Section B

For Examiner's Use

Answer **two** questions from this section.

6 **(a)** Define *force*.

.....

.....

.....[2]

(b) A light helical spring is suspended vertically from a fixed point, as shown in Fig. 6.1.

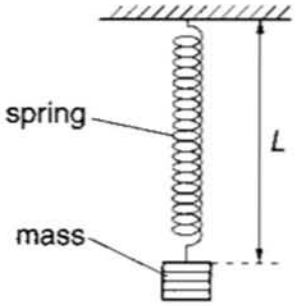

Fig. 6.1

Different masses are suspended from the spring. The weight W of the mass and the length L of the spring are noted.

The variation with weight W of the length L is shown in Fig. 6.2.

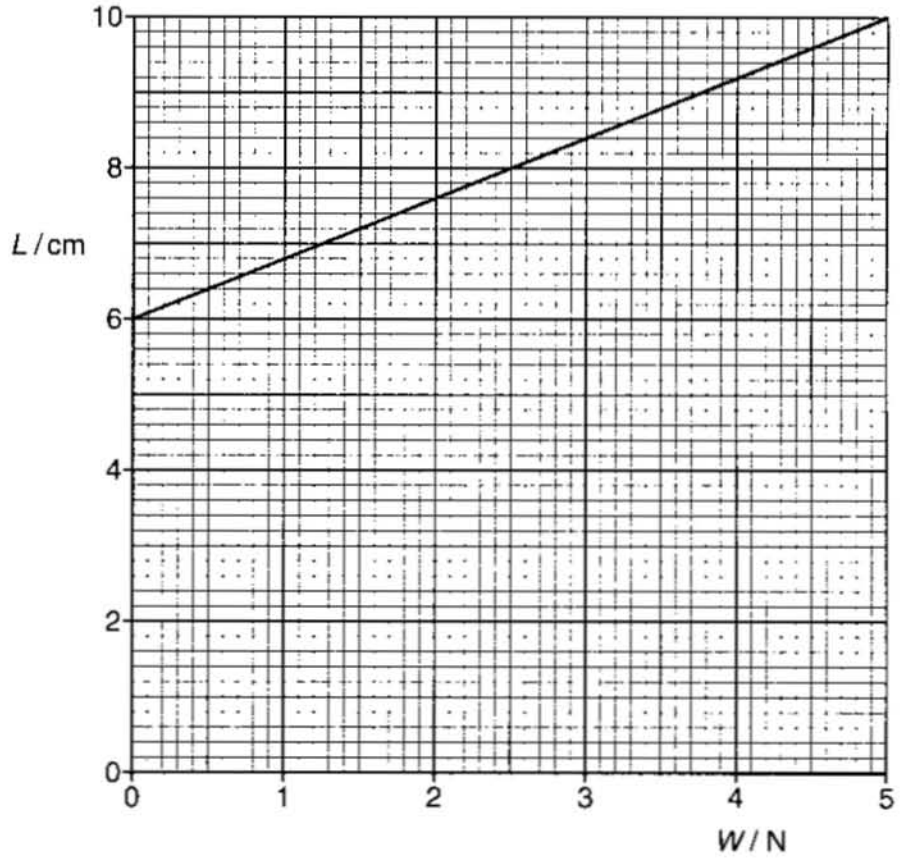

Fig. 6.2

(i) On Fig. 6.2, show clearly the area of the graph that represents energy stored in the spring when the weight on the spring is increased from zero to 5.0 N. [1]

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(ii) For a spring undergoing an elastic change, the force per unit extension of the spring is known as the force constant k.

Show that the energy E stored in the spring for an extension x of the spring is given by the expression

$$E = \tfrac{1}{2}kx^2.$$

[2]

Question 6 continues on the next page.

(c) A mass of weight 4.0 N is suspended from the spring in **(b)**.

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When the mass is stationary, it is then pulled downwards a distance of 0.80 cm and held stationary.

(i) Determine the total length of the spring.

length = ... cm [1]

(ii) For the increase in extension of 0.80 cm, determine the magnitude of the change in

1. the gravitational potential energy of the mass,

change = ... J [2]

2. the elastic potential energy of the spring.

change = ... J [3]

(iii) Use your answers in **(ii)** to show that the work done to cause the additional extension of 0.80 cm is 4.0×10^{-3} J.

[1]

(d) The mass in **(c)** is now released. The mass performs simple harmonic motion.

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(i) State the total energy of oscillation of the mass.

energy = ... J [1]

(ii) Calculate, for the mass,

1. its maximum speed,

speed = ... ms^{-1} [2]

2. the frequency of oscillation.

frequency = ... Hz [3]

(e) The spring in **(d)** is assumed to be light. In practice, the spring will have some mass.

Assuming that the spring constant k is unchanged, suggest and explain the effect on the frequency of oscillation of having a spring with mass.

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.....[2]

[Turn over