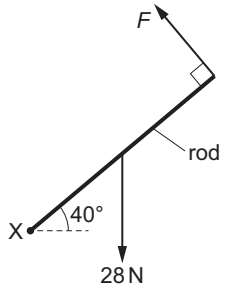
13 A uniform rod of weight 28 N is supported at one end by force *F*.

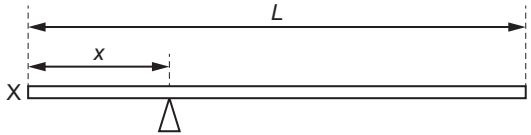
The rod is in equilibrium and attached to a frictionless hinge at end X.



What is the magnitude of *F*?

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

14 The diagram shows a uniform bar of mass *M* and length *L* resting on a pivot at a distance *x* from end X.

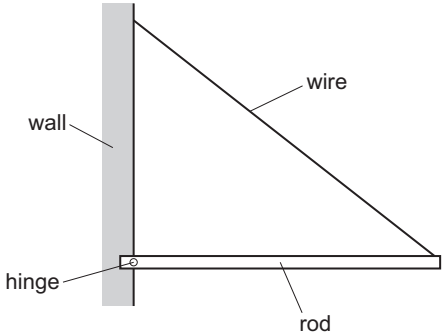


An object of mass *m* is placed on the bar at distance *y* from the pivot so that the bar is in equilibrium.

What is an expression for *y*?

A $\frac{xM}{m}$ **B** $\frac{M}{m}(L-x)$ **C** $\frac{M}{2m}(L-2x)$ **D** $\frac{1}{m}(Lm-xM)$

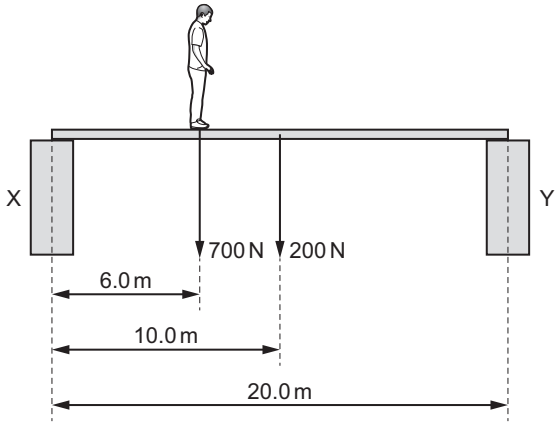
13 A uniform rod is attached by a hinge at one end to a wall. The other end of the rod is supported by a wire so that the rod is horizontal and in equilibrium.



Which arrow shows the direction of the force on the rod from the hinge?

A **B** **C** **D**

15 A uniform beam rests on two supports, X and Y, as shown.



not to scale

The beam has length 20.0 m and weight 200 N.

A man of weight 700 N stands on the beam at a distance of 6.0 m from support X.

The beam is in equilibrium.

What is the contact force of support X on the beam?

A 310 N **B** 450 N **C** 590 N **D** 900 N

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.

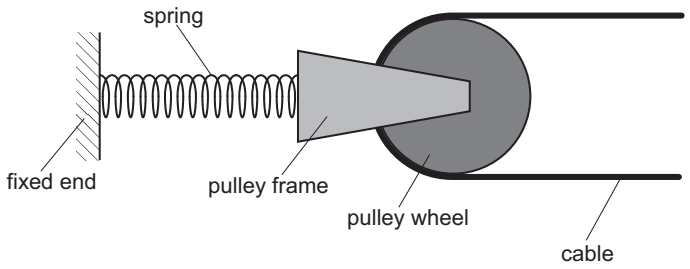


Fig. 3.1

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.

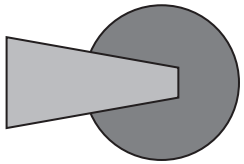


Fig. 3.2

[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.

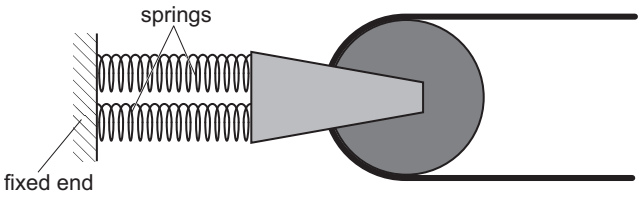


Fig. 3.3

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]

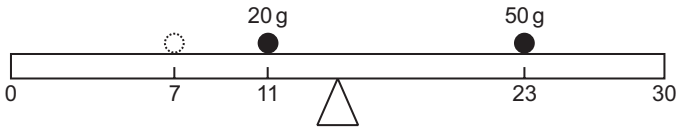
(ii) The elastic potential energy stored in the spring in Fig. 3.1 is E_1. The **total** elastic potential energy stored in the two springs in Fig. 3.3 is E_2.

