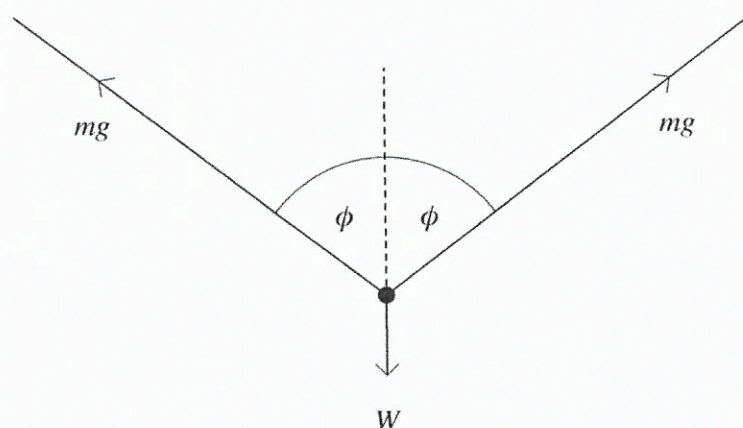


- 2 (a) **Figure 2** shows the three forces acting through the point at which the strings are attached to the load. The weight of the load is W and the tension in each string is mg , where g is gravitational field strength.

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.

$$\begin{aligned}
 W &= mg \cos \phi + mg \cos \phi \\
 W &= 2mg \cos \phi \quad (= 2g \cos \phi) \\
 \frac{W}{2g \cos \phi} &= m \qquad m = \frac{W}{2g \cos \phi}
 \end{aligned}$$

(1 mark)

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

(2 marks)

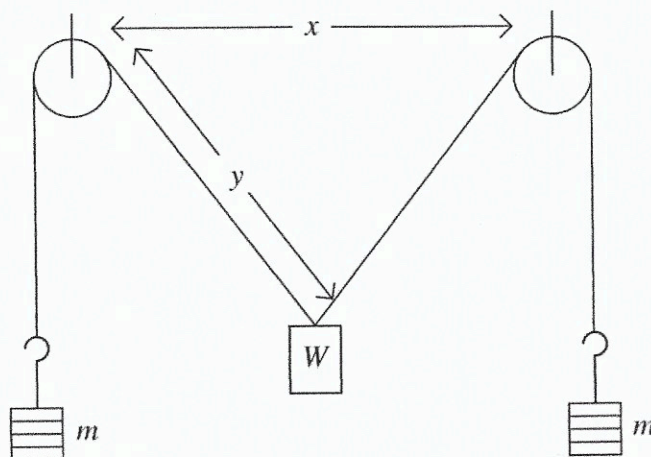
- 2 (a) (iii) Complete the graph on the following page by plotting the missing two points and drawing a straight line of best fit.

(2 marks)

2

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**.

