2 **(a)** A student clamps one end of a flexible plastic ruler against the laboratory bench and sets it into simple harmonic oscillation. The end of the ruler moves a distance of 8.0 cm as shown in Fig. 2.1 and makes 28 complete oscillations in 10 s.

Fig. 2.1

(i) Calculate the angular frequency ω of the oscillations of the ruler.

angular frequency = …………………….. rad s^{-1} [1]

(ii) Sketch a graph of velocity v against displacement x for the motion at the tip of the ruler on Fig. 2.2.

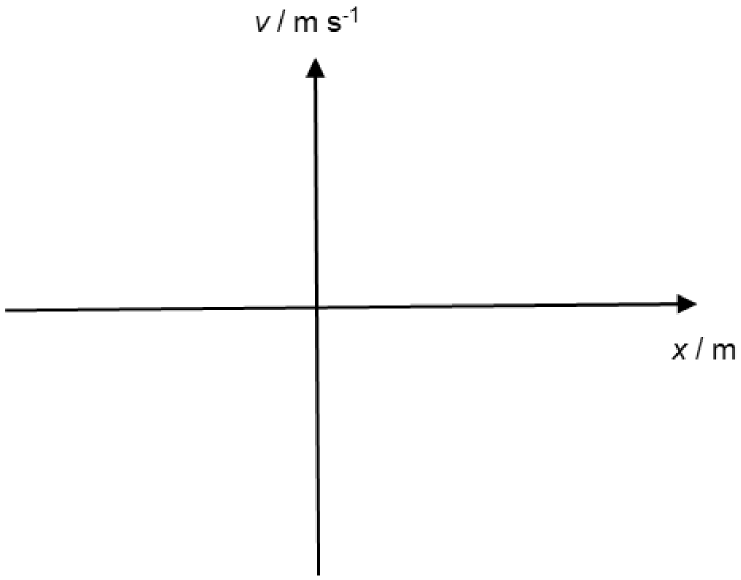

Fig. 2.2

[2]

(iii) Fig. 2.3 shows the variation with time t of the displacement x for the oscillations.

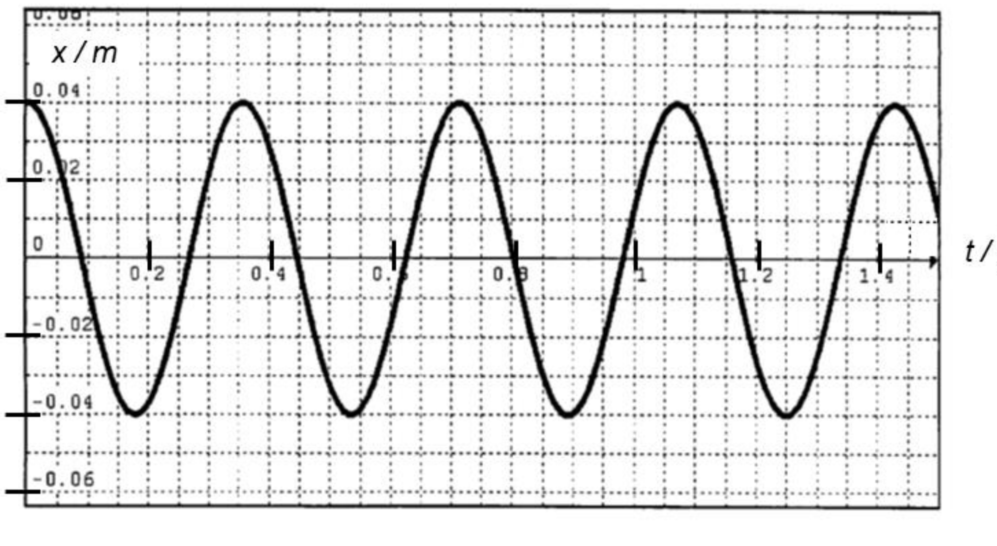

Fig. 2.3

Write down the equation for the displacement x in terms of the time t for these oscillations.

…………………………………………………………………………………………. [2]

(iv) The end of the ruler is attached with a piece of card of large surface area and the experiment is then repeated. Sketch a graph on Fig. 2.3 to show the effect of this change on the variation with t of the displacement of the ruler. [2]

(b) When a mass m attached to a spring of force constant k is set into oscillation, the period T of oscillations of the mass is given by

$$T = 2\pi\sqrt{\frac{m}{k}}\ .$$

A mass of 0.20 kg is connected to a light, horizontal spring of force constant 6.0 N m^{-1}. The mass, which is free to oscillate on a frictionless surface, is then displaced 5.0 cm from its equilibrium position and released from rest as shown in Fig. 2.4.

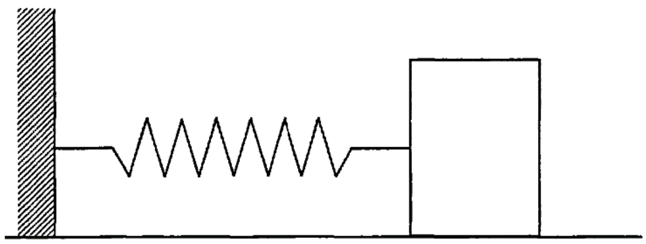

Fig. 2.4

(i) Calculate the period of oscillation of the mass.

period = ………..…………… s [1]

(ii) Calculate the maximum speed of the mass.

maximum speed = ………………… m s^{-1} [2]

(iii) Determine the total energy of this spring-mass system.

total energy = …..………………. J [2]

[Total: 12]