

LOCATION: SWANSEA

LEVEL 3

EXAMINATION PERIOD
JANUARY 2019

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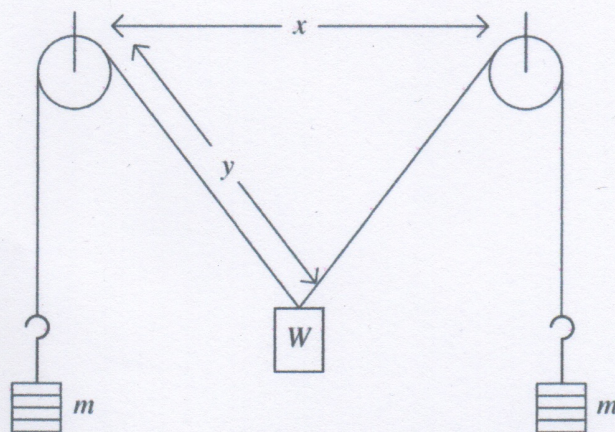
MODULE CODE: M3X01513
SCIENCE

COURSEWORK PART 2

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



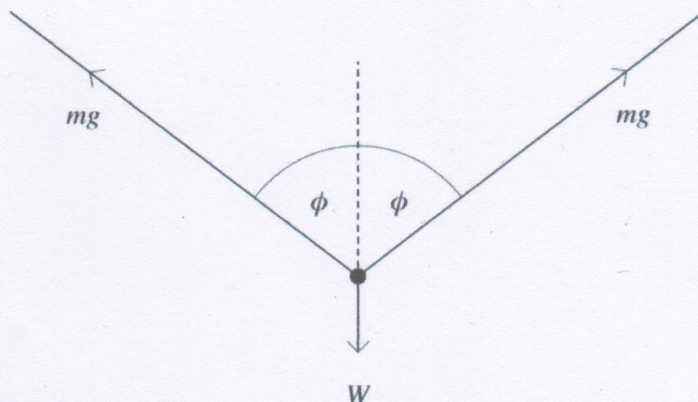
The distance x was kept constant throughout the experiment. The length y was measured for different values of m . The results are shown in the table.

The distance between the strings at the pulleys, $x = 0.500 \text{ m}$

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.

$$\begin{aligned}
 mg_1 \cos(\phi) + mg_2 \cos(\phi) - W &= 0 \\
 2mg \cos(\phi) &= W & 2mg &= \frac{W}{\cos \phi} \\
 m &= \frac{W}{2g \cos \phi}
 \end{aligned}$$

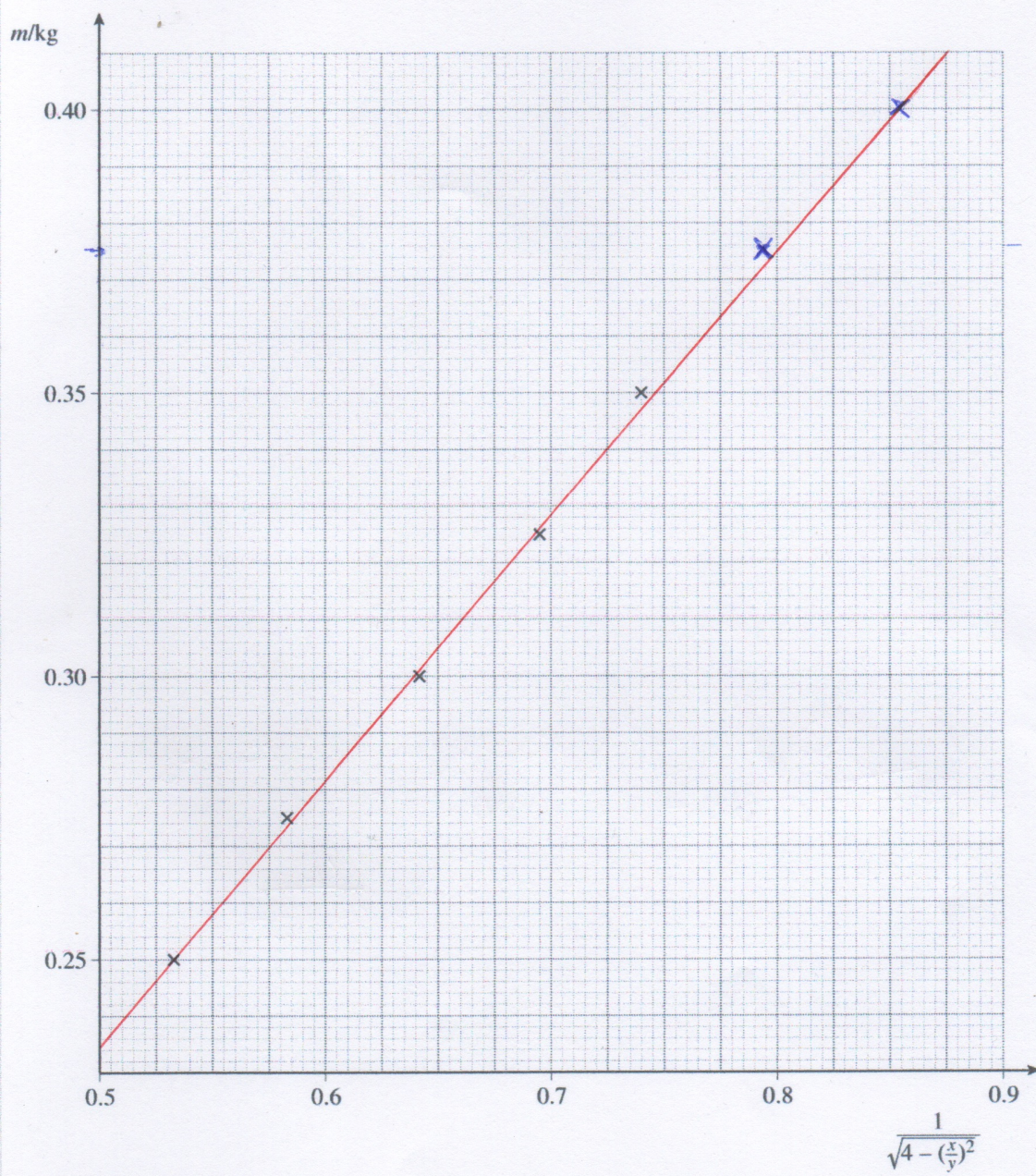
(1 mark)

- 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.

$$m = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

$$m = \frac{(0.375 - 0.275)}{(0.793 - 0.584)} = \frac{100}{209}$$

$$m = 0.478$$

(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 .

$$0.25 = \frac{W}{9.81} \times 0.532$$

$$0.25 = 0.05423 W$$

$$\frac{0.05423 W}{0.05423} = \frac{0.25}{0.05423}$$

$$W = 4.61$$

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

$$\% U_x = \frac{0.001}{0.5} \times 100 = 0.2\%$$

$$\% U_y = \frac{0.002}{0.4} \times 100 = 0.5\%$$

$$\% U_{x+y} = 0.2 + 0.5 = \pm 0.7\%$$

$$\% U_{\text{total}} = \pm 0.7 \times 2 = \pm 1.4\%$$

(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 & follow a pattern or trend or bias. Often caused by poor measurement technique or by using incorrectly calibrated instruments.

(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 .

friction effects motion & acts in opposite direction of the motion
 $\therefore$ measured values of y would be longer.

(2 marks)