**1** **(a)** A spring of original length 3.0 cm is extended to a total length of 5.0 cm by a force of 8.0 N.

Assuming the limit of proportionality of the spring has not been reached, calculate the force needed to extend it to a total length of 6.0 cm.

force = ..... [3]

**(b)** Fig. 3.1 shows the arrangement for an experiment on moments.

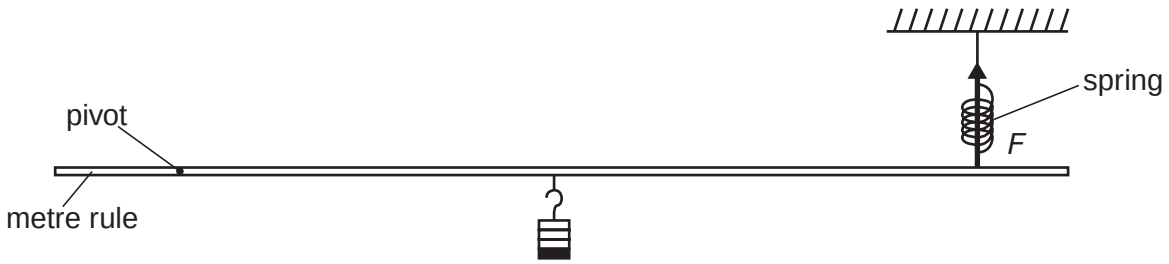


**Fig. 3.1**

The spring exerts a force *F* on the metre rule.

**(i)** On Fig. 3.1, mark another quantity which must be measured to find the moment of the force *F*. [1]

**(ii)** State how the moment of the force *F* is calculated.

.....

..... [1]

[Total: 5]

**2** A student sets up the apparatus shown in Fig. 2.1 in order to find the resultant of the two tensions $T_1$ and $T_2$ acting at P. When the tensions $T_1$, $T_2$ and $T_3$ are balanced, the angles between $T_1$ and the vertical and $T_2$ and the vertical are as marked on Fig. 2.1.

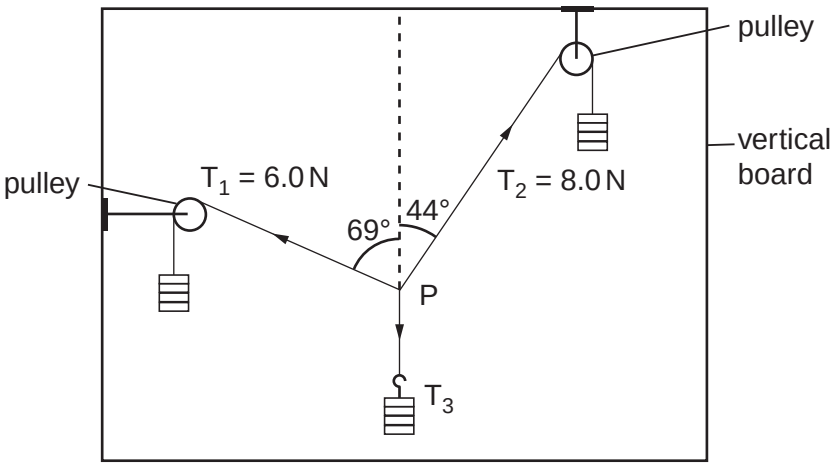


**Fig. 2.1**

In the space below, draw a scale diagram of the forces $T_1$ and $T_2$. Use the diagram to find the resultant of the two forces.

State

**(a)** the scale used, scale = .....

**(b)** the value of the resultant, value = .....

**(c)** the direction of the resultant. direction = .....

[Total : 6]

**3** In an experiment, forces are applied to a spring as shown in Fig. 2.1a. The results of this experiment are shown in Fig. 2.1b.

