PHYSICS

Class	**PUC 2nd Yr.**	
	Class work	
Topic	**S.H.M**	**March 2014**

1. A simple pendulum of frequency f is taken to a height above the ground and then dropped along with its support so that it falls freely under gravity. The frequency of oscillation of the falling pendulum is
   (A) f (B) infinity (C) f/2 (D) zero
2. A person measures the time period of a simple pendulum inside a stationary lift and finds it to be T. If the lift starts accelerating upwards with an acceleration of g/3, time period of the pendulum will be
   (A) $T\sqrt{3}$ (B) $\sqrt{3}T/2$ (C) $T/\sqrt{3}$ (D) T/3
3. A car is coming down an inclined plane without friction. If the inclination of the plane is 30^0 with the horizontal and a pendulum is suspended from the roof of it, what will be its time period of oscillation, if it has a period T when suspended from the roof of a stationary car?
   (A) (B) (C) (D)
4. A simple pendulum with a brass bob has a time period T. The bob is now immersed in a non-viscous liquid and oscillated. If the density of the liquid is 1/8 that of brass, the time period of the same pendulum will be
   (A) $T\sqrt{(8/7)}$ (B) 8T/7 (C) 64T/49 (D) T
5. A simple pendulum of frequency f has a metal bob. If the bob is charged negatively and is allowed to oscillate with a positively charged plate placed under it, the frequency will be
   (A) f (B) $\frac{1}{2}f$ (C) 3f/2 (D) zero
6. A uniform spring has a certain mass suspended from it and its period of vertical oscillation is T_1. The spring is now cut into two equal halves and the same mass is suspended from one of the halves. The period of vertical oscillations is now T_2. The ratio T_2/T_1 is
   (A) 1/2 (B) $1/\sqrt{2}$ (C) 2 (D) $\sqrt{2}$
7. An S.H.M is given by $x = 3 \sin 3\pi t + 4 \cos 3\pi t$ where x is in meters and t in sec. The amplitude of motion is
   (A) 3 (B) 4 (C) 5 (D) 7
8. Two springs of equal length and cross sectional areas are made of material whose Young's moduli are in the ratio 3: 2 they are suspended and loaded with the same mass. When stretched and released, they will oscillate with periods in the ratio of
   *(A) $\sqrt{(3/2)}$ (B) 3: 2 (C) $(3\sqrt{3})/(2\sqrt{2})$ (D) 9: 4
9. A particle is executing linear S.H.M of amplitude A. What fraction of the total energy is kinetic when the displacement is half the amplitude?
   (A) ¼ (B) ½ (C) 3/4 (D) $1/2\sqrt{2}$

10. At what displacement is energy of an oscillator half kinetic and half potential?
(A) A/4 (B) A/2 (C) A/√2 (D) A/√3

When the force is $F = -kx^n$ and k is a positive constant, the value of n will decide what will be the motion.

If n is even, force is always negative and the motion cannot be oscillatory.

If n is odd, force is negative for values of x that are positive and force is positive for values of x that are negative and force is zero for x = 0. Thus the particle will oscillate about stable equilibrium position x = 0. The force is called restoring force. If n = 1, the motion is S.H.M

S.H.M is possible if $\frac{d^2y}{dt^2} = -y$

Kinetic and potential energies in S.H.M are periodic with frequency double that of the particle but not S.H.

Total energy is constant and does not oscillate.

A function is said to be periodic with the time period T if **f (t + T) = f (t)**

The time period of a simple pendulum for small oscillations is $T = 2\pi\sqrt{\frac{l}{g}}$. Due to change in temperature, length changes and so does the time period. $\frac{T^1}{T} = \sqrt{\frac{l^1}{l}} = (1+\alpha\Delta\theta)^{1/2} = \left(1+\frac{1}{2}\alpha\Delta\theta\right)$

$\Delta T = \frac{1}{2}T\alpha\Delta\theta$. Pendulum loses time if T increases. Time lost or gained in time t is $\Delta t = \frac{\Delta T}{T^1}t$

Suppose T = 2 and $T^1 = 3$ then the time lost by the clock in 1 hr. is (1/3)3600 = 1200 s

For large amplitudes the calculation is more complex and is $T = 2\pi\sqrt{\frac{l}{g}\left(1+\frac{A^2}{16}\right)}$ where A is the amplitude in radians.

$T = 2\pi\sqrt{\frac{1}{g\left(\frac{1}{l}+\frac{1}{R}\right)}}$, if the length of the pendulum is comparable with the radius of the earth.

$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{l}{g}}$, where *l* is the elongation in the spring when the mass m is suspended.

If the spring has the mass m_s the time period is $T = 2\pi\sqrt{\frac{m+\frac{m_s}{3}}{k}}$

If there are two masses connected by a spring and oscillating on a horizontal surface $T = 2\pi\sqrt{\frac{\mu}{k}}$,

$\mu = \frac{m_1 m_2}{m_1 + m_2}$ is the reduced mass.

Force constant k is inversely proportional to the length of the spring.

11. Find the period of the function, y = sin ωt + sin 2ωt + sin 3ωt
    Ans: 2π/ω
12. A linear harmonic oscillator has a potential energy of 50 J at its mean position. It has a total energy of 200 J. Find maximum kinetic energy, minimum potential energy, and maximum potential energy.
    Ans: 150, 50, 200
13. The potential energy of a particle oscillating along the x-axis is given by
    $U = 20 + (x-2)^2$
    Where U is in joules and x in meter. Total mechanical energy is 36 J.
    State if the motion is S.H
    Find the mean position.
    Find the maximum kinetic energy of the particle.
14. A particle moves under the force $F(x) = x^2 - 6x$ N, where x is in meters. For small displacements from the origin what is the force constant in the S.H.M approximation?