PHYSICS – CLASS XI

Chapter 13 : Oscillations

PRACTICE PAPER (Chapter-wise Test)

Time : 1½ Hours **Max. Marks : 35**

General Instructions

(a) All questions are compulsory.

(b) There are 17 questions in total. Section A: Q. 1 to 8 carry 1 mark each. Section B: Q. 9 to 12 carry 2 marks each. Section C: Q. 13 to 15 carry 3 marks each. Section D: Q. 16 and 17 carry 5 marks each.

(c) There is no overall choice. An internal choice is given in one 2-mark question (Q. 11), one 3-mark question (Q. 14) and both 5-mark questions (Q. 16, Q. 17). Attempt only one of the given choices.

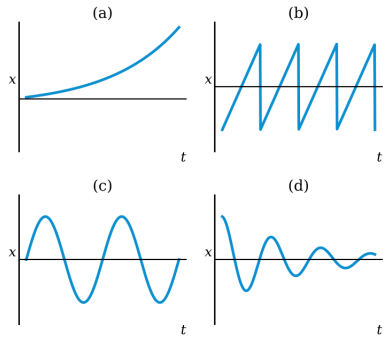
(d) Use of calculators is not permitted. Take $g = 10\ \text{m s}^{-2}$ and $\pi^2 = 10$ (so $\sqrt{10} = \pi$) unless a different value is given in the question. Angles in trigonometric functions are in radians.

(e) Figures are schematic and not drawn to scale. Write the unit with every numerical answer.

SECTION A

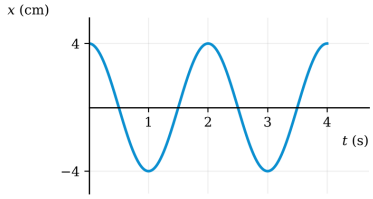
Questions 1 to 8 carry 1 mark each.

1. Which of the displacement–time graphs (a) to (d) represents simple harmonic motion? **(1)**



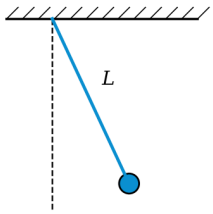
(a) graph (a)
(b) graph (b)
(c) graph (c)
(d) graph (d)

2. The displacement–time graph of a particle in SHM is shown (figure). Its angular frequency is **(1)**



(a) π/2 rad s^{-1}
(b) π rad s^{-1}
(c) 2π rad s^{-1}
(d) 4π rad s^{-1}

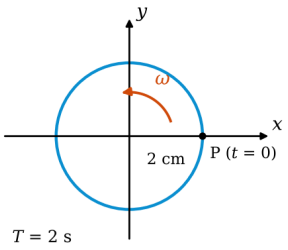
3. The length of a simple pendulum (figure) is made four times. Its time period becomes **(1)**



(a) $T/2$
(b) T
(c) $2T$
(d) $4T$

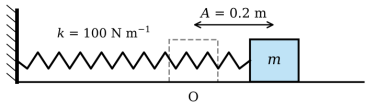
4. **Assertion (A):** In SHM the acceleration of the particle is zero at the mean position. **(1)**
Reason (R): In SHM the acceleration is directly proportional to the displacement from the mean position.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

5. A particle P moves anticlockwise on a circle of radius 2 cm with a period of 2 s (figure). Write the equation of SHM of its x-projection (in cm, with t in s). **(1)**



6. A particle executes SHM with amplitude 0.2 m and angular frequency 5 rad s^{-1}. Find its maximum speed. **(1)**

7. A block attached to a spring of force constant 100 N m^{-1} is displaced by 0.2 m on a frictionless surface and released (figure). Find the total energy of the oscillator. **(1)**

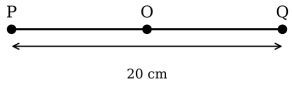


8. A body in SHM completes 120 oscillations in one minute. Find its time period. **(1)**

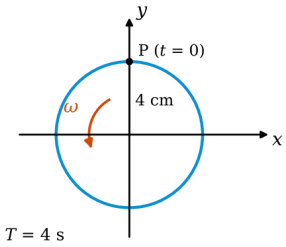
SECTION B

Questions 9 to 12 carry 2 marks each.

9. A particle oscillates in SHM between two points P and Q, 20 cm apart, with an angular frequency of 20 rad s^{-1} (figure). Find (i) its maximum speed and (ii) its maximum acceleration. **(2)**



10. A particle P moves anticlockwise on a circle of radius 4 cm with a period of 4 s. At t = 0 it is at the top of the circle (figure). Write the equation of SHM of the x-projection of P and find its displacement at t = 1 s. **(2)**

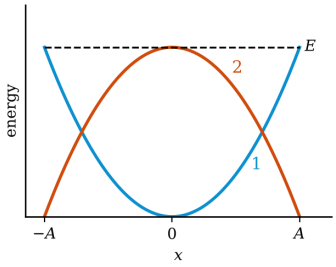


11. Starting from $x = A\cos(\omega t + \varphi)$, obtain expressions for the velocity and acceleration of a particle in SHM and show that $a = -\omega^2 x$. **(2)**

OR

Write expressions for the kinetic and potential energies of a particle in SHM and show that the total energy is $E = \frac{1}{2}kA^2$.

