Assignment-1 **Periodic Motion** Date: ……...

MCQs:

1. In SHM, acceleration is directly proportional to
   a. time b. displacement c. velocity d. frequency
2. For a body executing SHM with displacement A, the displacement of the body in one time period is:
   a. A b. 2A c. 4A d. Zero
3. For a body executing SHM, which parameter comes out to be non-periodic?
   a. Displacement b. velocity
   c. acceleration d. None of these
4. A system exhibiting SHM must possess
   a. Elasticity only b. Inertia only
   c. Elasticity as well as inertia d. elasticity, inertia, and an external force
5. A particle moves in a circular path with a uniform speed. Its motion is
   a. Periodic b. Oscillatory
   c. Linear simple harmonic d. Rotational simple harmonic
6. A hole is bored in the earth along its diameter. When a ball is dropped from its one end,
   a. it remains stationary. b. it moves and stops at the centre.
   c. it exhibits SHM. d. it comes out from the other end.
7. The time period of a simple pendulum is T remaining at rest inside a lift. Find the time period of the pendulum when the lift starts to move up with an acceleration of g/3
   a. T b. T/2 c. 2T/5 d. T√3/2

Answer: (d) T√3/2

8. The length of the second's pendulum on the surface of the earth is 1m. The length of the same pendulum on the surface of the moon, where the acceleration due to gravity is (⅙)th of the g on the surface of the earth is
   a. 36 m b. 1m c. 1/36 m d. ⅙ m

Answer: (d) ⅙ m

9. The displacement of a particle performing simple harmonic motion is given by,$x = 8\,sin\,\omega t + 6\,cos\,\omega t$, where distance is in cm and time is in second. The amplitude of motion is
   a. 10 cm b. 14 cm c. 3.5 cm d. 2 cm

Answer: (a) 10 cm

10. A particle executes S.H.M of amplitude A. At what distance from the mean position is its kinetic energy equal to its potential energy?
    a. 0.51 A b. 0.61 A c. 0.71 A d. 0.81 A

Answer: (c) 0.71 A

11. A simple pendulum on length l and mass m is suspended vertically. The string makes an angle θ with the vertical. The restoring force acting on the pendulum is
    a. mg tanθ b. mg sinθ c. – mg sinθ d. – mg cosθ

Answer: (c) – mg sinθ

12. The mass and diameter of a planet are twice those of earth. The period of oscillation of pendulum on this planet will be (if it is a second's pendulum on earth)
    a. 1/√2 second b. 2 x √2 second c. 2 second d. ½ second

Answer: (b) 2 x √2 second

13. A particle of mass m is hanging vertically by an ideal spring of force constant k. If the mass is made to oscillate vertically, its total energy is
    a. Maximum at extreme position b. Maximum at mean position
    c. Minimum at mean position d. Same at all positions

Answer: (d) Same at all positions

14. A place where g = 980 cm/sec^2 the length of seconds pendulum is about
    a. 50 cm b. 100 cm c. 2 cm d. 2 m

Answer: (b) 100 cm

15. The maximum velocity for a particle in S.H.M is 0.16 m/s and maximum acceleration is 0.64 m/s^2. The amplitude is
    a. 4 x 10^{-2} m b. 4 x 10^{-1} m c. 4 x 10 m d. 4 x 10^0 m

Answer: (a) 4 x 10^{-2} m

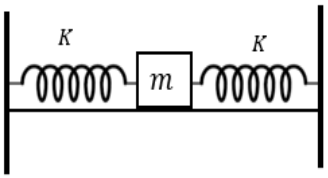
16. For a magnet of a time period T magnetic moment is M. If the magnetic moment becomes one-fourth of the initial value, then the time period of oscillation becomes
    a. Half of the initial value b. One-fourth of the initial value
    c. Double of the initial value d. Four times the initial value

