CBSE

OSCILLATIONS WS 5

Class 11 - Physics

Section A

1. A pendulum suspended from a ceiling of a train has a period T when the train is at rest. When the train is accelerating with a uniform acceleration α, the period of oscillation will: **[1]**

   a) Become infinite
   b) Increase
   c) Decrease
   d) Remain unaffected

2. A body of mass 5 g is executing simple harmonic motion about a point O with an amplitude of 10 cm. Its maximum velocity is 100 cm/s. Its velocity will be 50 cm/s at a distance (in cm) from O. **[1]**

   a) $5\sqrt{2}$
   b) $10\sqrt{3}$
   c) $5\sqrt{5}$
   d) $10\sqrt{2}$

3. A simple harmonic motion is represented by **[1]**
   F(t) = 17sin(20t + 0.5)
   The amplitude of the SHM is

   a) A = 20
   b) A = 30
   c) A = 17
   d) A = 5

4. A particle in SHM is described by the displacement function x(t) = A $\cos(\omega t + \theta)$. If the initial (t = 0) position of the particle is 1 cm and its initial velocity is π cm/s, what is its amplitude? The angular frequency of the particle is π rad s^{-1}. **[1]**

   a) $\sqrt{2}$ cm
   b) 2.5 cm
   c) 1 cm
   d) 2 cm

5. A particle is acted simultaneously by mutually perpendicular simple hormonic motions x = a cos ωt and y = a sin ωt . The trajectory of motion of the particle will be **[1]**

   a) a parabola
   b) an ellipse
   c) a straight line
   d) a circle

6. Out of the following functions representing motion of a particle which represents SHM **[1]**

   i. y = $\sin\omega t - \cos\omega t$
   ii. y = $\sin^3\omega t$
   iii. y = $5\cos\left(\frac{3\pi}{4} - 3\omega t\right)$
   iv. y = $1 + \omega t + \omega^2 t^2$

   a) Only (iv) does not represent SHM
   b) Only (i)
   c) Only (i) and (iii)
   d) Only (i) and (ii)

7. A particle is executing SHM of amplitude 10 cm. Its time period of oscillation is n seconds. The velocity of the **[1]**

particle when it is 2 cm from the extreme position is

a) 10 cms^{-1} b) 12 cms^{-1}

c) 14 cms^{-1} d) $16\sqrt{16}$ cms^{-1}

8. The composition of two simple harmonic motions of equal periods at right angle to each other and with a phase difference of n results in the displacement of the particle along: **[1]**

a) straight line b) figure of eight

c) ellipse d) circle

9. A particle executing S.H.M. has a maximum speed of 30 cm/s and a maximum acceleration of 60 cm/s^2. The period of oscillation is **[1]**

a) $\frac{\pi}{t}s$ b) πs

c) $\frac{\pi}{2}s$ d) 2π s

10. A mass m is vertically suspended from a spring of negligible mass; the system oscillates with a frequency n. What will be the frequency of the system, if a mass 4 m is suspended from the same spring? **[1]**

a) 4n b) $\frac{n}{4}$

c) 2n d) $\frac{n}{2}$

11. The displacement of a particle in SHM varies according to the relation x = 4 ($\cos\pi t + \sin\pi t$). The amplitude of the particle is **[1]**

a) $4\sqrt{2}$ b) 4

c) 8 d) -4

12. A particle is having potential energy $\frac{1}{3}$ of the maximum value at a distance of 4 cm from mean position. Amplitude of motion is **[1]**

a) $\frac{6}{\sqrt{2}}$ b) $4\sqrt{3}$

c) $\frac{2}{\sqrt{6}}$ d) $2\sqrt{6}$

13. Two pendulums of length I meter and 16 meters start vibrating one behind the other from the same stand. At some instant, the two are in the mean position in the same phase. The time period of the shorter pendulum is T. The minimum time after which the two threads of the pendulums will be one behind the other is: **[1]**

a) $\frac{T}{4}$ b) $\frac{4T}{3}$

c) $\frac{T}{3}$ d) $\frac{2T}{5}$

14. A mass m is suspended from a spring. Its frequency of oscillation is f. The spring is cut into two halves and the same mass is suspended from one of the two pieces of the spring. The frequency of oscillation of mass will be **[1]**

a) 2f b) $\sqrt{2}f$

c) $\frac{f}{2}$ d) f

15. A particle executes SHM, its time period is 16 s. If it passes through the centre of oscillation, then its velocity is 2 m/s at time 2s. The amplitude will be **[1]**

a) 7.2 m b) 0.72 m

c) 4 cm d) 6 cm

16. **Assertion (A):** In simple harmonic motion, the motion is to and fro and periodic. **[1]**
Reason (R): Velocity of the particle (v) = $\omega\sqrt{a^2 - x^2}$ (where x is the displacement).

