9 **(a)** State what is meant by *simple harmonic motion.*

……

……

……

……[2]

A long strip of springy steel is clamped at one end so that the strip is vertical. A mass *m* of 65 g is attached to the free end of the strip, as shown in Fig. 9.1.

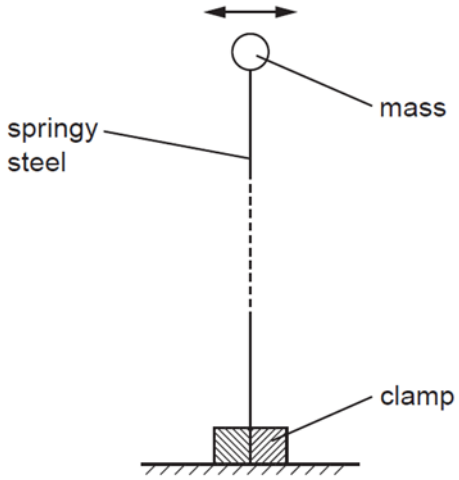

Fig. 9.1

The mass is pulled to one side and then released. The variation with time *t* of the horizontal displacement of the mass is shown in Fig. 9.2

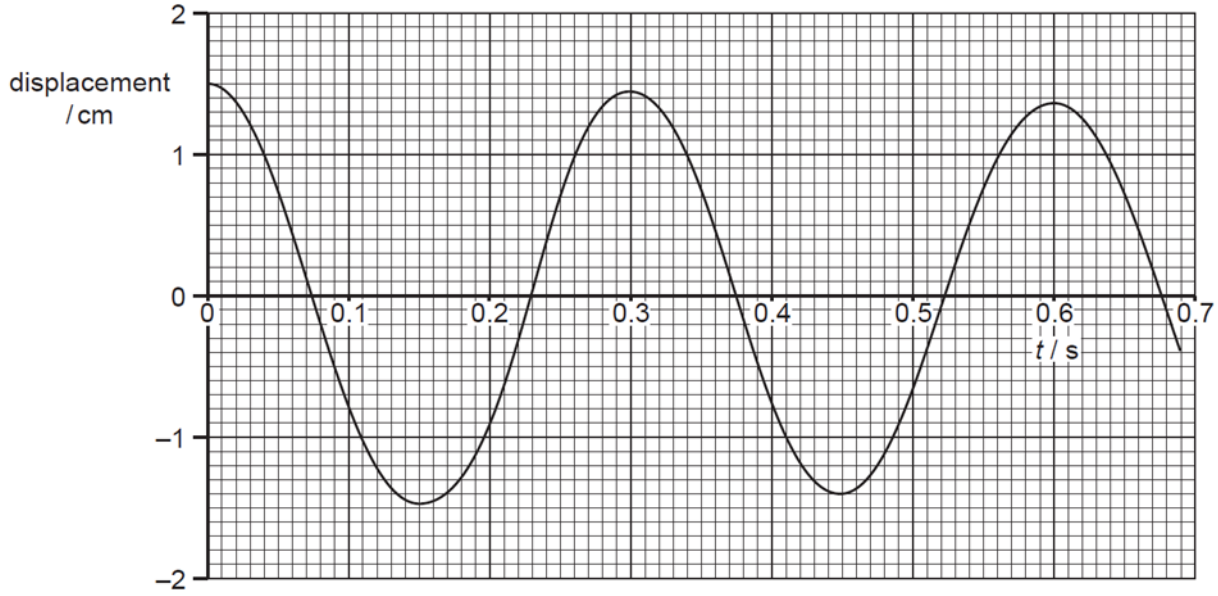

Fig. 9.2

[Turn over

The mass undergoes damped oscillation.

(b) **(i)** Suggest, with a reason, whether the damping is light, critical or heavy.

……

……

…… [2]

(ii) **1.** Using the data from Fig. 9.2, determine the maximum speed of the oscillation. State one time at which it is moving at maximum speed.

maximum speed =……..m s^{-1}

time = …… s [2]

2. Sketch a graph showing the variation of the velocity of the mass *v* with its displacement from the equilibrium position in Fig. 9.3 for the first complete period of the oscillation.

Label the axes with an appropriate scale.

