3

(a)

Write down an equation which defines simple harmonic motion.

……………………..………………………………………………………………………….. [1]

(b)

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. 3.1 and makes 28 complete oscillations in 10 s.

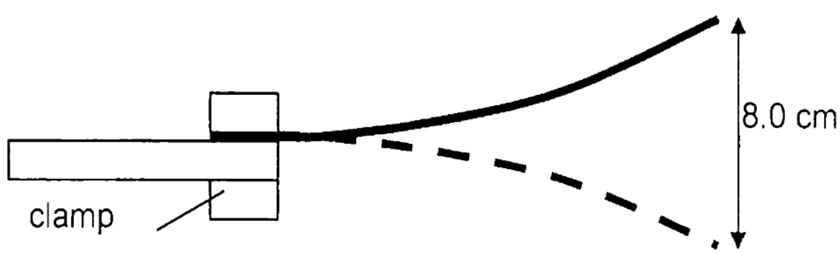


Fig. 3.1

(i)

Calculate the angular frequency ω of the oscillations.

angular frequency = …………………….... [1]

(ii)

Fig. 3.2 shows the variation with time t of the displacement x for the oscillations.

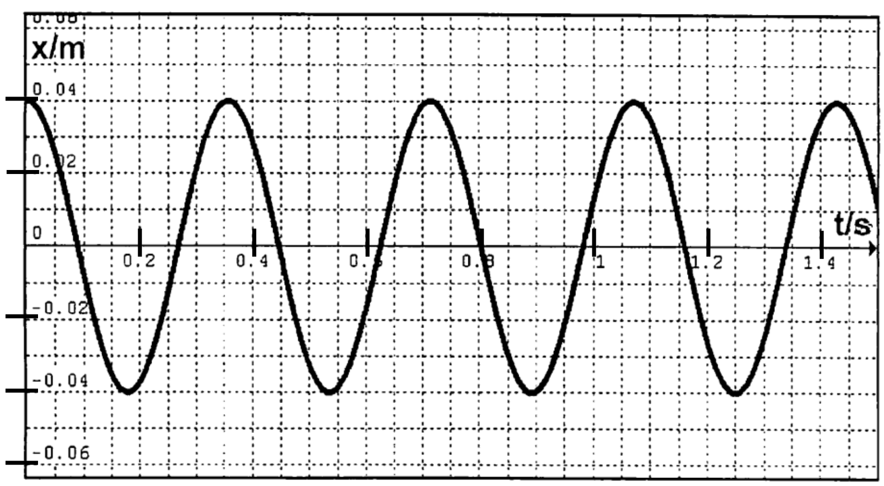


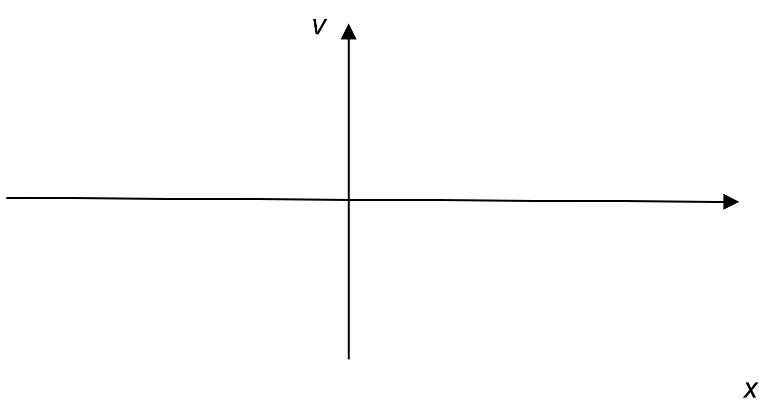
Fig. 3.2

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

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

(iii)

Sketch a graph of velocity *v* against displacement *x* for this motion.



[1]

(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. 3.2 to show the effect of this change on the variation with *t* of the displacement of the ruler. [2]

(c)

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 0.200 kg is connected to a light, horizontal spring of force constant 6.00 N m^{-1} .The mass, which is free to oscillate on a frictionless surface, is then displaced 5.00 cm from its equilibrium position and released from rest as shown in Fig. 3.3.

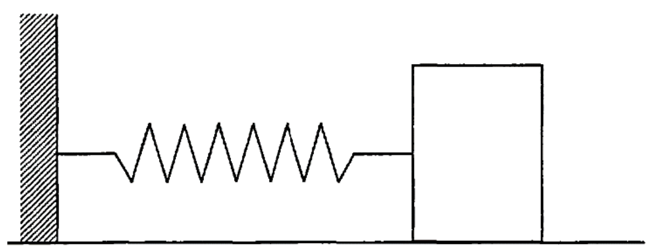


Fig. 3.3

(i)

Calculate the period of oscillation of the mass.

period = ………..……………s [1]

(ii)

Calculate the maximum speed of the mass.

speed = …………………m s^{-1} [2]

(iii)

Determine the total energy of this spring-mass system.

total energy = ….………………J [1]

(iv)

When the mass is at a displacement of 2.00 cm from its equilibrium position, determine

1. the velocity of the mass,

velocity = ……………… m s^{-1} [2]

2. the potential energy of the system.

potential energy = …………………..J [2]

[Total: 15]