Answer: (c) Double of the initial value

17. The graph plotted between the velocity and displacement from mean position of a particle executing SHM is
    a. Circle b. Parabola c. Ellipse d. Straight line
18. A body executing linear SHM has a velocity of 3m/s when its displacement is 4cm and a velocity of 4m/s when its displacement is 3cm. The amplitude of oscillation is:
    a. 5cm b. 7.5cm c. 10cm d. 12.5cm
19. The total energy of the particle executing simple harmonic motion of amplitude A is 100J. At a distance 0.707A from the mean position, its kinetic energy is:
    a. *50J* b. 100J c. 125J d. 250J
20. When the displacement of a particle executing SHM is half of its amplitude, the ratio of its kinetic energy to potential energy is:
    a. *3:1* b. 1:3 c. 2:1 d. 1:2
21. If the maximum velocity and acceleration of a particle executing SHM are equal in magnitude, the time period will be
    a. 1.57 secs b. 3.14 secs c. 6.28 secs d. 12.56 secs
22. A simple pendulum oscillates in air with time period T and amplitude A. As the time passes
    a. T remains same and A decreases b. T decreases and A decreases

c. T and A both decrease d. T and A both increase

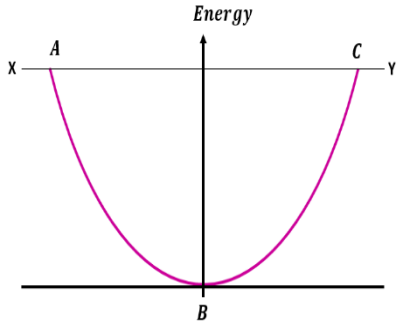
23. Which of the following will change the time period as they are taken to moon?
    a. A simple pendulum b. A torsional pendulum
    c. A physical pendulum d. A spring-mass system
24. For an oscillating simple pendulum, the tension in the string is
    a. Maximum at mean position b. Maximum at extreme position
    c. Constant throughout the motion d. Cannot be predicted
25. A particle undergoes SHM having time period T. What is the time taken by it to move from mean position to half of the amplitudes?
    a. T/2 b. T/3 c. T/6 d. T/12
26. A particle is vibrating simple harmonically with amplitude A. The displacement of the particle when its energy is half kinetic and half potential is
    a. A/2 b. A/4 c. $A/\sqrt{2}$ d. $A/\sqrt{3}$
27. A particle undergoes SHM with time period T. The time taken in completing 3/8 oscillation from mean position is
    a. 3T/8 b. 5T/8 c. 5T/12 d. 7T/12
29. The maximum velocity of a particle executing SHM with an amplitude of 7mm is 4.4 m/s. The time period of oscillation is
    a. $0.01\ s$ b. $0.1s$ c. $10s$ d. $100s$
30. The time period of simple pendulum inside a satellite orbiting the earth is
    a. zero b. infinite c. 1 s d. 9.8 s
31. Two identical springs are arranged with a block as in figure. The oscillation frequency of the mass is f. If one spring is removed, the frequency of the oscillation will be given by



