CBSE

OSCILLATIONS WS 10

Class 11 - Physics

Section A

1. A point particle of mass 0.1 kg is executing SHM of amplitude 0.1 m. When the particle passes through the mean position, its KE is 8×10^{-3} J. The equation of motion of this particle if its initial phase of oscillation is 45°, is **[1]**

   a) y = 0.1 sin $\left(\frac{t}{2} + \frac{\pi}{4}\right)$ b) y = 0.1 sin $\left(4t - \frac{\pi}{4}\right)$

   c) y = 0.1 sin $\left(4t + \frac{\pi}{4}\right)$ d) y = 0.1 sin $\left(\frac{t}{4} + \frac{\pi}{4}\right)$

2. A spring with spring constant k, when stretched through 1 cm, has a potential energy U. If it is stretched by 4 cm, the potential energy will become: **[1]**

   a) 16U b) 32U

   c) 4U d) 8U

3. A simple pendulum performs simple harmonic motion about x = 0 with an amplitude **a** and time period **T**. The speed of the pendulum at x = $\frac{a}{2}$ will be: **[1]**

   a) $\frac{3\pi^2 a}{T}$ b) $\frac{\pi a}{T}$

   c) $\frac{\pi a\sqrt{3}}{2T}$ d) $\frac{\pi a\sqrt{3}}{T}$

4. If x, F, and V denote the displacement, force acting, and the potential energy of a particle then F = ? **[1]**

   a) $\frac{-dV}{dx}$ b) + $\frac{dV}{dx}$

   c) Vx d) $\frac{1dv}{xdx}$

5. A simple harmonic oscillator has amplitude A, angular velocity ω and mass m, Then average kinetic energy in one time period will be **[1]**

   a) $\frac{1}{2}m\omega^2 A^2$ b) 0

   c) $m\omega^2 A^2$ d) $\frac{1}{4}m\omega^2 A^2$

6. The total energy of a particle, executing simple harmonic motion is: **[1]**

   a) $\propto \frac{x}{2}$ b) independent of x

   c) $\propto x^2$ d) $\propto x$

7. Average value of K.E. and P.E. over entire time period is **[1]**

   a) 0, $\frac{1}{2}m\omega^2 A^2$ b) $\frac{1}{4}m\omega^2 A^2, \frac{1}{4}m\omega^2 A^2$

   c) $\frac{1}{2}m\omega^2 A^2, \frac{1}{2}m\omega^2 A^2$ d) $\frac{1}{2}m\omega^2 A^2, 0$

8. A block rests on a horizontal table which is executing SHM in the horizontal plane with an amplitude a. If the coefficient of friction is μ, then the block just starts to slip when the frequency of oscillation is **[1]**

   a) $\frac{1}{2\pi}\sqrt{\frac{a}{\mu g}}$ b) $\frac{1}{2\pi}\sqrt{\frac{\mu g}{a}}$

c) $\sqrt{\frac{a}{\mu g}}$ d) $2\pi\sqrt{\frac{a}{\mu g}}$

9. A particle executes SHM of time period T, the time period with which the total energy changes is: **[1]**

a) T/2 b) 2T

c) T d) Independent

10. For any SHM, amplitude is 6 cm. If instantaneous potential energy is half the total energy, then distance of particle from its mean position is **[1]**

a) 6 cm b) 4.2 cm

c) 5.8 cm d) 3 cm

11. The potential energy of a particle with displacement x is V(x). The motion is simple harmonic when (k is a positive constant): **[1]**

a) $V = k\frac{x^2}{2}$ b) $V = kx^2$

c) V = kx d) V = k

12. **Assertion (A):** In a SHM, kinetic and potential energies become equal when the displacement is $\frac{1}{\sqrt{2}}$ times the amplitude. **[1]**

Reason (R): In SHM, kinetic energy is zero when potential energy is maximum.

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.

13. **Assertion:** The graph of potential energy and kinetic energy of a particle in SHM with respect to position is a parabola. **[1]**

Reason: Potential energy and kinetic energy do not vary linearly with position.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion. b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement. d) Assertion is wrong statement but reason is correct statement.

14. The potential energy of a particle in S.H.M. varies periodically. If ν is the frequency of oscillation of the particle, then what is the frequency of variation of potential energy? **[1]**

15. What is the ratio between the potential energy and the total energy of a particle executing S.H.M., when its displacement is half of its amplitude? **[1]**

16. How is the frequency of oscillation related with the frequency of change in the of K.E. and P.E. of the body in S.H.M.? **[1]**

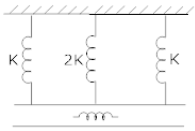
17. At what distance from the mean position, is the kinetic energy in simple harmonic oscillator equal to potential energy? **[1]**

18. Water in a U-tube executes S.H.M. Will the time period for mercury filled up to the same height in the tube be lesser or greater than that in case of Water? **[1]**

Section B

19. The springs of spring factor k, 2k, k respectively are connected in parallel to a mass m. If the mass = 0.08kg m **[2]**

and k = 2N|m, then find the new time period?



