CHAPTER NO. 7 (OSCILLATIONS)

Question 7.1:- Name two characteristic of simple harmonic motion.

Answer:- Simple harmonic motion has following characteristics:-

- **(i)** It is a type of oscillatory motion.
- **(ii)** Acceleration of a body performing simple harmonic motion is directly proportional to the displacement.
- **(iii)** Acceleration of a body performing simple harmonic motion is always directed towards the mean position.
- **(iv)** The total energy of an object performing simple harmonic motion is always constant.

Question 7.2:- Does frequency depend on amplitude for harmonic oscillators?

Answer:- The frequency of a harmonic oscillator does not depend upon its amplitude.

For a simple pendulum f = $\frac{1}{2\pi}\sqrt{\frac{g}{l}}$ It depends on length of the pendulum and value of acceleration due to gravity.	For a mass spring system f = $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ It depends on suspended mass and spring constant.

Question 7.3:- Can we realize an ideal simple pendulum?

Answer:- No, we cannot realize an ideal simple pendulum because it consists of:-

- (i) A small but heave and dense bob
- (ii) A massless but an inextensible string
- (iii) A rigid and frictionless support in an air free atmosphere so that no mechanical energy is dissipated.

Question 7.4:- What is the total distance travelled by an object moving with SHM in a time equal to its period, if its amplitude is A?

Answer:- Time to complete one round trip about the mean position is called time period. If amplitude of a simple harmonic oscillator is A, it covers a total distance of 4A in one time period.

Question 7.5:- What happens to the period of a simple pendulum if its length is doubled? What happens if the suspended mass is doubled?

Answer:- Time period of a simple pendulum is given as T = $2\pi\sqrt{\frac{l}{g}}$.

If length is doubled, $l_1 = 2\,l$	Time period of a simple pendulum is

$T_1 = 2\pi\sqrt{\frac{l_1}{g}} = 2\pi\sqrt{\frac{2l}{g}} = \sqrt{2}\ 2\pi\sqrt{\frac{l}{g}} = \sqrt{2}\ T$ Time period increases $\sqrt{2}$ = 1.41 times.	independent of the suspended mass. If suspended mass is doubled, time period of the pendulum remains same.

Question 7.6:- Does the acceleration of a simple harmonic oscillator remain constant during its motion? Is the acceleration ever zero? Explain.

Answer:- No, the acceleration of simple harmonic oscillator does not remain constant during its motion. It depends directly on displacement of the harmonic oscillator from mean position. Mathematically, $\vec{a} = \omega^2\vec{x}$.

Yes, the acceleration is zero at mean position as $\vec{a} = \omega^2\overrightarrow{(0)} = \vec{a} = \vec{0}$.

Question 7.7:- What is meant by phase angle? Does it define angle between maximum displacement and the driving force?

Answer:- The angle which specifies the displacement as well as the direction of motion of the point or object performing simple harmonic motion is called the phase angle. It determines the state of the motion of harmonic oscillator. Mathematically, $\theta = \omega t$.

No, it does not define the angle between maximum displacement and the driving force.

Question 7.8:- Under what conditions does the addition of two simple harmonic motions produce a resultant, which is also simple harmonic?

Answer:- If two simple harmonic motions with same frequency or time period are added together, the resultant will also be a simple harmonic motion.

For example sum of $Y_1 = A \sin \omega t$ and $Y_2 = B \sin (\omega t + \phi)$ will also be simple harmonic motion because frequency (time period) of both is same.

Question 7.9:- Show that in SHM the acceleration is zero when the velocity is greatest and the velocity is zero when the acceleration is greatest?

Answer:- For a simple harmonic oscillator, $a = -\omega^2 x$ and $v = \omega\sqrt{x_o^2 - x^2}$.

AT MEAN POSITION x = 0		**AT EXTREME POSITION x = x_o**	
Acceleration	**Velocity**	**Acceleration**	**Velocity**
$a = -\omega^2(0)$ $a = 0$	$v = \omega\sqrt{x_o^2 - 0^2}$ $v = \omega x_o$ (Maximum)	$a = -\omega^2(x_o)$ $\|a\| = \omega^2(x_o)$ (Maximum)	$v = \omega\sqrt{x_o^2 - x^2}$ $v = \omega(0) = 0$
The acceleration is zero and velocity is greatest at mean position during		The acceleration is greatest and velocity is zero at extreme position during SHM.	

SHM.	

Question 7.10:- In relation to SHM, explain the equations; (a) y = A sin (ωt + ϕ) (b) $\vec{a} = \omega^2\vec{x}$.

Answer:-

y = A sin (ωt + ϕ)	**$\vec{a} = \omega^2\vec{x}$**
This equation describes the instantaneous displacement of an object performing simple harmonic motion where y = Instantaneous displacement A = Amplitude of oscillator ϕ = Initial phase ω = Angular velocity = $\frac{2\pi}{T}$ ωt + ϕ = Instantaneous phase	This equation describes the instantaneous acceleration on an object performing simple harmonic motion where a = Instantaneous acceleration ω = Angular velocity = $\frac{2\pi}{T}$ x = Instantaneous displacement

Question 7.11:- Explain the relation between total energy, potential energy and kinetic energy for a body oscillating with SHM.

Answer:- For an object performing simple harmonic motion, total energy is sum of potential energy and kinetic energy i.e. E = K.E. + P.E.

Total energy remains constant in the absence of frictional effects; K.E. and P.E. are interchanged in continuously from one form to another.

At mean position, energy is totally K.E. and P.E. is zero.

At extreme positions, energy is totally P.E. and K.E. is zero.

In between, energy is partially P.E. and partially K.E.

Question 7.12:- Describe some common phenomena in which resonance plays an important role.

Answer:- Resonance plays an important role in following common phenomena:-

1) By tuning a radio, natural frequency of AC in the radio receives is made equal to the frequency of desired broadcasting radio station and we can listen to desired radio station through resonance.

2) Swings in a park are pushed after a fixed / regular interval of time and amplitude goes on increasing gradually through resonance.

3) The EM waves produced in a microwave oven have wavelength of 12 cm at frequency of 2450 MHz. The fat and water molecules in food absorb these EM waves through resonance and helps in even heating & cooking of food.

4) In the stringed musical instrument, when frequency of enclosed air column becomes equal to the string frequencies due to resonance, a loud music is heard.

Question 7.13:- If a mass spring system is hung vertically and set into oscillations, why does the motion eventually stop?

Answer:- When a vertical spring mass system is hung vertically and set into oscillations, it eventually stops due to friction, air resistance and other damping forces. The mechanical energy of the system gradually dissipates as a result of friction and doing work against air resistance & damping forces and motion eventually stops.