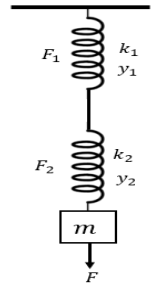
    a. f b. $2f$ c. $\sqrt{2}\,f$ d. $f/\sqrt{2}$
32. The maximum velocity and maximum acceleration of a particle executing SHM are $4m/s$ and $2m/s^2$ respectively. Then, its time period of oscillation will be
    a. $2\pi\ sec$ b. $\frac{\pi}{2}\ sec$ c. $\frac{2}{\pi}\ sec$ d. $4\pi\ sec$
33. For a simple pendulum, the graph between T^2 and l comes out to be
    a. straight line b. parabola c. circular d. hyperbola
34. starting from the mean position, a particle in simple harmonic motion takes time T_1 and T_2 to cover first half and next half displacement in moving from mean position to the extreme position, then
    a. $T_1 = T_2$ b. $T_1 = 2\,T_2$ c. $T_2 = 2\,T_1$ d. $T_1 > T_2$
35. The vertical extension in a light spring by a weight of 1Kg suspended from the wire is 9.8cm. The period of oscillation is
    a. $2\pi\ sec$ b. $20\pi\ sec$ c. $\frac{2\pi}{10}\ sec$ d. $200\pi\ sec$
36. A pendulum suspended from the ceiling of train has a period T when the train is at rest. When the train accelerates with a uniform acceleration a, the period of oscillation will
    a. increase b. decrease
    c. remain unaffected d. become infinite
37. The time period of simple pendulum is doubled when
    a. length is increased by 2 times c. length is increased by 4 times
    c. length is reduced to half d. mass is increased by 2 times
38. A hollow sphere is filled with water through a small hole at bottom. It is hung by thin thread and made to oscillate. As the water slowly flows out of the hole, the period of oscillation will
    a. continuously increases b. first increases and then decreases
    c. continuously decreases c. first decreases and then increases
39. If the time period of oscillation of mass m suspended from a spring is 1 sec. The period of the oscillation of mass 4 m will be
    a. 1 sec b. 2 sec c. 0.5 sec d. 4 sec
40. The differential equation of SHM is given by $\frac{d^2y}{dt^2} + 100y = 0$. The frequency of this motion is
    a. 1 b. 10 c. $10/2\pi$ d. $100/2\pi$
41. The potential energy of a simple harmonic oscillator at extreme position is $2J$. Its maximum kinetic energy is
    a. $1J$ b. $2J$ c. $3J$ d. $4J$
42. The kinetic energy of a simple harmonic oscillator at mean position is $2J$. The ratio of total energy and Potential energy at extreme position is
    a. 1: 2 b. 2: 1 c. 1: 1 d. 1: 3
43. A particle executing SHM with a frequency f, its kinetic energy oscillates with frequency
    a. f b. 2f c. 3f d. 4f
44. The phase difference between KE and PE of a particle executing Shm is
    a. π b. $\pi/2$ c. 2π d. 3π
45. The phase difference between displacement and velocity of a particle executing Shm is
    a. π b. $\pi/2$ c. 2π d. 3π
46. The phase difference between displacement and acceleration of a particle executing Shm is
    a. π b. $\pi/2$ c. 2π d. 3π
47. A body of mass $0.5\ kg$ is undergoing SHM of amplitude $0.5m$ and frequency $10Hz$. The maximum value of the force acting on it is
    a. $987N$ b. $1087N$ c. $1187N$ d. $1287N$

Subjective Questions:

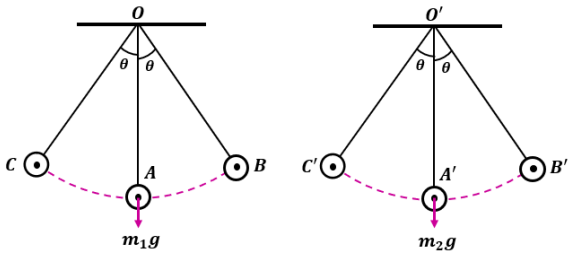
1. a) Define simple harmonic motion. 1
   b) For a simple harmonic oscillator, show that acceleration is directly proportional to the displacement. 2
   c) Prove that in SHM, when a particle is passing through the mean position, its velocity is maximum. 2
   d) The displacement of a mass vibrating with simple harmonic motion is given by $y = 20sin10\pi t$, where y *is in* mm and t *is in seconds*. Calculate,
      i. the amplitude
      ii. the period of oscillation
      iii. the velocity at $t = 0$. 3
2. Simple harmonic motion is defined by periodic functions like sine or cosine functions.
   a) State the basic equations of motion for a body executing SHM. 1
   b) Find an expression for time period of particle executing SHM. 2
   c) The tip of the tuning fork goes through 550 complete vibrations in 1 sec. Find the angular frequency and time period of the motion. 2
3. a) What is the necessary and sufficient condition for a motion to be simple harmonic? 1
   b) Find an expression for the energy of a particle in SHM and show that the particle obeys principle of conservation of energy. 3
   c) A mass of $0.1kg$ oscillates in simple SHM with an amplitude of $0.2m$ and a period $1.0s$. Calculate its maximum kinetic energy. 2
4. a) A body is moving in a circular path with constant speed. Is this motion a simple harmonic? Why? 1
   b) In usual notation, a SHM is given as
   $$y = a\sin(\omega t - \phi).$$
   Find its acceleration. 1
   c) Analyzing the given plot,
      i. Write the necessary formula for the nature of graph. 1
      ii. What are the points A, B and C? 1
      iii. What is the formula of potential energy at points A, B and C, as the horizontal line XY shows the total energy.