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

17. **Assertion (A):** In X = Acos (ωt), ω represents the angular velocity of a particle moving on a circular path. **[1]**
Reason (R): The uniform circular motion and simple harmonic motion can be correlated.

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

18. **Assertion (A):** x = Acos(ωt) and x = Asin(ωt) can represent same motion depending on initial position of particle. **[1]**
Reason (R): Phase constant depends on position of particle at t = 0.

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

19. **State True or False:** **[1]**
(a) Flexibility and length of the spring means the same. **[1]**

20. Give the general expression for displacement of a particle undergoing S.H.M. **[1]**

21. Can an ideal simple pendulum be realised in practice? Is the motion of a simple pendulum linear simple harmonic or angular simple harmonic? **[1]**

22. When will the motion of a simple pendulum be simple harmonic? **[1]**

23. Give some practical examples of S.H.M? **[1]**

24. The equation of motion of a particle executing S.H.M. is a = - bx, where a is the acceleration of the particle, x is the displacement from the mean position and b is a constant. What is the time period of the particle? **[1]**

25. A block of mass one kg is fastened to a spring with a spring constant 50 Nm^{-1}. The block is pulled to a distance x = 10 cm from its equilibrium position at x = 0 on a frictionless surface from rest at t = 0. Write the expression for its x (t) and v(t). **[1]**

26. Define amplitude of S.H.M. **[1]**

27. What is meant by SHM? **[1]**

28. If a hollow pipe passes across the centre of gravity of the earth, then what changes would take place in the velocity and acceleration of a ball dropped in the pipe? **[1]**

29. Two simple pendulums of unequal length meet each other at the mean position while oscillating. What is their phase difference? **[1]**

30. Find the period of vibrating particle (SHM), which has acceleration of 45 cms^{-2}, when displacement from mean position is 5cm. **[1]**

31. Are the functions tan ωt and cot ωt periodic? Are they harmonic? **[1]**

32. What fraction of the total energy is kinetic when the displacement of a simple harmonic oscillator is half of its amplitude? **[1]**

33. The bob of a vibrating simple pendulum is made of ice. How will the period of swing will change when the ice **[1]**

starts melting?

34. In what time after its motion begins, will a particle oscillating according to the equation, y = 7 sin 0.5 πt, move from the mean position to maximum displacement? **[1]**

35. Write the relation between acceleration, displacement, and frequency of a particle executing S.H.M. **[1]**

36. A body moves along a straight line OAB simple harmonically. It has a zero velocity at points A and B which are at distances a and b respectively from O and has velocity v when halfway between them. Find the period of S.H.M. **[1]**

37. How would the time period of a spring-mass system change, when it is made to oscillate horizontally, and then vertically? **[1]**

38. A particle executes S.H.M. of amplitude A. At what positions of its displacement (x), will its **[1]**

    i. velocity be zero and maximum and

    ii. acceleration be zero and maximum?

39. What provides the restoring force for simple harmonic oscillations in the following cases? **[1]**

    i. Simple pendulum

    ii. Spring

    iii. Column of Hg in U-tube?

40. A simple pendulum is described by a = -16 x; where a is acceleration, x is displacement in metre. What is the time period? **[1]**

41. Define periodic time. Give its SI unit. **[1]**

Section B

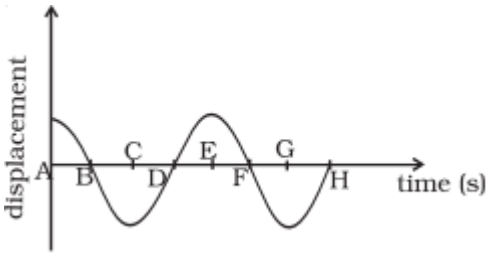
42. **Fill in the blanks:** **[2]**

    (a) The _____ of a particle executing SHM at an instant is given by the distance of the particle from the mean position at the instant. **[1]**

    (b) The magnitude of maximum displacement of a particle executing SHM is called _____ of the oscillation of that particle. **[1]**

43. Two pendulums of lengths 100 cm and 110.25 cm start oscillating in phase. After how many oscillations will they again be in same phase? **[2]**

44. Displacement versus time curve for a particle executing S.H.M. is shown in Figure. Identify the points marked at which **[2]**



    a. velocity of the oscillator is zero,

    b. speed of the oscillator is maximum

45. For a particle in SHM, the displacement x of the particle as a function of time t is given as **[2]**

    $x = A \sin (2 \pi t)$

    Here x is in cm and t is in seconds.