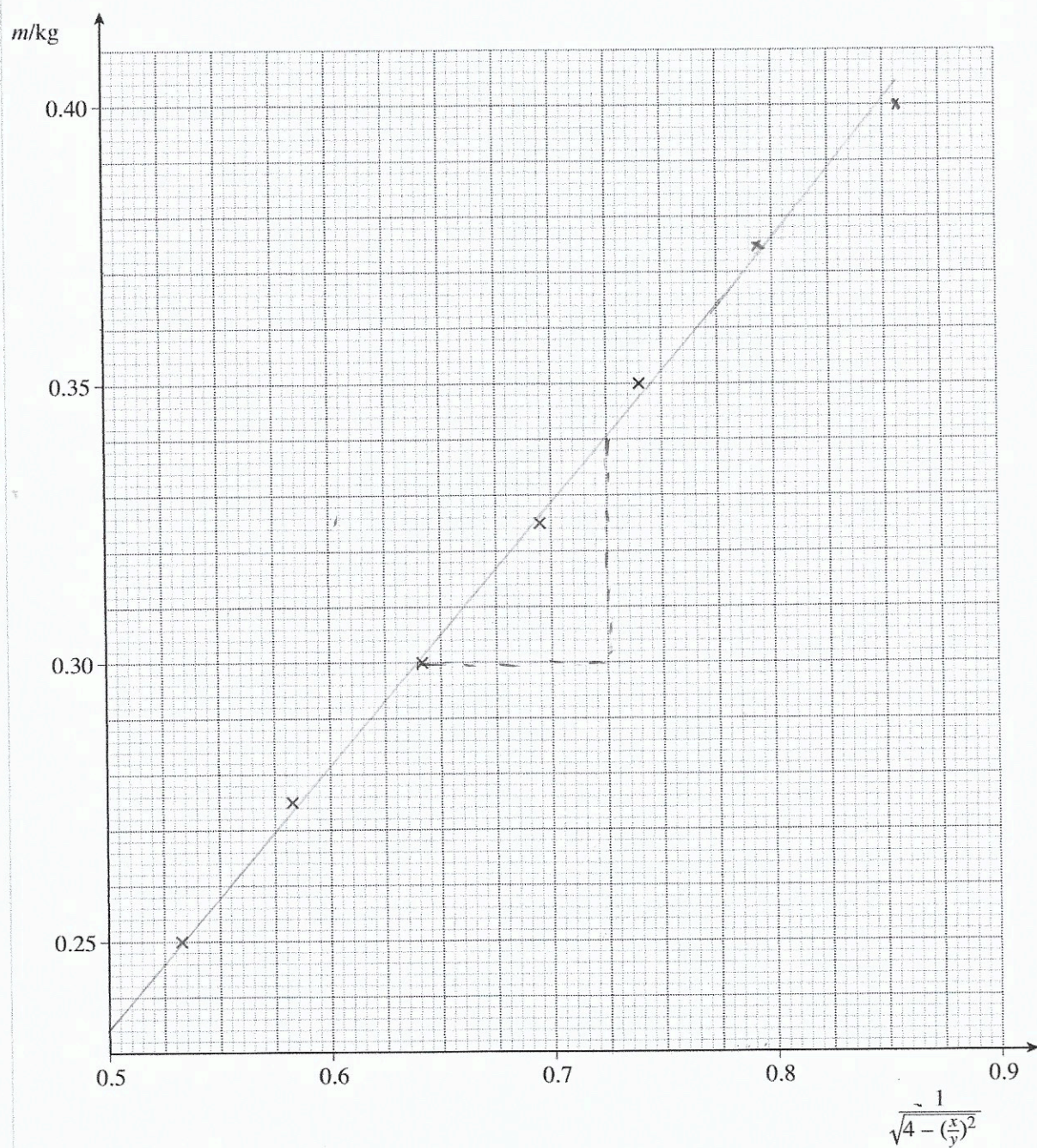
Figure 1



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

$$m = \text{gradient}$$

$$m = \frac{dy}{dx} \quad m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$(0.64, 0.3) \quad (0.725, 0.34)$$

$$m = \frac{0.34 - 0.3}{0.725 - 0.64}$$

$$m = \underline{\underline{0.471}}$$

(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 .

$$W = \frac{m \times g}{\sqrt{4 - (\frac{x}{y})^2}}$$

$$W = \frac{0.250 \times 9.81}{0.532}$$

$$W = \underline{\underline{4.619 \text{ N}}}$$

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

$$\frac{\text{percentage uncertainty}}{\text{of } x} = \frac{1}{500} \times 100$$

$$= 0.2 \%$$

$$\frac{\text{percentage uncertainty}}{\text{of } y} = \frac{2}{400} \times 100$$

$$= 0.5 \%$$

$$\text{or } \frac{x}{y} = 0.2 + 0.5 = 0.7 \%$$

$$(\frac{x}{y})^2 = 0.7 \times 2 = 1.4 \%$$

(3 marks)

$$\underline{\underline{1.563 \pm 1.4 \% m}}$$

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

Repeated or a trend in readings due to
improper use or improper equipment
calibration

(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 .

The friction in the pulleys, they will
cause them to move less meaning that
the weight at the centre will not lift
in the same manner as there is the additional
frictional force

(2 marks)