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

ratio = ... [2]

[Total: 9]

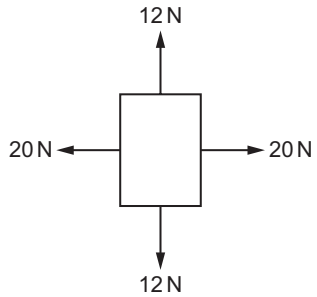
15 A student balances a 30 cm ruler on a fulcrum set at the 15 cm mark. She then places a 50 g mass on the 23 cm mark and a 20 g mass on the 11 cm mark, as shown.



Which mass should she place on the 7 cm mark to restore the balance?

A 30 g **B** 40 g **C** 47 g **D** 133 g

10 Four forces, all in the same plane, act on an object.



What could describe the motion of the object?

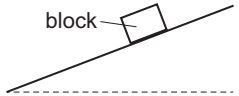
A It is accelerating.

B It is moving in a straight line.

C It is moving with decreasing speed.

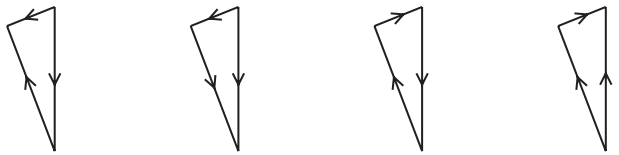
D It is moving with increasing momentum.

14 A block is in equilibrium on a slope.

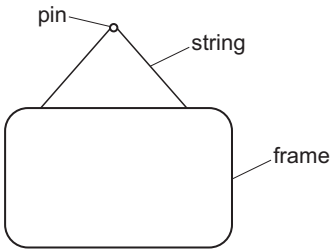


Which vector triangle represents the three forces acting on the block?

A **B** **C** **D**

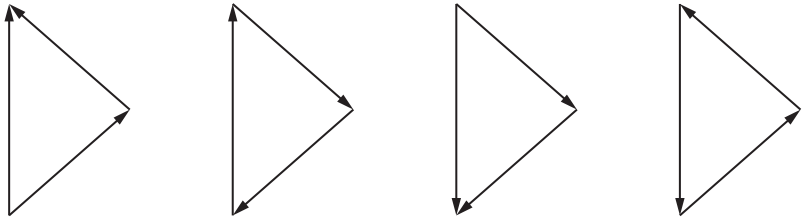


11 A picture frame hangs from a string. The string is supported by a pin. The frame is in equilibrium.

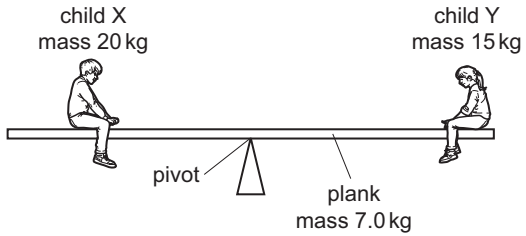


Which diagram shows the vector triangle of forces acting on the picture frame?

A **B** **C** **D**



9 The diagram shows a child X of mass 20 kg and a child Y of mass 15 kg seated on a uniform plank.



The plank has a mass of 7.0 kg and has a pivot at its midpoint. The plank is horizontal and in equilibrium.

Which statement about the weight of the plank is correct?

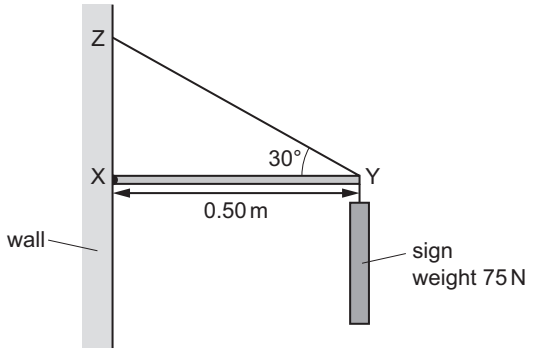
A The weight of the plank can be considered to be acting at its midpoint.

B The weight of the plank is causing an anticlockwise moment.

C The weight of the plank is causing a clockwise moment.

D The weight of the plank equals the force on the plank from the pivot.

11 A shop sign weighing 75 N hangs from a frame attached to a vertical wall.



The frame consists of a horizontal rod XY and a rod YZ that is at an angle of 30° to the horizontal. Rod XY is attached to the wall by a hinge at X and has length 0.50 m. Assume that the weights of the rods are negligible.

What is the horizontal force exerted by the wall on rod XY?

A 0 N **B** 43 N **C** 130 N **D** 150 N

2 **(a)** State the principle of moments.

.....

.....

