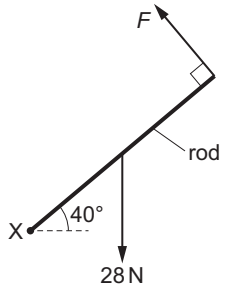
13 A uniform rod of weight 28 N is supported at one end by force *F*.

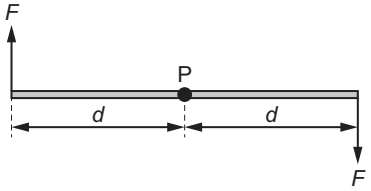
The rod is in equilibrium and attached to a frictionless hinge at end X.



What is the magnitude of *F*?

A 9.0 N **B** 11 N **C** 18 N **D** 21 N

14 Two forces, each of magnitude *F*, act in opposite directions on a rod.



Each force acts on the rod at a distance *d* from the pivot P.

What is the torque of this couple about P?

A 0 **B** $F \times d$ **C** $2F \times d$ **D** $2F \times 2d$

16 The formula for the upthrust on a block of wood partially submerged in water is shown.

$$F = \rho g V$$

What do the symbols ρ and V represent?

	ρ	V
A	density of water	volume of whole block
B	density of water	volume of block below surface of water
C	density of wood	volume of whole block
D	density of wood	volume of block below surface of water

9 A sphere moves vertically downwards at terminal (constant) velocity in a liquid.

Which statement about the magnitude of the upthrust acting on the sphere is correct?

A It is proportional to the acceleration of free fall.

B It is equal to the weight of the sphere.

C It is proportional to the density of the sphere.

D It is proportional to the square of the radius of the sphere.

3 A spring is fixed at one end and attached to the frame of a pulley at the other end. A cable is passed around the wheel of the pulley. The spring is stretched to a fixed length using the cable and pulley.

Fig. 3.1 shows the view from above of the spring, cable and pulley.

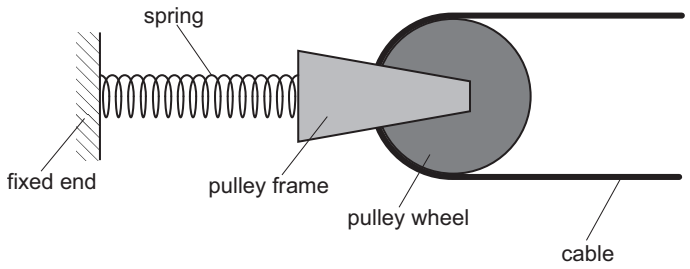


Fig. 3.1

The spring obeys Hooke's law and has a spring constant k of 250 N m^{-1}. A force F acts on the spring. The tension in the cable is T. The pulley is in equilibrium.

(a) On Fig. 3.2, draw labelled arrows to show the directions of the forces acting on the pulley.

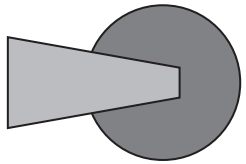


Fig. 3.2

[2]

(b) The force F is 110 N.

(i) Determine T.

T = ... N [1]

(ii) Calculate the extension of the spring.

extension = ... m [2]

(c) A second identical spring with the same spring constant of 250 N m^{-1} is now also connected to the pulley, as shown in Fig. 3.3.

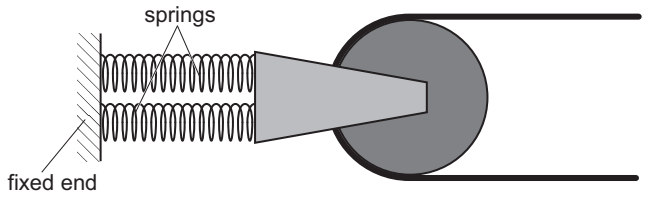


Fig. 3.3

The tension in the cable is kept the same. The pulley is again in equilibrium.

(i) Determine the extension of the springs.

extension = ... m [2]

(ii) The elastic potential energy stored in the spring in Fig. 3.1 is E_1. The **total** elastic potential energy stored in the two springs in Fig. 3.3 is E_2.

Calculate the ratio $\frac{E_1}{E_2}$.

ratio = ... [2]

[Total: 9]

2 In this experiment, you will investigate the tension in a string.

(a) • Set up the apparatus as shown in Fig. 2.1.

