

Oscillations — CBSE Pattern Test 2

Class 11 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

Class 11 Physics · Oscillations · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- The time period of a simple pendulum depends on
 - its length and the value of g
 - its mass
 - its amplitude for large swings
 - the material of the bob
- The frequency of a spring–mass system is
 - $(1/2\pi)\sqrt{k/m}$
 - $(1/2\pi)\sqrt{m/k}$
 - $2\pi\sqrt{k/m}$
 - $2\pi\sqrt{m/k}$
- At the extreme position the energy of a SHM particle is
 - entirely potential
 - entirely kinetic
 - half kinetic and half potential
 - zero
- The total energy of a particle executing SHM is
 - constant at all positions
 - maximum at the mean position
 - maximum at the extremes
 - zero at the mean position
- In the equation $x = A \sin(\omega t + \phi)$, the phase at $t = 0$ is
 - ϕ
 - ω
 - A
 - 0
- Damped oscillations are characterised by
 - a steadily decreasing amplitude
 - a constant amplitude
 - an increasing amplitude
 - a constant frequency only
- A pendulum swinging in air eventually comes to rest. This is because of
 - damping

- (B) resonance
 (C) forced oscillation
 (D) a change in g
8. Which of the following relations represents simple harmonic motion?
 (A) $a = -10x$
 (B) $a = 10x$
 (C) $a = 10x^2$
 (D) $a = \text{constant}$
9. What is a restoring force?
10. State the relation between frequency and time period.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. The period of a simple pendulum is 2 s on the Earth. Find its period on the Moon, where g is one-sixth of its value on Earth.
12. Write the time period of a mass–spring system and state the factors the period of a simple pendulum depends on.
13. A particle of mass m executes SHM of amplitude A and angular frequency ω . Write its kinetic and potential energies as functions of displacement.
14. Distinguish between free, damped and forced oscillations, giving one example of each.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. A mass hangs from springs of force constant k each. Derive its time period when supported by (i) a single spring and (ii) two springs in parallel.
16. The kinetic energy of a SHM particle is maximum at the mean position and zero at the extremes. Explain this graphically and derive $E = \frac{1}{2}m\omega^2A^2$.
17. Describe how the amplitude of a forced oscillator varies with the driving frequency, and explain the phenomenon of resonance from this graph.
18. Show that the displacement $x = A \sin(\omega t + \phi)$ satisfies the differential equation of simple harmonic motion, and obtain the expression for its velocity.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Explain the energy of a particle in SHM, derive the expressions for the kinetic energy, potential energy and total energy as functions of displacement, and sketch their graphs.
20. Define simple harmonic motion. Derive the time-period expressions for (a) a mass–spring system and (b) a simple pendulum, and explain when these motions are approximately simple harmonic.

Answer Key (Marking Scheme)

- Q1 — (A) its length and the value of g . Q2 — (A) $(1/2\pi)\sqrt{k/m}$. Q3 — (A) entirely potential. Q4 — (A) constant at all positions.
- Q5 — (A) ϕ . Q6 — (A) a steadily decreasing amplitude. Q7 — (A) damping. Q8 — (A) $a = -10x$.
- Q9 — A force that is always directed towards the mean position and whose magnitude is proportional to the displacement from it.
- Q10 — $f = 1/T$ (frequency is the reciprocal of the time period).

Q11 — $T = \sqrt{6} \times 2 \approx 4.9 \text{ s}$.

Q12 — $T = 2\pi\sqrt{m/k}$; the simple pendulum's period depends only on its length and g .

Q13 — $KE = \frac{1}{2}m\omega^2(A^2 - x^2)$; $PE = \frac{1}{2}m\omega^2x^2$.

Q14 — Free: no energy loss, constant amplitude (ideal spring). Damped: amplitude decays (pendulum in air). Forced: driven by a periodic force (child on a swing pushed periodically).

Q15 — (i) $T_1 = 2\pi\sqrt{m/k}$; (ii) parallel springs give effective constant $2k$, so $T_2 = 2\pi\sqrt{m/2k}$.

Q16 — $KE = \frac{1}{2}m\omega^2(A^2 - x^2)$ is maximum ($= \frac{1}{2}m\omega^2A^2$) at $x = 0$ and zero at $x = \pm A$; total $E = KE + PE = \frac{1}{2}m\omega^2A^2$ is constant.

Q17 — Amplitude peaks sharply when the driving frequency equals the natural frequency; this is resonance.

Q18 — $x = A \sin(\omega t + \phi)$ $\frac{d^2x}{dt^2} = -\omega^2x$, exactly the SHM equation; $v = A\omega \cos(\omega t + \phi)$.

Q19 — $KE = \frac{1}{2}m\omega^2(A^2 - x^2)$, $PE = \frac{1}{2}m\omega^2x^2$, $E = \frac{1}{2}m\omega^2A^2$; both are parabolas in x , KE inverted, PE upright, crossing at $x = A/\sqrt{2}$; total is a horizontal line.

Q20 — SHM: $a = -\omega^2x$. (a) mass-spring: $F = -kx$ $\ddot{\theta} = 2\pi\sqrt{m/k}$. (b) pendulum: for small angles $\sin \theta \approx \theta$ $\ddot{\theta} = 2\pi\sqrt{l/g}$; valid only for small oscillations.