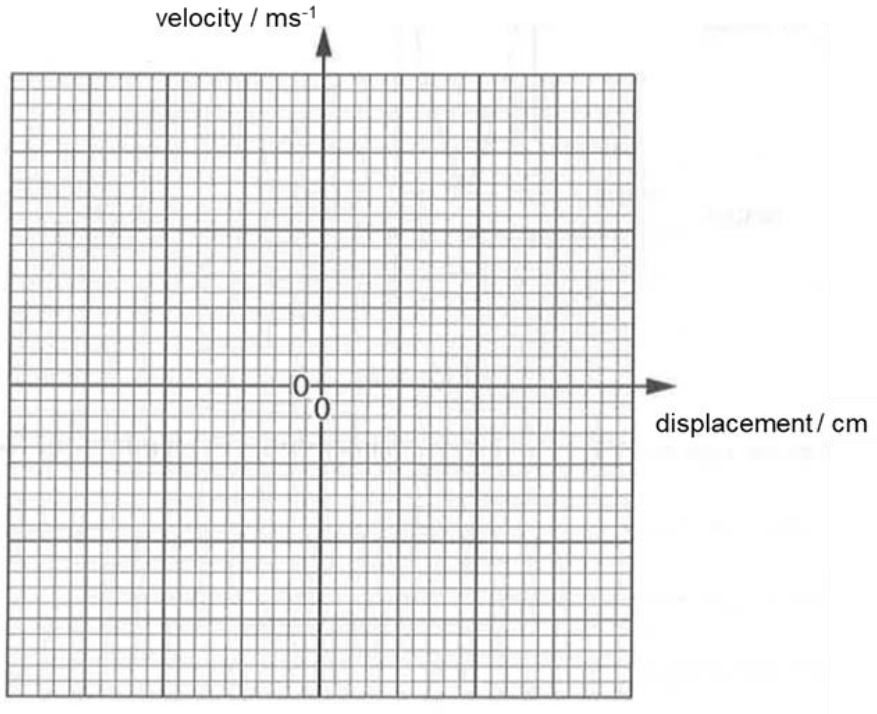

Fig. 9.3

[3]

(iii) After eight complete oscillations of the mass, the amplitude of vibration is reduced from 1.5 cm to 1.1 cm.

1. Show that the total energy of a body oscillating in simple harmonic motion is given by

$$E_T = \frac{1}{2} m\omega^2 x_0^2$$

where ω is the angular frequency of the oscillation and x_0 is its amplitude

[3]

2. Calculate the angular frequency of the oscillations.

angular frequency = …….rad s^{-1} [2]

3. Calculate the loss of energy after eight complete oscillations.

loss of energy = …….J [2]

[Turn over

4. Suggest with a reason, whether after another eight complete oscillations, the amplitude will be 0.7 cm.

……

……

…… [2]

(c) The variation of kinetic energy E_k of the mass with displacement x from its equilibrium position for the first period of oscillation is shown in Fig. 9.4.

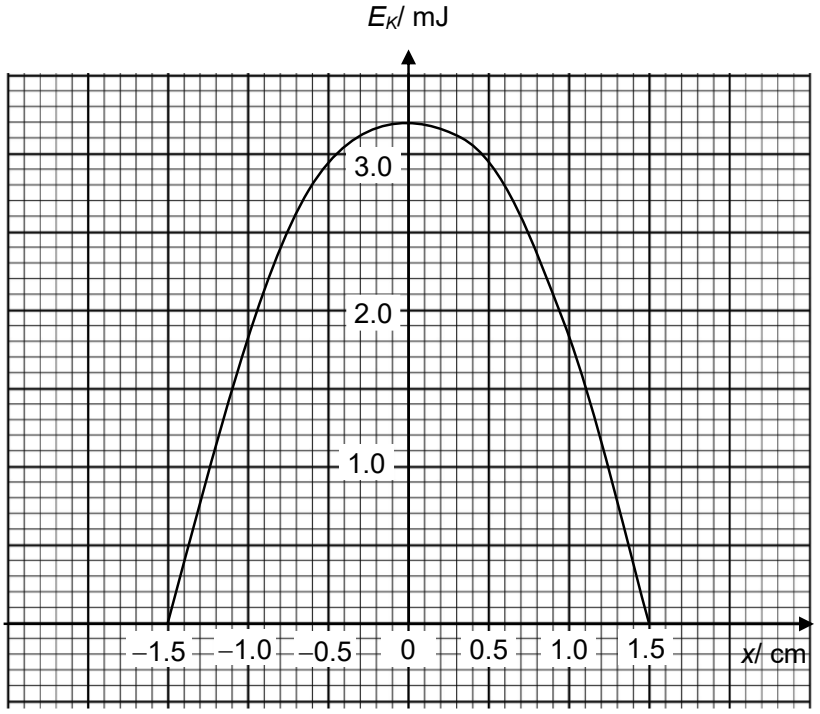

Fig. 9.4

The mass loses energy such that, after some time, its maximum kinetic energy is reduced by 1.5 mJ.

Use Fig. 9.4, without further calculation, to determine the amplitude of the oscillations. Show your construction on Fig. 9.4.

amplitude = ... cm [2]

[Total: 20]

-- END OF PAPER