    Let the time taken by the particle to travel from x = 0 to x = $\frac{A}{2}$ be t_1 and the time taken to travel from x = $\frac{A}{2}$ to x = A be t_2. Find $\frac{t_1}{t_2}$.

46. Particle executes S.H.M. of amplitude 25cm and time period 3s. What is the minimum time required for the particle to move between two points 12.5cm on either side of the mean position? **[2]**

47. Which of the following examples represent (nearly) simple harmonic motion and which represent periodic but not simple harmonic motion? **[2]**

a. the rotation of the earth about its axis.

b. the motion of an oscillating mercury column in a U-tube.

c. the motion of a ball bearing inside a smooth curved bowl, when released from a point slightly above the lower most point.

d. general vibrations of a polyatomic molecule about its equilibrium position.

48. A body of mass 0.1 kg is executing SHM according to the equation **[2]**

$y = 0.5 \cos (100t + \frac{3\pi}{4})$ metre

Find

i. the frequency of oscillation

ii. initial phase

iii. maximum velocity

iv. maximum acceleration and

v. total energy

49. Give four examples of simple harmonic oscillations. **[2]**

50. What are the two basic characteristics of a simple harmonic motion? **[2]**

51. A particle executing S.H.M has a maximum displacement of 4cm and its acceleration at a distance of 1 cm from its mean position is 3 cm/s^2. What will be its velocity when it is at a distance of 2cm from its mean position? **[2]**

52. Show that the motion of a particle represented by $y = \sin \omega t - \cos s\omega t$ is simple harmonic with a period of $\frac{2\pi}{\omega}$. **[2]**

53. A particle executes simple harmonic motion between x = -A and x = + A. The time taken for it to go from 0 to $\frac{A}{2}$ is T_1 and to go from $\frac{A}{2}$ to A is T_2. Then how are T_1 and T_2 related? **[2]**

54. Two simple harmonic motions, are represented by the equations: **[2]**

$y_1 = 0.1 \sin (100\pi t + \frac{\pi}{3})$ and $y_2 = 0.1 \cos \pi t$

What is the phase difference of the velocity of the particle 1 with respect to the velocity of particle 2?

55. A simple harmonic motion is represented by x = 12 sin (10t + 0.6) Find out the amplitude, angular frequency, frequency, time period and initial phase if displacement is measured in metre and time in seconds. **[2]**

56. A body oscillates with SHM according to the equation: **[2]**

$x(t) = 5 \cos (2\pi t + \frac{\pi}{4})$

where t is in sec. and x in metres. Calculate

i. Displacement at t = 0

ii. Time period

iii. Initial velocity

57. A simple harmonic motion is represented by x = 10 sin (20t + 0.5) **[2]**

Write down its amplitude, angular frequency, frequency, time period and initial phase, if displacement is measured in metres and time in seconds.

58. A mass of 2 kg is suspended from a vertical spring. An additional force of 2.5 N stretched it by 1 cm. **[2]**

i. Calculate the force constant.

ii. Calculate the frequency of oscillations if the spring is stretched by the given force and then released.

59. Two simple harmonic motions are represented by the equations: **[2]**

$x_1 = 5 \sin(2\pi t + \pi/4)$, $x_2 = 5\sqrt{2}(\sin 2\pi t + \cos 2\pi t)$

What is the ratio of their amplitudes?

Section C

60. A particle performs SHM on a rectilinear path. Starting from rest, it travels x_1 distance in first second and in the next second, it travels x_2 distance. Find out the amplitude of this SHM. **[3]**

61. A particle is S.H.M. is described by the displacement function: $x = A\cos(\omega t + \phi); \omega = \frac{2\pi}{T}$ **[3]**

If the initial (t = 0) position of the particle is 1 cm and its initial velocity is π cm / s, What are its amplitude and phase angle?

