Chapter 10
Short answer question

This question is about the motion of a mass suspended from a spring.

The spring shown in Figures 1 and 2 obeys the Hooke law. The mass is displaced from its equilibrium position, as shown in Figure 3 and then released, causing it to oscillate about its equilibrium position with a periodic time *T*.

At time $t = 0$ the mass is at its highest position and has a positive displacement *A* from its rest position.

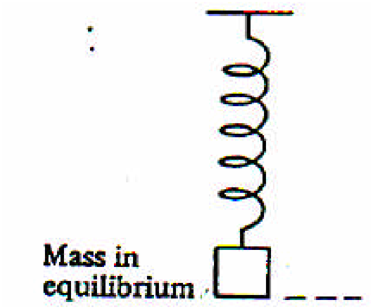


Fig. 1

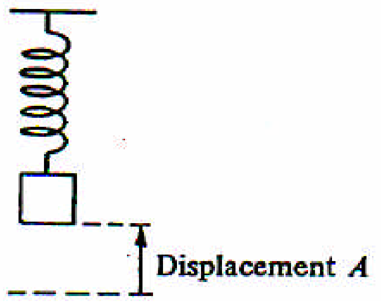


Fig. 2

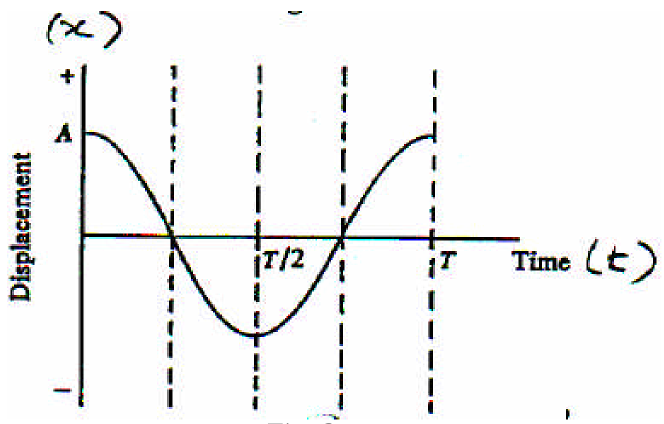


Fig. 3

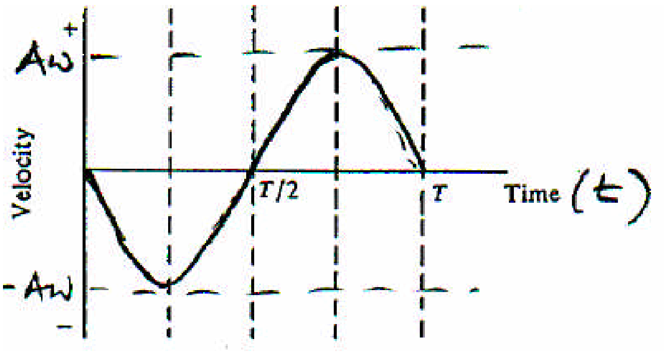
$x = A \cos wt$

w>1

The graph above (*Fig. 3)* shows the displacement of the mass against time.

On the axes below sketch graphs of:

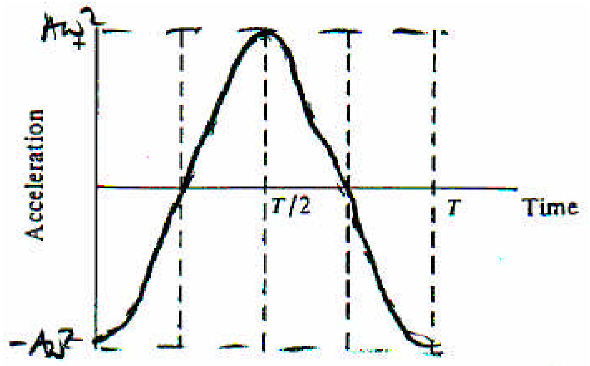
(i) velocity of the mass against time



$$\frac{dx}{dt} = -A\,w \sin wt$$

or gradient x v t graph

(ii) acceleration of the mass against time



$$\frac{d^2x}{dt} = -Aw^2 \cos wt$$

or gradient v vt graph

The mass is now made to oscillate with twice the previous amplitude. Assuming that the spring still obeys the Hooke law, state with reason(s), the effect on:

(i) the maximum energy stored in the spring

Maximum energy $\propto$ (amplitude)^2.

If amplitude doubles the maximum energy increases by a factor of 4.

(ii) the maximum kinetic energy of the mass

$$KE_{max} = \frac{1}{2} k A^2$$

So KE_{max} increases by 4

(iii) the average speed of the mass during one oscillation

Average speed doubles since the mass travels twice the distance in the same time T.