20. The total energy of a particle executing SHM of period 2π seconds is 1.024×10^{-3} J. The displacement of the particle at $\frac{\pi}{4}$ s is $0.08\sqrt{2}$ m. Calculate the amplitude of motion and mass of the particle. **[2]**

21. A body weighing 10 g has a velocity of 6 cm s^{-1} after one second of its starting from mean position. If the time period is 6 s, then find the kinetic energy, potential energy and the total energy. **[2]**

22. A particle is executing SHM of amplitude A. At what displacement from the mean position, is the energy half kinetic and half potential? **[2]**

23. A particle executes SHM of period 8 s. After what time of its passing through the mean position, will the energy be half kinetic and half potential? **[2]**

24. Find the displacement of a simple harmonic oscillator at which its P.E. is half of the maximum energy of the oscillator. **[2]**

Section C

25. **Fill in the blanks:** **[3]**
    (a) The total energy of a particle in SHM equals the _____ at the endpoints and the _____ at the mean position. **[1]**
    (b) Potential energy is _____ at the mean position and maximum at the extreme displacements. **[1]**
    (c) Kinetic energy is maximum when the particle is at the _____ position. **[1]**

26. Define SHM. What are its characteristics? At what distance from the mean position of amplitude r, the energy is half kinetic and half potential? **[3]**

27. Show that the total energy of a body executing SHM is independent of time? **[3]**

28. A block whose mass is 1 kg is fastened to a spring. The spring has a spring constant of 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. Calculate the kinetic, potential and total energies of the block when it is 5 cm away from the mean position. **[3]**

29. Show that for a particle in linear SHM the average kinetic energy over a period of oscillation equal the average potential energy over the same period. **[3]**

30. Write down the differential equation for S.H.M. Give its solution. Hence obtain expression for the time period of S.H.M. **[3]**

Section D

31. **State True or False:** **[4]**
    (a) Kinetic energy is also a periodic function of time, being zero when the displacement is maximum. **[1]**
    (b) In the absence of any frictional force, the total energy of a harmonic oscillation is conserved. **[1]**
    (c) In SHM, when the displacement is one-half the amplitude, the kinetic energy is three-fourth of the total energy. **[1]**
    (d) Potential energy of a particle executing simple harmonic motion is also periodic with period T. **[1]**

Section E

Question No. 32 to 36 are based on the given text. Read the text carefully and answer the questions: **[5]**

A particle executing SHM possesses both kinetic energy and potential energy. When a body is displaced from its equilibrium position by doing work upon it, it acquires potential energy. When the body is released, it begins to move

back with velocity, thus acquiring kinetic energy.

Both kinetic and potential energies of a particle in SHM vary between zero and their maximum values.

32. In SHM,

a) KE is stored due to inertia of system

b) PE is stored due to elasticity of system

c) PE is stored due to elasticity of system and KE is stored due to inertia of system

d) Both KE and PE are stored by virtue of elasticity of system

33. The expression for displacement of an object in SHM is x = Acos(ωt). The potential energy at t = $\frac{T}{4}$ is

a) $\frac{1}{8}$k A^2

b) $\frac{1}{2}$k A^2

c) $\frac{1}{4}$k A^2

d) Zero

34. For a SHM, if the maximum potential energy become double, choose the correct option.

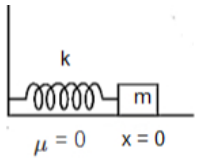
a) Maximum kinetic energy will become double

b) The total mechanical energy will become double

c) Maximum kinetic energy will become triple

d) Maximum kinetic energy will become double and the total mechanical energy will become double

35. A block is in simple harmonic motion as shown in the figure on a frictionless surface. i.e. μ = 0. Choose the correct option.



a) The potential energy varies between a maximum value and zero

b) All of these

c) Total energy remains constant

d) The kinetic energy varies between a maximum value and zero

36. In simple harmonic motion, let the time period of variation of potential energy is T_1 and time period of variation of position is T_2, then relation between T_1 and T_2 is

a) $T_1 = T_2$

b) $2T_1 = T_2$

c) $T_1 = 2T_2$

d) $2T_1 = 2T_2$

37. Using the correspondence of S.H.M. and uniform circular motion, find displacement, velocity, amplitude, time period and frequency of a particle executing S.H.M? **[5]**

38. Show that for a particle in linear S.H.M., the average kinetic energy over a period of oscillation is equal to the average potential energy over the same period. At what distance from the mean position is the kinetic energy in simple harmonic oscillator equal to potential energy? **[5]**

39. Explain the total energy in simple harmonic motion and show the graphical representation of energy in SHM. **[5]**