**4** **(a)** State what is meant by *elastic potential energy*.

.....

.....[1]

**(b)** A spring is extended by applying a force. The variation with extension $x$ of the force $F$ is shown in Fig. 4.1 for the range of values of $x$ from 20 cm to 40 cm.

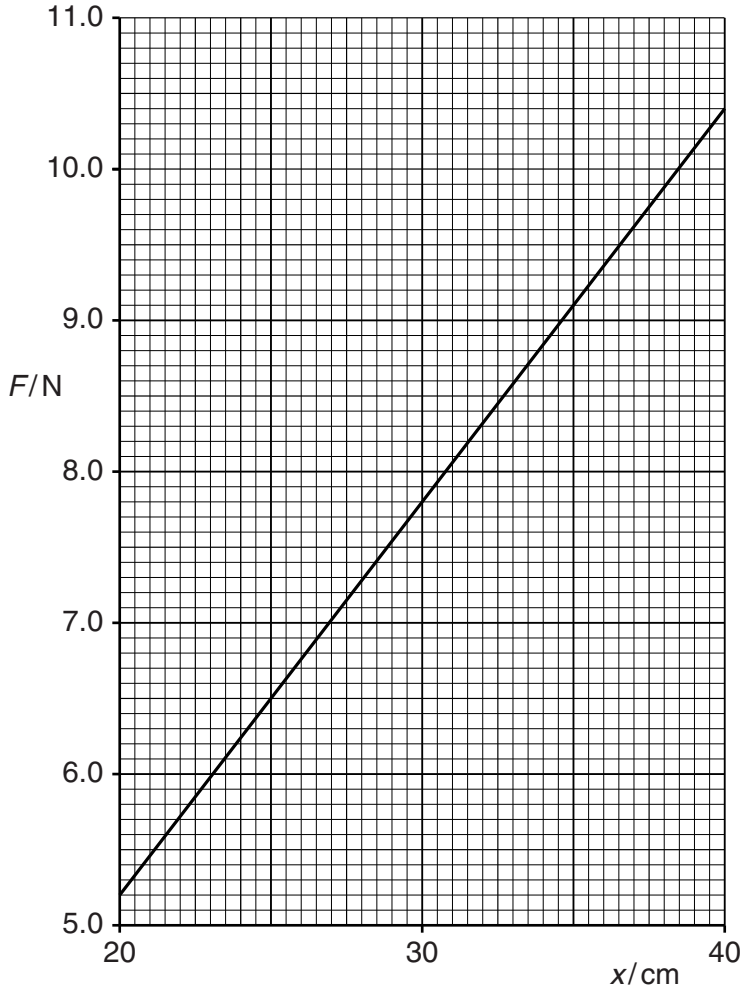


**Fig. 4.1**

**(i)** Use data from Fig. 4.1 to show that the spring obeys Hooke's law for this range of extensions.

.....

.....

.....[2]

**(ii)** Use Fig. 4.1 to calculate

**1.** the spring constant,

spring constant = ..... $N\,m^{-1}$ [2]

**2.** the work done extending the spring from $x = 20\,cm$ to $x = 40\,cm$.

work done = ..... J [3]

**(c)** A force is applied to the spring in **(b)** to give an extension of 50 cm.

State how you would check that the spring has not exceeded its elastic limit.

.....

.....[1]

[Total: 9]

**BLANK PAGE**

**3** **(a)** State what is meant by

**(i)** *work done*,

.....

..... [1]

**(ii)** *elastic potential energy*.

.....

..... [1]

**(b)** A block of mass 0.40 kg slides in a straight line with a constant speed of 0.30 m s$^{-1}$ along a horizontal surface, as shown in Fig. 3.1.

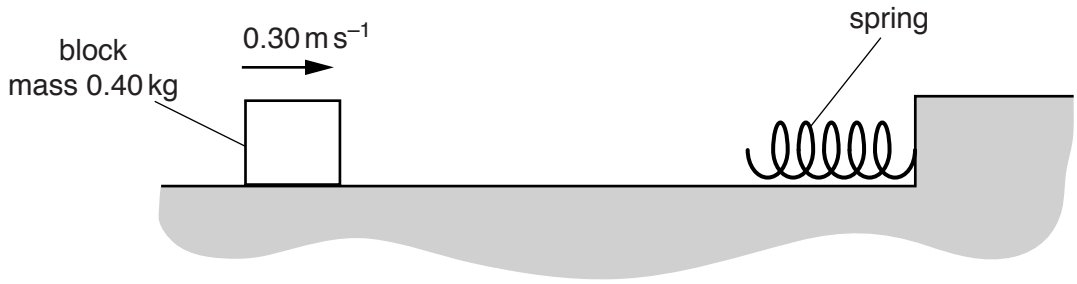


**Fig. 3.1**

The block hits a spring and decelerates. The speed of the block becomes zero when the spring is compressed by 8.0 cm.

**(i)** Calculate the initial kinetic energy of the block.

kinetic energy = ..... J [2]

**(ii)** The variation of the compression $x$ of the spring with the force $F$ applied to the spring is shown in Fig. 3.2.

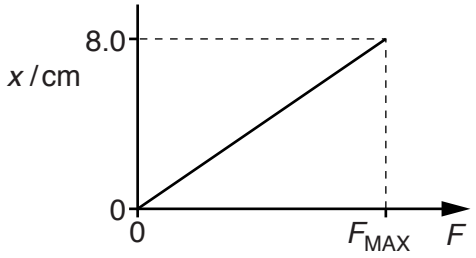


**Fig. 3.2**

Use your answer in **(b)(i)** to determine the maximum force $F_{MAX}$ exerted on the spring by the block.
Explain your working.

$F_{MAX}$ = ..... N [3]

**(iii)** Calculate the maximum deceleration of the block.

deceleration = ..... $m\,s^{-2}$ [1]

**(iv)** State and explain whether the block is in equilibrium

**1.** before it hits the spring,

.....

.....

**2.** when its speed becomes zero.

.....

.....
[2]

**(c)** The energy $E$ stored in a spring is given by

$$E = \tfrac{1}{2} k x^2$$

where $k$ is the spring constant of the spring and $x$ is its compression.

The mass $m$ of the block in **(b)** is now varied. The initial speed of the block remains constant and the spring continues to obey Hooke's law.

On Fig. 3.3, sketch the variation of the maximum compression $x_0$ of the spring with mass $m$.

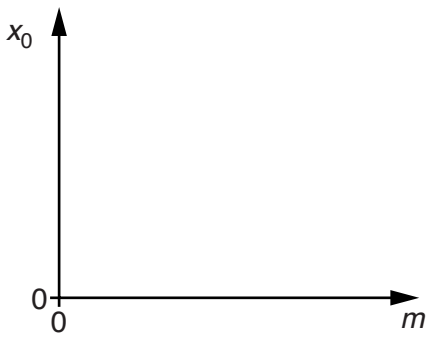


**Fig. 3.3** [2]

[Total: 12]

**BLANK PAGE**