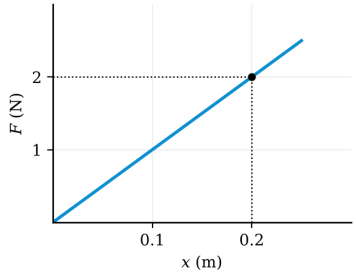
12. The figure shows the variation of two energies of a particle in SHM with displacement x. (i) Which curve, 1 or 2, represents the kinetic energy? Give a reason. (ii) Find the ratio of kinetic to potential energy at $x = A/2$. **(2)**



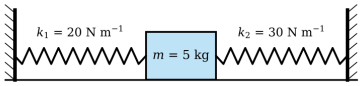
SECTION C

Questions 13 to 15 carry 3 marks each.

13. The graph shows the restoring force of a spring against the displacement x of a 1 kg block attached to it (figure). Find (i) the force constant of the spring, (ii) the time period of oscillation of the block and (iii) the maximum acceleration if the block is released from x = 0.2 m. **(3)**

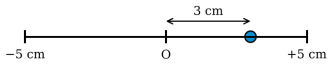


14. A block of mass 5 kg is attached to two springs of force constants k_1 = 20 N m^{-1} and k_2 = 30 N m^{-1} as shown (figure). It is displaced slightly and released on a frictionless surface. Find (i) the net restoring force for a displacement x, (ii) the effective force constant and (iii) the time period of oscillation. **(3)**

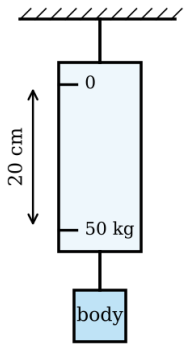


OR

A particle oscillates in SHM about O with amplitude 5 cm and angular frequency 10 rad s^{-1} (figure). Using $v = \omega\sqrt{(A^2 - x^2)}$, find (i) its speed when it is 3 cm from O, (ii) its speed at O and (iii) its acceleration when it is 3 cm from O.



15. A spring balance reads 0 to 50 kg over a scale length of 20 cm (figure). A body suspended from it, when displaced and released, oscillates with a period of 0.4 s. Find (i) the force constant of the spring, (ii) the mass of the body and (iii) the weight of the body. **(3)**



SECTION D

Questions 16 and 17 carry 5 marks each.

16. The displacement–time graph of a particle in SHM is shown (figure). **(5)**

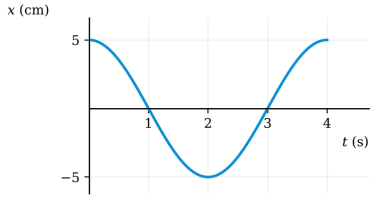
(a) Write the amplitude of the motion. (1)

(b) Write the time period and the frequency. (1)

(c) Find the angular frequency. (1)

(d) Write the equation of the displacement in the form $x = A\cos(\omega t + \varphi)$. (1)

(e) Find the displacement at $t = 2/3$ s. (1)



OR

A liquid column of total length 2.0 m is kept in a U-tube of uniform cross-section A and density ρ. The liquid in one limb is pushed down by y and released (figure).

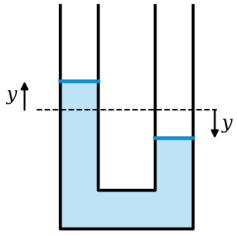
(a) By how much does the level in the other limb rise, and what is the difference in levels? (1)

(b) Find the restoring force on the liquid column. (1)

(c) Show that the motion is simple harmonic. (1)

(d) Derive the time period in terms of the length L of the liquid column and g. (1)

(e) Find the time period for $L = 2.0$ m. (1)



total liquid column length = 2.0 m

17. A block of mass 2 kg is attached to a spring of force constant 50 N m^{-1}. It is pulled to x = 0.2 m on a frictionless surface and released from rest at t = 0. The figure shows the variation of the two energies of the block with time. **(5)**

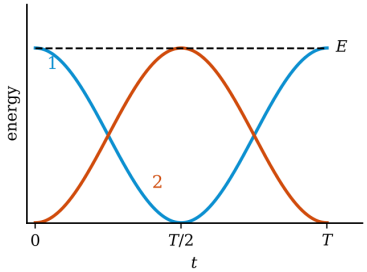
(a) Which curve, 1 or 2, represents the kinetic energy? (1)

(b) What is the time period of variation of the kinetic energy in terms of the time period T of the SHM? (1)

(c) Find the total energy of the oscillator. (1)

(d) Find the maximum speed of the block. (1)

(e) Find the kinetic energy of the block when it is 0.1 m from the mean position. (1)



OR

A simple pendulum of length L and bob of mass m is displaced through a small angle θ (figure).

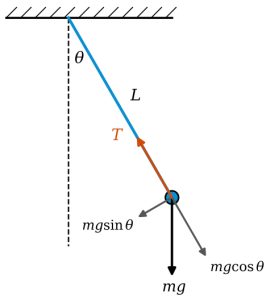
(a) Name the two forces acting on the bob. (1)

(b) Write the restoring torque about the point of suspension. (1)

(c) Using sin θ ≈ θ, write the equation for the angular acceleration α. (1)

(d) Hence derive $T = 2\pi\sqrt{(L/g)}$. (1)

(e) Find the period when L = 0.25 m. (1)



— END OF QUESTION PAPER —