62. Write down the differential equation for SHM Give its solution. **[3]**

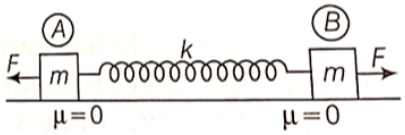
63. If x = a cos ωt + b sin ωt, show that it represents simple harmonic motion. **[3]**

64. Give the graphical representation of displacement, velocity and acceleration in SHM. **[3]**

Section D

Question No. 65 to 69 are based on the given text. Read the text carefully and answer the questions: **[5]**

A system of two blocks is attached with a spring and stretched by two equal and opposite forces as shown in the figure. Let the maximum stretch of spring towards each block is $\frac{X}{2}$.



65. The magnitude of spring force on block B is

a) kx-2 b) 2kx

c) kx d) $\frac{kx}{2}$

66. The equation of SHM for block B when F from both blocks is removed, is

a) $F_{SHM} = kx$ b) $F_{SHM} = -kx$

c) $F_{SHM} = -m\omega^2 x$ d) $F_{SHM} = -\frac{m\omega^2 x}{2}$

67. The time period of the two blocks system is

a) $2\pi\sqrt{\frac{2m}{k}}$ b) $2\pi\sqrt{\frac{m}{4k}}$

c) $2\pi\sqrt{\frac{m}{k}}$ d) $2\pi\sqrt{\frac{m}{2k}}$

68. In SHM,

a. PE is stored due to elasticity of system

b. KE is stored due to inertia of system

c. Both KE and PE are stored by virtue of elasticity of system

d. PE is stored due to elasticity of system and KE is stored due to inertia of system

a) Option (a) b) Option (d)

c) Option (b) d) Option (c)

69. I. Time period of a spring-mass system depends on its amplitude.

II. Time period of a spring-mass system depends on its mass.

III. Time period of a spring-mass system depends on spring constant.

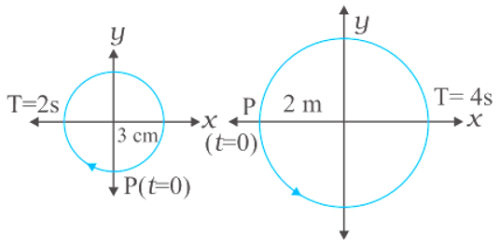
a) I and II

b) II and III

c) All of these

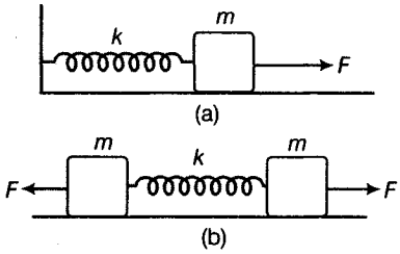
d) I and III

70. In figures correspond to two circular motions. The radius of the circle, the period of revolution, the initial position, and the sense of revolution (i.e. clockwise or anti-clockwise) are indicated on each figure. **[5]**



Obtain the corresponding simple harmonic motions of the *x*-projection of the radius vector of the revolving particle P, in each case.

71. Fig. (a) shows a spring of force constant k clamped rigidly at one end and a mass m attached to its free end. A force F applied at the free end stretches the spring. Fig. (b) shows the same spring with both ends free and attached to a mass m at either end. Each end of the spring in Fig. (b) is stretched by the same force F **[5]**



i. What is the maximum extension of the spring in the two cases?

ii. If the mass in Fig. (a) and the two masses in Fig. (b) are released, then what is the period of oscillation in each case?

72. Define the terms; harmonic motion, displacement, velocity, acceleration, amplitude, time period, frequency, angular frequency and phase with reference to oscillatory motion. **[5]**

73. A particle executes simple harmonic motion of amplitude A. **[5]**

i. At what distance from the mean position is its kinetic energy equal to its potential energy?

ii. At what points is its speed half the maximum speed?

74. The motion of a particle executing simple harmonic motion is described by the displacement function, x (t) = A cos $(\omega_t + \omega)$. **[5]**

If the initial (t = 0) position of the particle is 1 cm and its initial velocity is ω cm/s, what are its amplitude and initial phase angle? The angular frequency of the particle is π s^{-1}. If instead of the cosine function, we choose the sine function to describe the SHM: x = B sin $(\omega t + a)$, what are the amplitude and initial phase of the particle with the above initial conditions.