5. Simple pendulum is used to find the acceleration due to gravity in laboratory.
   a) Show that the bob of a simple pendulum is simple harmonic. Obtain an expression for its frequency. 3
   b) What is second pendulum? Find the length of second pendulum. Sketch the nature for $l - T$ and $l - T^2$ graph. 2
   c) A pendulum clock is in an elevator that descends at constant velocity. Does it keep correct time? If the same clock is in free fall, does it keep correct time? 2
   d) What is the time period of simple pendulum in the space? 1
   e) What happens to the time period of oscillation of a simple pendulum if its bob is made of ice? 1
6. In the given figure, two springs are set in series combination.



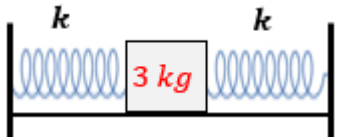
   a) Is there any difference of force acting in upper and lower spring? 1
   b) Find the value of spring constant of the combination. 2
   c) Find the time period of combination. 2
   d) If the springs are rearranged in parallel combination, what would be the time period of combination. 3
7. The time period and velocity of a simple pendulum are to be calculated in the following condition (Fig. 1 and Fig. 2).



   a) What happens to the time period when
      i. $OA > O'A'$ 1
      ii. $OA = O'A'$ 1
      iii. $m_1 < m_2$ 1
      iv. $CB > C'B'$. 1
   b) What would be the frequency of oscillation of the pendulum if $m_1 > m_2$? 1
   c) If $CB > C'B'$, what would be the velocity at the mean position? 1
   d) If $CB = 2cm$ and $C'B' = 4cm$ find the ratio of kinetic energy KE *and* KE' for $OA = O'A'$. 2
8. Find the time period of simple pendulum in the following conditions
   a) If length of a simple pendulum is increased by 4 times its original length, will its time period change? If yes, by how much? 2
   b) If the length of a second's pendulum is increased further by 20 percent, will it loss or gain time? Express the change in percentage. 2
   c) A pendulum clock is in an elevator that descends at constant velocity. Does it keep correct time? If the same clock is in free fall, does it keep correct time? 2
   d) The bob of a simple pendulum of length l is negatively charged. A positively charged metal plate is placed just below the bob and the pendulum is made to oscillate. What will be the effect on the time period of the pendulum? 2
      [Hint: effective acceleration due to gravity increases]
9. Simple harmonic motion is defined by periodic functions like sine and cosine functions.

a) State the conditions required for a motion to be SHM. 1

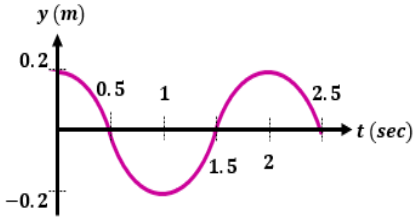
b) A trolly of mass $3Kg$ is connected to two identical rubber bands each of force constant ($K = 600N/m$) as shown in the figure. If the trolly is displaced from an equilibrium position by $5cm$ and released, what is the period of ensuring oscillations? 3



c) Among two springs if one is delicate and another is stiffer, which spring will have greater frequency of oscillation? 1

[Hint: spring constant k is lager for the stiffer spring.]

10. The displacement of an oscillating object of mass $2kg$ as a function of time as shown in figure. Calculate its:



i. Time period
ii. Maximum velocity
iii. Maximum restoring force
iv. PE at $t = 1\ sec.$
v. KE at $t = 2.5\ sec.$ 5

11. a) The bob of a simple pendulum is made of wood. What will be the effect on the time period if the wooden bob is replaced by an identical bob of iron? 1

b) A spring having force constant k is divided into three equal parts. What would be the force constant for individual part? 2

[Hint: for a spring: $\boldsymbol{F = ke}$. When a spring is divided into three equal parts, extension in individual part will be $e/3$ for same force.]

