Oscillations

Very Short Answer Type Questions

1. Displacement versus time curve for a particle executing S.H.M. is shown in Fig. 14.7. Identify the points marked at which (i) velocity of the oscillator is zero, (ii) speed of the oscillator is maximum.

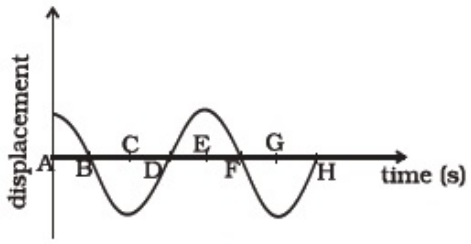

Fig. 14.7

2. Two identical springs of spring constant K are attached to a block of mass m and to fixed supports as shown in Fig. 14.8. When the mass is displaced from equilllibrium position by a distance x towards right, find the restoring force

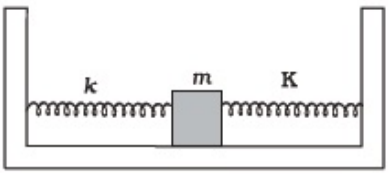

Fig. 14.8

3. What are the two basic characteristics of a simple harmonic motion?
4. When will the motion of a simple pendulum be simple harmonic?
5. What is the ratio of maxmimum acceleration to the maximum velocity of a simple harmonic oscillator?
6. What is the ratio between the distance travelled by the oscillator in one time period and amplitude?
7. In Fig. 14.9, what will be the sign of the velocity of the point P ′ , which is the projection of the velocity of the reference particle P . P is moving in a circle of radius R in anticlockwise direction.

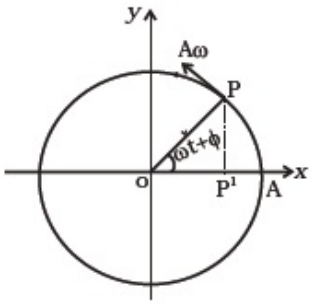

Fig. 14.9

8. Show that for a particle executing S.H.M, velocity and displacement have a phase difference of π/2.
9. Draw a graph to show the variation of P.E., K.E. and total energy of a simple harmonic oscillator with displacement.
10. The length of a second's pendulum on the surface of Earth is 1m. What will be the length of a second's pendulum on the moon?

Short Answer Type Questions

1. Find the time period of mass M when displaced from its equilibrium positon and then released for the system shown in Fig 14.10.

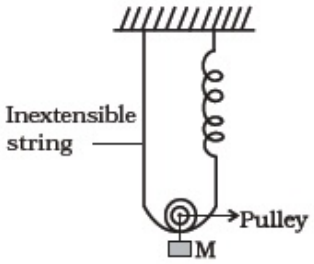

Fig. 14.10

2. Show that the motion of a particle represented by y = sin ω t – cos ω t is simple harmonic with a period of 2π/ω.
3. Find the displacement of a simple harmonic oscillator at which its P.E. is half of the

maximum energy of the oscillator.

4. A body of mass m is situated in a potential field $U(x) = U_0(1-\cos \alpha x)$ when U_0 and α are constants. Find the time period of small oscillations.
5. A mass of 2 kg is attached to the spring of spring constant 50 Nm^{-1}. The block is pulled to a distance of 5cm from its equilibrium position at x = 0 on a horizontal frictionless surface from rest at t = 0. Write the expression for its displacement at anytime t.
6. Consider a pair of identical pendulums, which oscillate with equal amplitude independently such that when one pendulum is at its extreme position making an angle of 2° to the right with the vertical, the other pendulum makes an angle of 1° to the left of the vertical. What is the phase difference between the pendulums?

Long Answer Type Questions

1. A person normally weighing 50 kg stands on a massless platform which oscillates up and down harmonically at a frequency of 2.0 s –1 and an amplitude 5.0 cm. A weighing machine on the platform gives the persons weight against time.
    - (a) Will there be any change in weight of the body, during the oscillation?
    - (b) If answer to part (a) is yes, what will be the maximum and minimum reading in the machine and at which position?

2. A body of mass m is attached to one end of a massless spring which is suspended vertically from a fixed point. The mass is held in hand so that the spring is neither stretched nor compressed. Suddenly the support of the hand is removed. The lowest position attained by the mass during oscillation is 4cm below the point, where it was held in hand.
    - (a) What is the amplitude of oscillation?
    - (b) Find the frequency of oscillation?

3. A cylindrical log of wood of height h and area of cross-section A floats in water. It is pressed and then released. Show that the log would execute S.H.M. with a time period.

$$T = 2\pi\sqrt{\frac{m}{A\rho g}}$$

where m is mass of the body and ρ is density of the liquid.

4. One end of a V-tube containing mercury is connected to a suction pump and the other end to atmosphere. The two arms of the tube are inclined to horizontal at an angle of 45° each. A small pressure difference is created between two columns when the suction pump is removed. Will the column of mercury in V-tube execute simple harmonic motion? Neglect capillary and viscous forces.Find the time period of oscillation.
5. A tunnel is dug through the centre of the Earth. Show that a body of mass 'm' when dropped from rest from one end of the tunnel will execute simple harmonic motion.
6. A simple pendulum of time period 1s and length l is hung from a fixed support at O, such that the bob is at a distance H vertically above A on the ground (Fig. 14.11). The amplitude is θ_0. The string snaps at $\theta = \theta_0/2$. Find the time taken by the bob to hit the ground. Also find distance from A where bob hits the ground. Assume θ_0 to be small so that $\sin\theta_0 \cong \theta_0$ and $\cos\theta_0 \cong 1$.

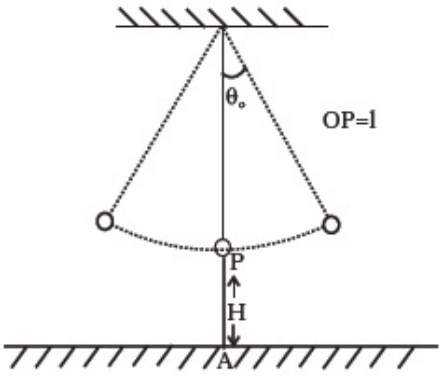

Fig. 14.11