SHORT QUESTIONS.

Q7.1 Name two characteristics of S.H.M.

Ans: (i) It is a type of oscillatory motion.

(ii) Acceleration of a vibrating body is directly proportional to the displacement and is always directed towards the mean position i.e $a \propto -x$

(iii) SHM can be represented by a single harmonic function of sine or cosine in the form of eq.

$$x = x_0 \sin(\omega t + \phi)$$
$$x = x_0 \cos(\omega t + \phi)$$

(iv) The system executing S.H.M. must possess elasticity and inertia.

Q7.2 Does frequency depend on amplitude for harmonic oscillator?

Ans: The frequency of harmonic oscillator is;

$$f = \frac{1}{2\pi}\sqrt{g/l} \quad \text{(for pendulum provided } \theta \text{ is small)}$$

and

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}} \quad \text{(for mass spring system)}$$

Both of above eqs. are independent of amplitude but eq.① depends upon the length of pendulum and acc. due to gravity. Eq.② depends on its mass. By increasing mass of harmonic oscillator, its frequency decreases.

Q7.3 Can we realize an ideal simple pendulum?

Ans: NO, we can not realize an ideal simple pendulum because an ideal simple pendulum consists of a small heavy bob suspended from a rigid, frictionless support by means of a light inextensible string in an air free atmosphere so that no mechanical energy is dissipated.

Q7.4 What is the total distance travelled by an object moving with SHM in a time equal to its period, if its amplitude is 'A'?

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Ans: The **time period** of a SHM is the time to complete one complete to and fro motion about the mean position. If 'A' is the amplitude of vibration, then during this time, the object moves a distance equal to "4A".

Q 7.5 What happens to the period of a simple pendulum if its length is double? What happens if the suspended mass is doubled?

Ans: (i) The time period of a simple pendulum is

$$T = 2\pi\sqrt{l/g} \quad \text{———} \; (1)$$

If length is double, eq. (1) becomes

$$T' = 2\pi\sqrt{\frac{2l}{g}} = \sqrt{2}\cdot 2\pi\sqrt{l/g} = \sqrt{2}\,T = 1.41\,T \quad \text{———} \; (2)$$

(ii) Eq. (1) shows that time period is independent of mass.

Q 7.6 Does the acc. of a simple harmonic oscillator remain constant during its motion? Is the acc. ever zero? Explain.

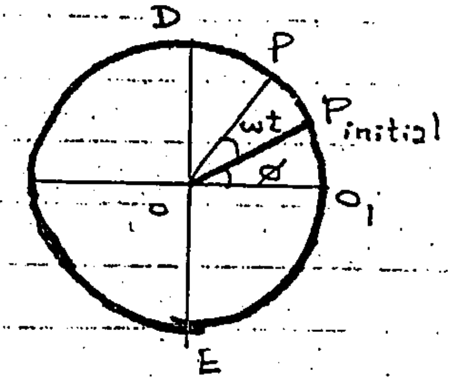
Ans: The acc. of a simple harmonic oscillator is

$$a = -\text{const.} \times x$$

where 'x' is the displacement from the mean position. As the displacement 'x' changes during a SHM, its acc. does not remain constant. The acc. becomes zero at the mean position ($x = 0$) and becomes max. at the extreme positions.

Q 7.7 What is meant by phase angle? Does it define angle between max. displacement and the driving force?

Ans: "The angle which specifies the displacement as well as the direction of motion of the point executing SHM is called phase angle."



Thus, it determines the state of motion of the vibrating point.

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It does not define angle between max. displacement and the driving force. It is the angle $\theta = \omega t$, which the rotating radius OP makes with the reference direction OO_1 at any instant as shown in fig.

Q7.8 Under what conditions does the addition of two SHM's produce a resultant, which is also simple harmonic?

Ans. Two SHMs of the same period but of different amplitudes and phases taking place in the same direction can be added to give another SHM. The amplitude of the resultant S.H.M. is equal to the algebraic sum of the amplitudes of the two component SHM. Its phase angle will also be different.

Given SHMs $\quad y_1 = a \sin \omega t$, $\quad y_2 = b \sin(\omega t + \phi)$

Resultant SHM is $\quad y = y_1 + y_2 = a \sin \omega t + b \sin(\omega t + \phi)$

Its converse is also true i.e; a given SHM may resolved into two components.

Q7.9 Show that in SHM the acc. is zero when the velocity is greatest and the velocity is zero when the acc. is greatest.