$\{\therefore \quad F = k'\, e/3 \qquad k' = 3F/e \qquad k' = 3k\}$

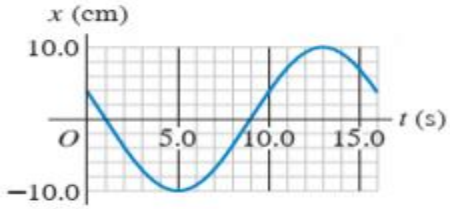
c) The displacement of a particle along the axis is given by $\boldsymbol{x = Asin^2\omega t}$. Is the motion of the particle simple harmonic? Find its' frequency. 2

12. a) A body is moving in a circular path with constant speed. Is this motion a simple harmonic? Explain. 1

b) A body of mass $0.2Kg$ is executing SHM with amplitude of $20mm$. The maximum force which acts upon it is $0.064N$. Calculate its maximum velocity and period of oscillation. 2

c) An object is undergoing SHM with amplitude A. For what values of the displacement is the kinetic energy equal to (a) 1/3 of the total mechanical energy; (b) 4/5 of the total mechanical energy? 3

13. The displacement of an oscillating object as a function of time is shown in figure. What are
(a) the frequency;
(b) the amplitude;
(c) the period;
(d) the angular frequency of this motion? 4



14. a. A small mass rests on a horizontal platform which vibrates vertically in SHM with period of $0.05sec$. Find the maximum amplitude of the motion which will allow the mass to remain in contact with the platform throughout the motion. 3

b. For the oscillation of simple pendulum, does the tension in the string remain constant throughout the oscillation? Explain minimum and maximum cases. 2

15. a. What is spring mass system? 1

b. Show that the oscillation of vertical spring mass system is simple harmonic under elastic limit. 2

c. You are provided with a light spring, a meter scale, and a known mass. How will you find the time period of oscillation of the mass attached to the spring without the use of clock? Explain. 2

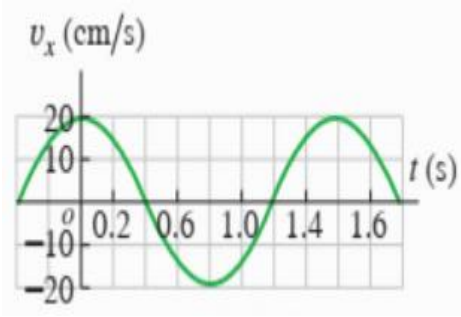
16. a. A small block is attached to an ideal spring and is moving in SHM on a horizontal, frictionless surface. When the block is at x = 0.310 m, the acceleration of the block is -5.96 m/s 2. What is the frequency of the motion? 2

b. A small mass of 0.2kg is attached to one end of a helical spring and produces an extension of 15mm. The mass is now set into vertical oscillation of amplitude 10mm. What is: i. The period of oscillation? ii. The maximum KE of the mass? iii. The potential energy of the spring when the mass is 5mm below the center of oscillation? 3

17. a. In a laboratory experiment with simple pendulum, it was found that it took 36 seconds to complete 20 oscillations when the effective length was kept at 80 cm. Calculate the acceleration due to gravity from these data. 2

b. A pendulum having time period equal to two seconds is called a second's pendulum. Those used in pendulum clocks are of this type. Find, the length of a second's pendulum at a place where $g = \pi^2\ ms^{-2}$. 3

18. A mass m is attached to a spring of force constant 75 N/m and allowed to oscillate. Figure shows a graph of its velocity component vx as a function of time t. Find



(a) the period,
(b) the frequency, and
(c) the angular frequency of this motion.
(d) What is the amplitude (in cm), and at what times does the mass reach this position?
(e) Find the maximum acceleration magnitude of the mass and the times at which it occurs.
(f) What is the value of m?