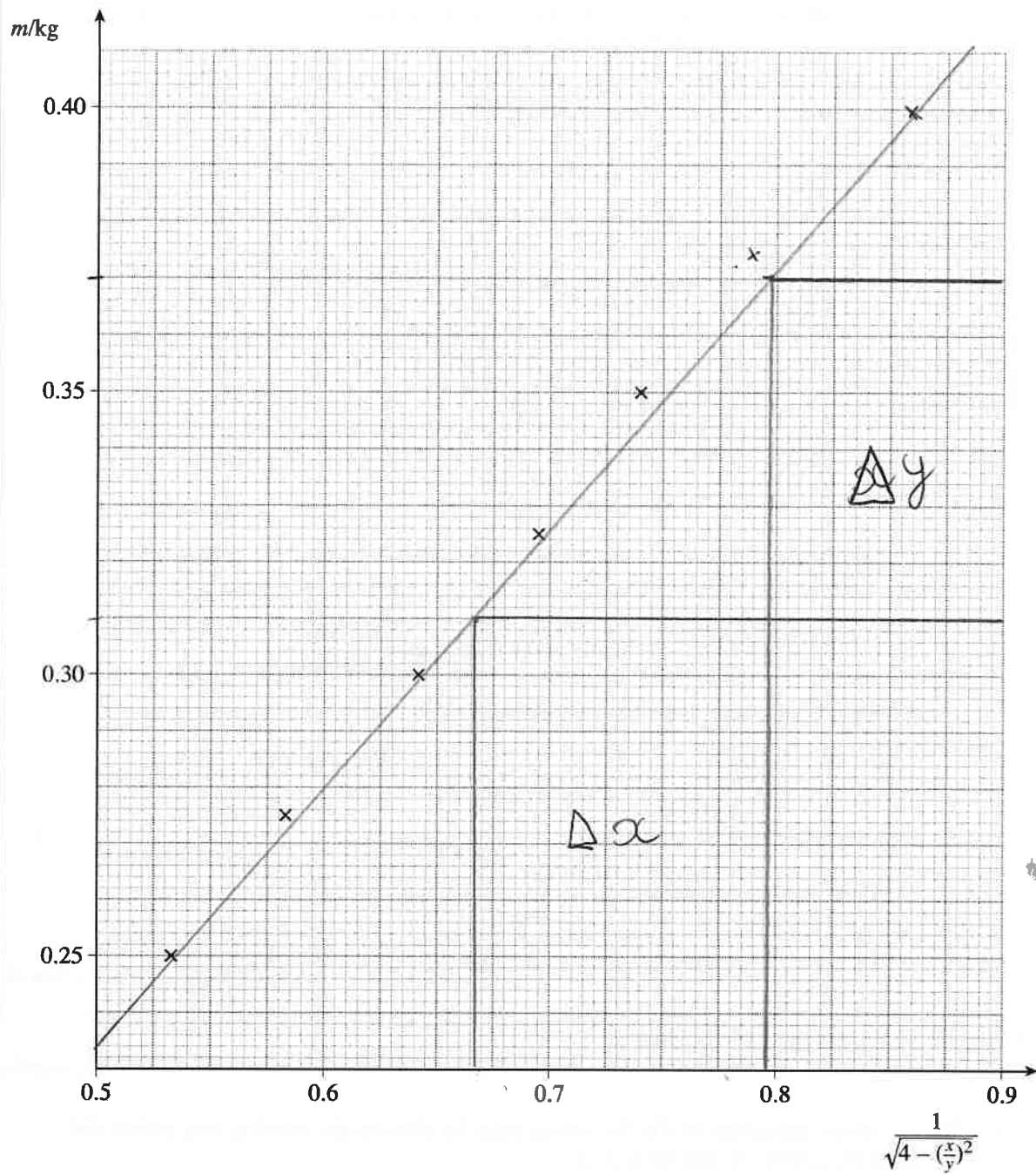
(1 mark)

- 2 (a) (ii) Complete the table on page 4.

(2 marks)

- 2 (a) (iii) Complete the graph on the following page by plotting the missing two points and drawing a straight line of best fit.

(2 marks)



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

$$M = \frac{\Delta y}{\Delta x}$$

$$M =$$

$$\Delta y = 0.37 - 0.31 = 0.06$$

$$\Delta x = 0.795 - 0.665 = 0.13$$

$$M = \frac{0.06}{0.13}$$

$$M = 0.46$$

(3 marks)

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

Given that $g = 9.81 \text{ N kg}^{-1}$, determine a value for W .

$$0.400 = \frac{W}{9.81} \times 0.856$$

$$0.400 \times 9.81 = W \times 0.856$$

$$W = \frac{0.400 \times 9.81}{0.856} \quad W = 4.58 \text{ N}$$

(2 marks)

- 2 (c) The uncertainty in the measurement of x was $\pm 1 \text{ mm}$ and the uncertainty in the measurement of y was $\pm 2 \text{ mm}$. Calculate the percentage uncertainty in $(\frac{x}{y})^2$ for $m = 0.300 \text{ kg}$.

$$x = \pm 1 \text{ mm}$$

$$y = \pm 2 \text{ mm}$$

$$\left(\frac{x}{y}\right)^2$$

$$\left(\frac{1 \text{ mm}}{2 \text{ mm}}\right)^2$$

$$\left(\frac{1 \times 10^{-3}}{0.500}\right)$$

$$\times 100$$

$$= 0.2\%$$

$$= 0.2\%$$

$$\left(\frac{2 \times 10^{-3}}{0.400}\right)$$

$$\times 100$$

$$= 0.5\%$$

$$(0.5 + 0.2)^2 = 0.7^2$$

(3 marks)

$$\text{Percentage uncertainty} = 1.4\%$$

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

A systematic error is error of measurement due to readings that differ from the true reading and follow a pattern or trend bias.

(1 mark)

2 (d) (ii) 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 .

If the friction of the pulleys would have affected " y " they would have decreased y as they would ~~reduce~~ reduce the amount of y would decrease as they would apply a friction force upon the string.

(2 marks)