..... [2]

(b) A solid plastic cylinder floats in water. It is used to support one end of a horizontal uniform beam AB as shown in Fig. 2.1.

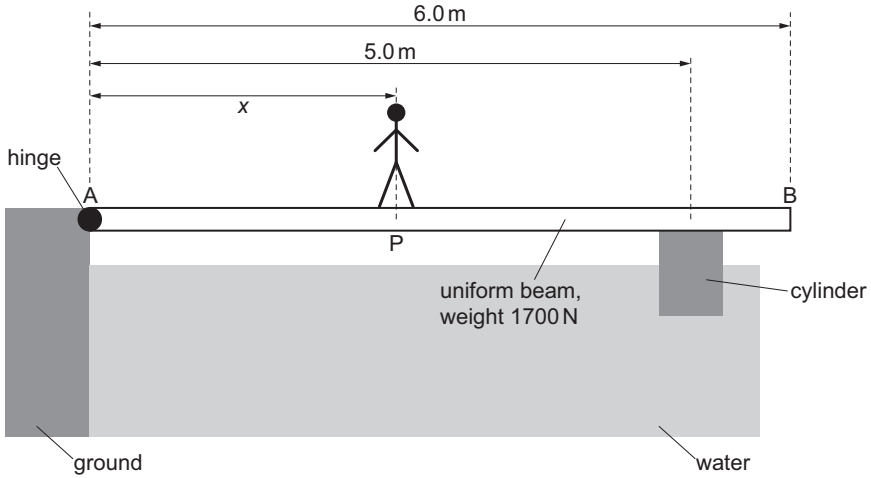


Fig. 2.1 (not to scale)

The beam has length 6.0 m and weight 1700 N. The beam is attached to solid ground with a hinge at end A.

The cylinder is floating vertically in the water. The top of the cylinder is attached at its centre to the beam at a horizontal distance of 5.0 m from end A. The cylinder applies a vertical force of 1300 N to the beam.

A person of weight 660 N stands on the beam at point P.

The beam AB is in equilibrium.

(i) By taking moments about end A, determine the distance *x* from A to P.

distance = ... m [3]

(ii) The bottom of the cylinder is submerged in the water to depth *y* as shown in Fig. 2.2. The beam is still attached to the cylinder but not shown.

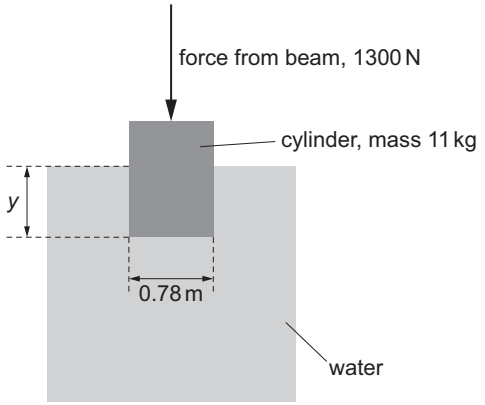


Fig. 2.2 (not to scale)

The cylinder has mass 11 kg and diameter 0.78 m. The beam exerts a vertical force of 1300 N on the cylinder. The cylinder is in equilibrium.

Show that the upthrust acting on the cylinder is 1400 N.

[1]

(iii) The water has density 990 kg m^{-3}.

Calculate the depth *y*.

y = ... m [2]

(iv) The person can stand anywhere between A and B.

On Fig. 2.3, sketch the variation of the depth of the bottom of the cylinder with the distance of the person from A, for distances between 0 and 6.0 m. Numerical values are not required.

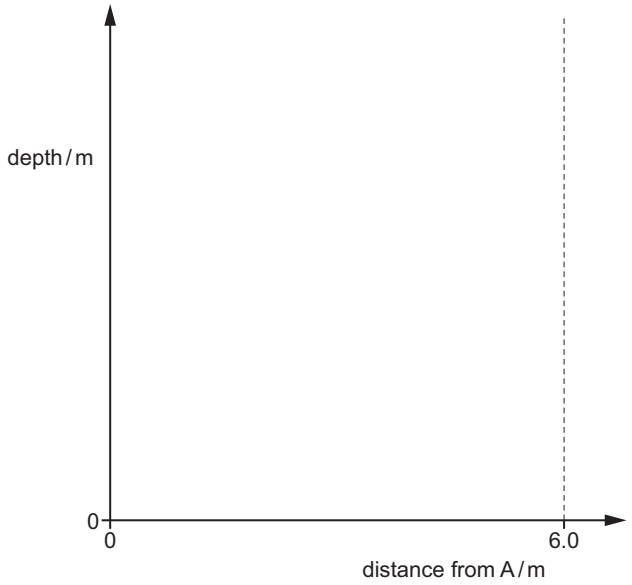


Fig. 2.3

[2]

[Total: 10]