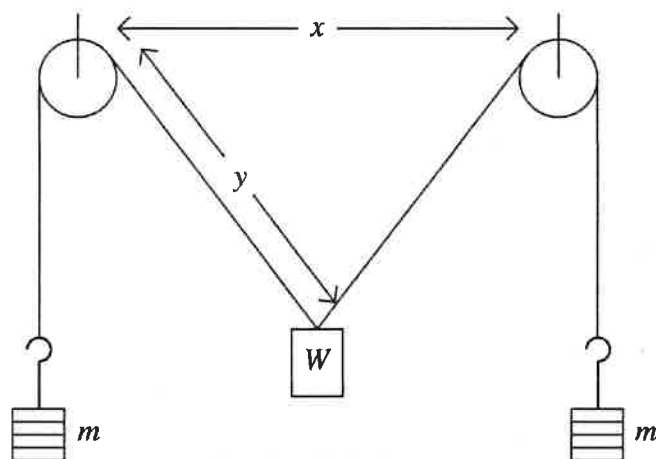


2

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



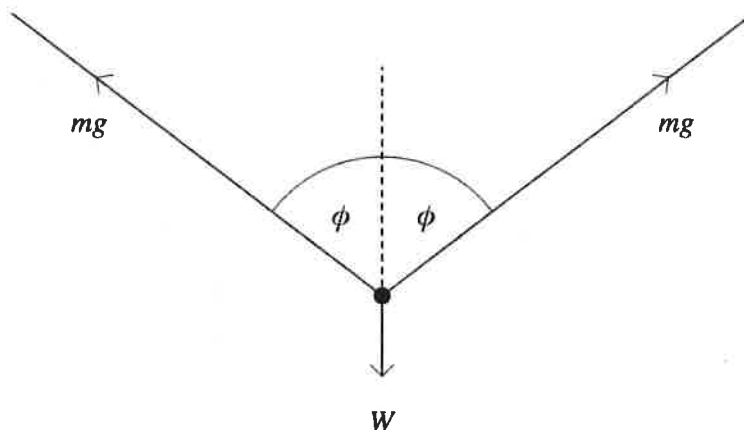
The distance x was kept constant throughout the experiment. The length y was measured for different values of m . The results are shown in the table.

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.

$$\begin{aligned}
 & \uparrow R \quad 2mg \cos \phi = W \\
 & m = \frac{W}{2g \cos \phi}
 \end{aligned}$$

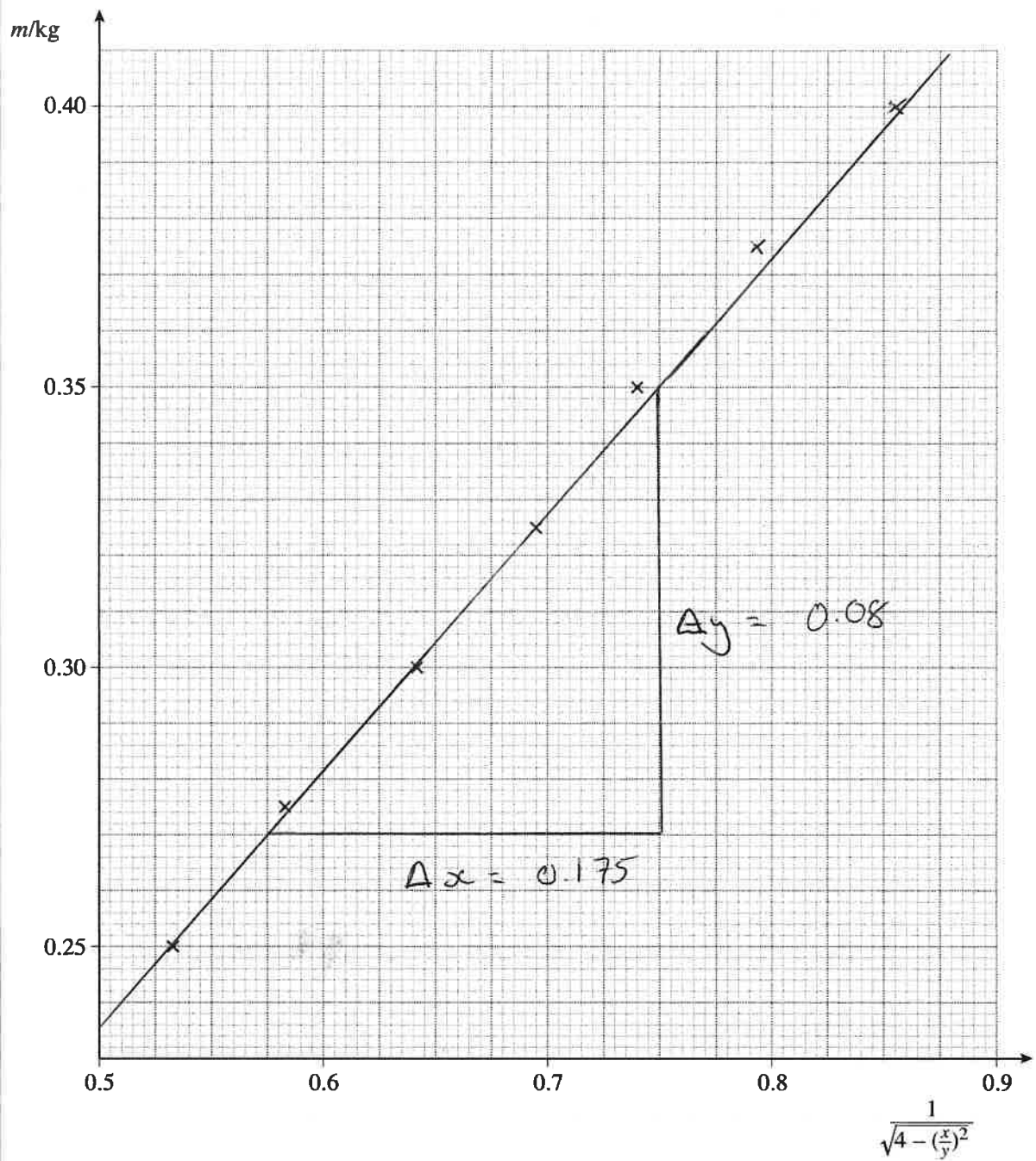
(1 mark)

- 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.

$$\text{gradient} = \frac{\Delta y}{\Delta x} = \frac{0.08}{0.175} = \underline{\underline{0.457}}$$

(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 .

$$\begin{aligned} 0.2500687 &= \frac{W}{9.81} \times \frac{1}{\sqrt{4 - (\frac{x}{y})^2}} \\ 0.25 &= \frac{W}{9.81} \times 0.532 \\ W &= \frac{0.25}{0.532} \times 9.81 \\ W &= 4.61 \text{ N} \end{aligned}$$

- 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 $m = 0.300 \text{ kg}$.

$$\begin{aligned} \% \text{ uncertainty } (y) &= \frac{2}{400} \times 100 \\ &= 0.5\% \\ \% \text{ uncertainty } (x) &= \frac{1}{500} \times 100 = 0.2\% \\ \% \text{ uncertainty } (\frac{x}{y})^2 &= 2(0.5 + 0.2) = \underline{\underline{1.4\%}} \end{aligned}$$

(3 marks)

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

Systematic error is error of measurement due to readings that systematically differ from the true reading and follow a pattern or 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 .

Due to friction it would mean that the value for y would be higher than it should be as when m increases y should decrease but friction causes resistance on the string causing it to move less.

(2 marks)