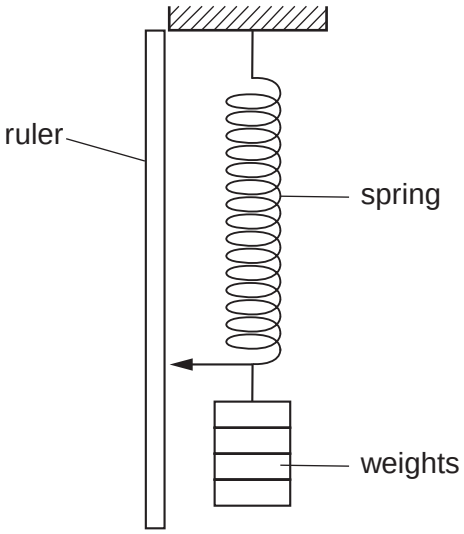


**Fig. 2.1a**

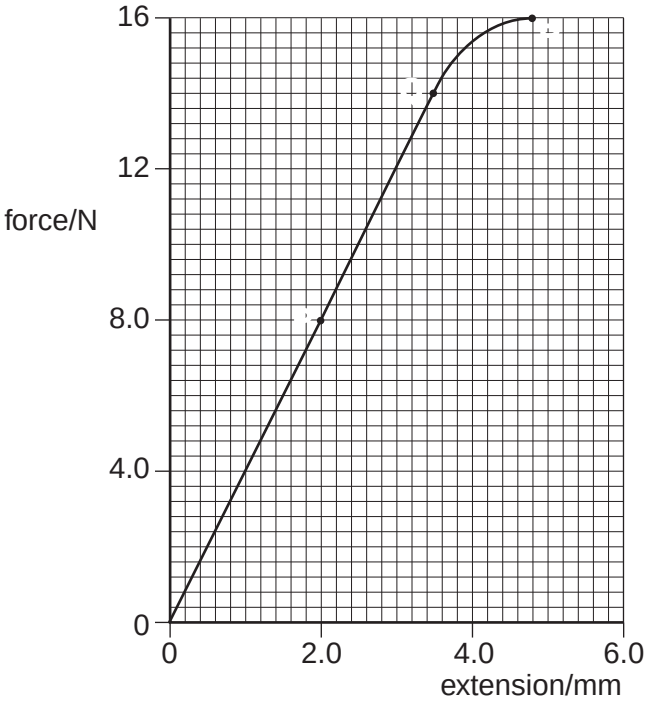


**Fig. 2.1b**

**(a)** What is the name given to the point marked Q on Fig. 2.1b?

.....[1]

**(b)** For the part OP of the graph, the spring obeys Hooke's Law.
State what this means.

.....

.....[1]

**(c)** The spring is stretched until the force and extension are shown by the point R on the graph. Compare how the spring stretches, as shown by the part of the graph OQ, with that shown by QR.

.....

.....[1]

**(d)** The part OP of the graph shows the spring stretching according to the expression

$$F = kx.$$

Use values from the graph to calculate the value of $k$.

$k$ =.....[2]

[ Total : 5 ]

**4** A mass of 3.0 kg accelerates at 2.0 $m/s^2$ in a straight line.

**(a)** State why the velocity and the acceleration are both described as vector quantities.

.....

..... [1]

**(b)** Calculate the force required to accelerate the mass.

force = ..... [2]

**(c)** The mass hits a wall.
The average force exerted on the wall during the impact is 120 N.
The area of the mass in contact with the wall at impact is 0.050 $m^2$.
Calculate the average pressure that the mass exerts on the wall during the impact.

pressure = ..... [2]

[ Total : 5 ]

**5** Fig. 2.1 shows apparatus for investigating moments of forces.

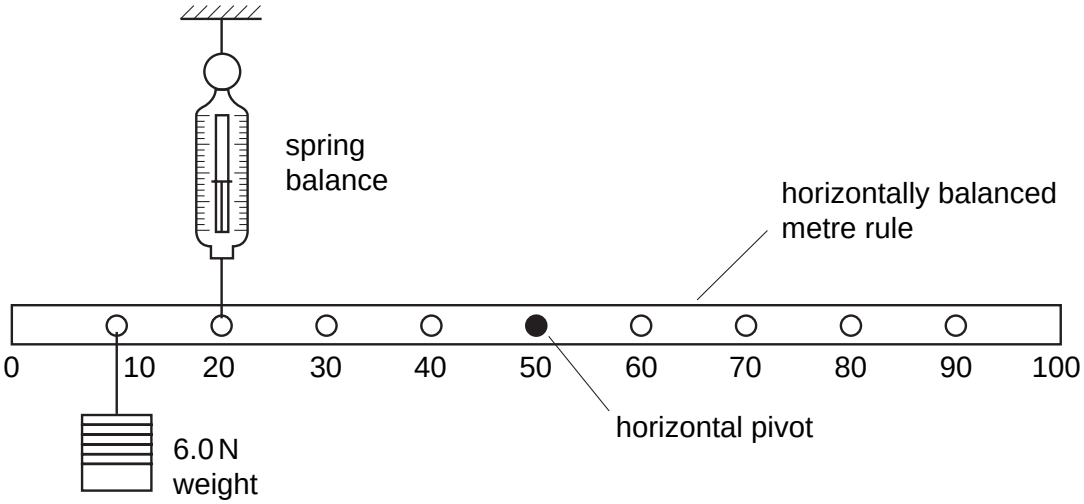


**Fig. 2.1**

The uniform metre rule shown in Fig. 2.1 is in equilibrium.

**(a)** Write down two conditions for the metre rule to be in equilibrium.

condition 1 .....

.....

.....

condition 2 .....

.....