Ans. For a typical SHM,

$$a = -\omega^2 x \quad \text{——— (1)}$$

$$\text{and} \quad v = \omega\sqrt{x_0^2 - x} \quad \text{——— (2)}$$

(i) At mean position $x = 0$, so

$$a = -\omega^2(0) = 0$$

$$\text{and} \quad v = \omega\sqrt{x_0^2 - 0} = \omega x_0 \quad \text{(max. value)}$$

(ii) At extreme position $x = x_0$, so

$$a = -\omega^2 x_0 \quad \text{(max. value)}$$

$$\text{and} \quad v = \omega\sqrt{x_0^2 - x_0^2} = \omega(0) = 0$$

Hence above statement is true.

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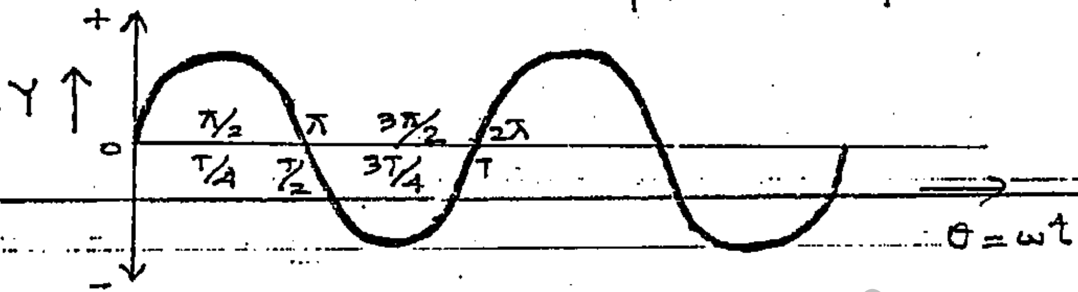
Q 7.10 In relation to SHM, explain the equation
(i) $Y = A\sin(\omega t + \phi)$ (ii) $\vec{a} = -\omega^2 \vec{x}$

Ans: (i) This equation represents the displacement of S.H. oscillator as a function of time.



Thus, this eq. tells that displacement follows a **Sine curve** i.e; varies harmonically.
'Y' is instantaneous displacement, 'A' is the amplitude of the oscillating particle, 'φ' is initial phase which tells us about the state of motion, '(ωt + φ)' is the phase angle made with reference direction and 'ωt' is the angle subtented in time t with angular frequency ω starting from initial phase φ.

(ii) It is the expression of acc. of an object executing SHM. It states that acc. is directly proportional to displacement and it is always directed towards the mean position.
'ω' is the angular frequency of the particle and '$\vec{x}$' is the instantaneous displacement from the mean position.

Q 7.11 Explain the relation between total energy, P.E and K.E for a body oscillating with SHM.

Ans: For a body oscillating with SHM,

$$E_{total} = P.E + K.E \quad \text{——— (1)}$$

Since total energy of SHM remains constant in the absence of frictional forces, the K.E and P.E are interchanged continuously from one form to another.
At mean position, the energy is totally K.E (i.e;

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K.E is max but P.E = 0). At the extreme positions the K.E is completely changed into P.E. In between, it is partly P.E and partialy K.E.

Q7.12 Describe some common phenomena in which resonance plays an important role.

Ans: Following are the common phenomena in which resonance plays an important role.

(i) **Tuning of a radio.** By tuning a dial, the natural frq. of an A.C in the receiving circuit is made equal to the frq. of the wave broadcast by the desired station. When the two frqs. match, resonance occur and we hear the programme of desired station.

(ii) **Swing.** If the swing is pushed after regular intervals of time (equal to the period of swing), its motion will increase with every push. If the pushes occur at irregular intervals, the swing will hardly vibrate.

(iii) **Microwave oven.** The wave produced in this type of oven have a wavelength of 12 cm at a frq. of 2450 MHZ. At this frq. the waves are absorbed due to resonance by water and fat molecules in the food resulting in efficient and evenly heating and cooking of the food.

(iv) **Musical strings.** In the musical strings when the frq. of enclosed air column in the wooden boxes under the strings becomes equal to the string frequencies, due to resonance a loud sound of music is heard.

Q7.13. If a mass spring system is hung vertically and set into oscillations, why does the motion eventually stop?

Ans. A SHM eventually stops due to friction, air resistance and some other damping forces. Thus, mechanical energy of the system is wasted into heat and consequently the system does not oscillate indefinitely and eventually stops.

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