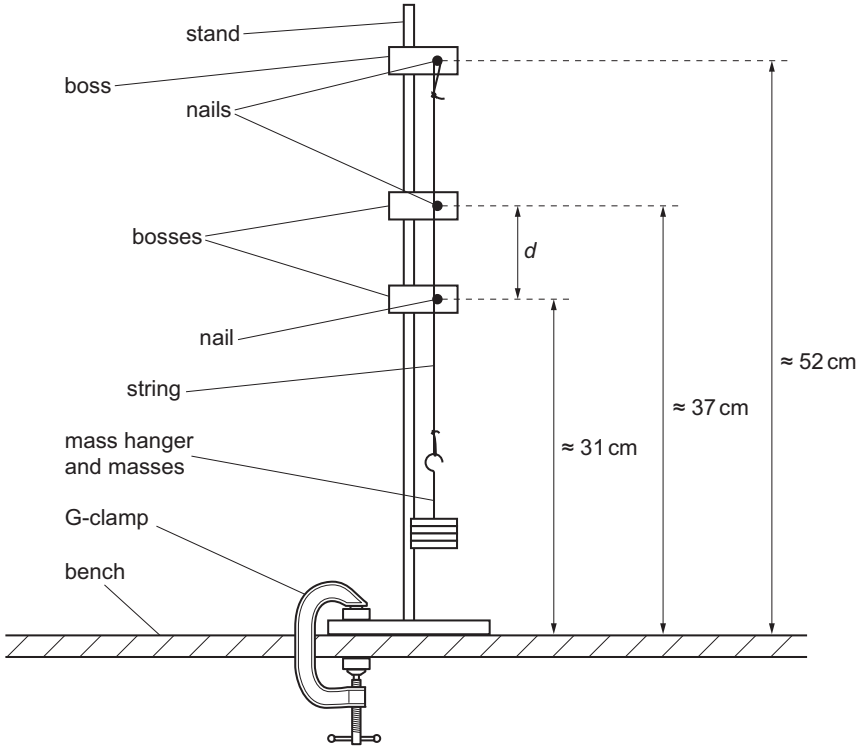


Fig. 2.1

- The mass hanger and masses should have a total mass M of 0.400 kg.
- The distance between the two lower nails is d, as shown in Fig. 2.1.

  Measure and record d.

d = ... cm [1]

(b) The tension in the string is T.

Calculate T using $T = Mg$, where $g = 9.81\,\text{N kg}^{-1}$.

T = ... N [1]

(c) **(i)** • Hook the newton meter on the string half-way between the two lower nails and pull it horizontally with a force F of 5.0 N, as shown in Fig. 2.2.

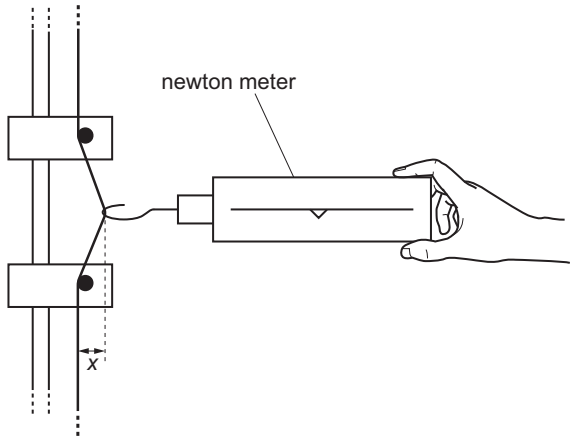


Fig. 2.2

- The force F causes the string to deflect a distance x, as shown in Fig. 2.2.

  Measure and record x.

x = ... cm [2]

(ii) Estimate the percentage uncertainty in your value of x. Show your working.

percentage uncertainty = ...% [1]

(iii) Calculate y, where

$$y = \sqrt{\left(x^2 + \frac{d^2}{4}\right)}.$$

y = ... cm [1]

(d) • Add slotted masses to the mass hanger so that the total mass M is 0.700 kg.

• Repeat **(b)**, **(c)(i)** and **(c)(iii)**.

T = ... N

x = ... cm

y = ... cm
[3]

(e) It is suggested that the relationship between y, T and x is

$$ky = Tx$$

where k is a constant.

(i) Using your data, calculate **two** values of k.

first value of k = ...

second value of k = ...
[1]

(ii) Justify the number of significant figures that you have given for your values of k.

.....

.....

..... [1]

(f) It is suggested that the percentage uncertainty in the values of k is 20%.

Using this uncertainty, explain whether your results support the relationship in **(e)**.

.....

.....

.....

..... [1]

(g) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

[4]

(ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1 .....

.....

2 .....

.....

3 .....

.....

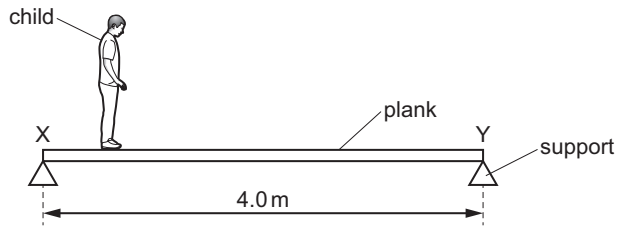
4 .....

.....

[4]

[Total: 20]

13 The diagram shows a uniform plank XY of length 4.0 m and weight 300 N.



The plank rests on fixed supports at its ends X and Y.

A child of weight 600 N stands in different positions on the plank.

The support at end X exerts a force *F* vertically upwards on the plank.

What is the magnitude of *F* when the child stands at X and when the child stands at Y?

	F / N when child is at X	*F* / N when child is at Y
A	600	0
B	600	150
C	750	0
D	750	150