..... [2]

**(b)** Show that the value of the reading on the spring balance is 8.0 N. [2]

**(c)** The weight of the uniform metre rule is 1.5 N.

Calculate the force exerted by the pivot on the metre rule.

magnitude of force = ……

direction of force …… [2]

[ Total : 6 ]

**6** A large spring is repeatedly stretched by an athlete to increase the strength of his arms. Fig. 3.1 is a table showing the force required to stretch the spring.

| extension of spring / m | 0.096 | 0.192 | 0.288 | 0.384 |
|---|---|---|---|---|
| force exerted to produce extension / N | 250 | 500 | 750 | 1000 |

**Fig. 3.1**

**(a)** **(i)** State Hooke's law.

.....

.....[1]

**(ii)** Use the results in Fig. 3.1 to show that the spring obeys Hooke's law.

[1]

**(b)** Another athlete using a different spring exerts an **average** force of 400 N to enable her to extend the spring by 0.210 m.

**(i)** Calculate the work done by this athlete in extending the spring once.

work done = ……

**(ii)** She is able to extend the spring by this amount and to release it 24 times in 60 s. Calculate the power used by this athlete while doing this exercise.

power = ……
[4]

[ Total : 6 ]

**7** Fig. 1.1 shows apparatus that may be used to compare the strengths of two springs of the same size, but made from different materials.

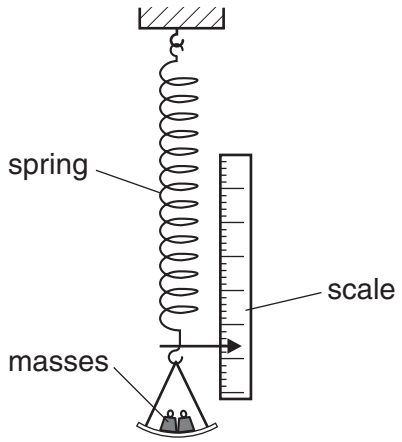


**Fig. 1.1**

**(a)** **(i)** Explain how the masses produce a force to stretch the spring.

.....

**(ii)** Explain why this force, like all forces, is a vector quantity.

.....

.....

[2]

**(b)** Fig. 1.2 shows the graphs obtained when the two springs are stretched.

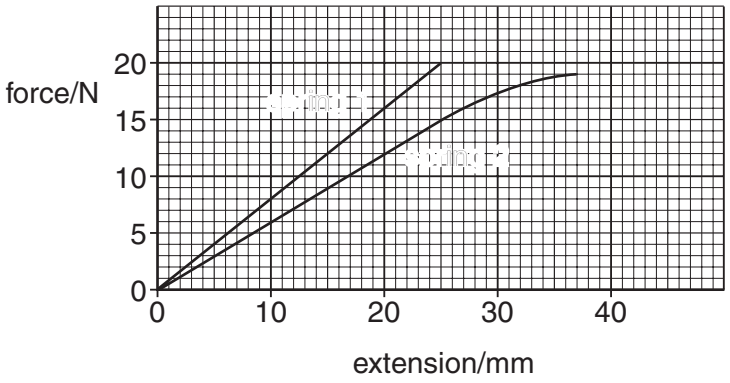


**Fig. 1.2**

**(i)** State which spring is more difficult to extend. Quote values from the graphs to support your answer.

.....

.....

.....

.....

**(ii)** On the graph of spring 2, mark a point P at the limit of proportionality. Explain your choice of point P.

.....

.....

.....

**(iii)** Use the graphs to find the difference in the extensions of the two springs when a force of 15 N is applied to each one.

difference in extensions = .....

[6]

[Total : 8]

**8** Fig. 3.1 shows the arm of a crane when it is lifting a heavy box.

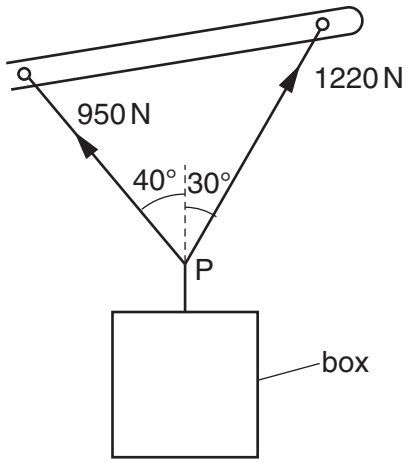


**Fig. 3.1**

**(a)** By the use of a scale diagram (**not** calculation) of the forces acting at P, find the weight of the box. [5]

**(b)** Another box of weight 1500 N is raised vertically by 3.0 m.

**(i)** Calculate the work done on the box.

work done = .....

**(ii)** The crane takes 2.5 s to raise this box 3.0 m. Calculate the power output of the crane.

power = .....
[4]

[ Total : 9 ]