

## STUDYNEST | CLASS 11 PHYSICS QUESTION PAPER 1

### Chapter 13: Oscillations

**Maximum Marks: 40 | Suggested time: 60 minutes**

Instructions: Answer all questions. Show calculation steps and units. Original practice paper, not an official examination.

#### Section A 1-mark questions - $8 \times 1 = 8$ marks

1. Define period. [1]
2. Frequency-period relation? [1]
3. Restoring force in SHM? [1]
4. Where is speed maximum in SHM? [1]
5. Where is acceleration magnitude maximum? [1]
6. Spring angular frequency? [1]
7. Small-angle pendulum period? [1]
8. Total spring energy for amplitude  $A$ ? [1]

#### Section B 2-mark questions - $6 \times 2 = 12$ marks

9. Period .5s: frequency? [2]
10.  $m=.5\text{kg}, k=200\text{N/m}$ : period? [2]
11. For  $x=A\cos\omega t$ , acceleration? [2]
12. Pendulum length becomes 4l: period factor? [2]
13. Velocity at an extreme? [2]
14. Condition for pendulum SHM approximation? [2]

#### Section C 3-mark questions - $4 \times 3 = 12$ marks

15.  $m=.5, k=200$ : angular frequency and period? [3]
16.  $A=.1\text{m}, \omega=4$ : maximum speed and acceleration? [3]
17. Pendulum length 1m,  $g=9.8$ : period? [3]
18. Describe energy in one SHM cycle. [3]

#### Section D 4-mark questions - $2 \times 4 = 8$ marks

19.  $k=50\text{N/m}, A=.2\text{m}$ : total energy and  $U$  at  $x=.1\text{m}$ ? [4]
20. Why does a real oscillator stop? [4]

**End of question paper.**

# FORMULA AND EQUATION REFERENCE

## Chapter-specific equations and relations

- Frequency  $f=1/T$ ; angular frequency  $\omega=2\pi f=2\pi/T$ .
  - SHM equation  $a=-\omega^2 x$ ; spring force  $F=-kx$ .
  - For a spring-mass oscillator  $\omega=\sqrt{k/m}$ ,  $T=2\pi \sqrt{m/k}$ .
  - For a simple pendulum at small angles  $T=2\pi \sqrt{l/g}$ .
  - Maximum speed  $v_{\max}=\omega A$ ; maximum acceleration  $a_{\max}=\omega^2 A$ .
  - Total energy  $E=(1/2)kA^2$ ; potential energy  $U=(1/2)kx^2$ ; kinetic energy  $K=E-U$ .
  - Period scaling: spring  $T$  proportional to  $\sqrt{m/k}$ ; pendulum  $T$  proportional to  $\sqrt{l/g}$ .
  - Undamped SHM exchanges kinetic and potential energy while total mechanical energy remains constant.
- Use equations only when their assumptions apply; keep units consistent.

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# STEP-BY-STEP SOLUTIONS

Concept questions are answered directly; numerical problems show the governing equation and substitution.

## Question 1

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Time for one cycle.

**Final answer: Time for one cycle.**

## Question 2

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here:  $f=1/T$ .

**Final answer:  $f=1/T$ .**

## Question 3

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here:  $F=-kx$ .

**Final answer:  $F=-kx$ .**

## Question 4

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: At equilibrium.

**Final answer: At equilibrium.**

## Question 5

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: At extreme displacement.

**Final answer: At extreme displacement.**

## Question 6

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here:  $\sqrt{k/m}$ .

**Final answer:  $\sqrt{k/m}$ .**

## Question 7

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here:  $2\pi\sqrt{l/g}$ .

**Final answer:  $2\pi\sqrt{l/g}$ .**

## Question 8

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here:  $kA^2$ .

**Final answer:  $kA^2$ .**

## Question 9

Working:  $f=1/T=1/0.5=2$  Hz.

**Final answer: 2 Hz.**

## Question 10

Working:  $T=2\pi\sqrt{m/k}=2\pi\sqrt{0.5/200}=2\pi\sqrt{0.0025}=2\pi(0.05)=0.314$  s.

**Final answer: 0.314 s.**

## Question 11

Working: For  $x=A\cos(\omega t)$ , acceleration is the second derivative:  $a=-\omega^2 A\cos(\omega t)=-\omega^2 x$ .

**Final answer:  $a=-\omega^2 x$ .**

## Question 12

Working: Pendulum period  $T=2\pi\sqrt{l/g}$ . If length becomes  $4l$ ,  $T$  changes by  $\sqrt{4}=2$ , so period doubles.

**Final answer: 2.**

## Question 13

Working: At an extreme, displacement magnitude is  $A$  and all ideal SHM energy is potential, so instantaneous velocity is zero.

**Final answer: Zero.**

## Question 14

Working: For the small-angle approximation, the angular displacement must be small and measured in radians; then  $\sin(\theta)$  is approximately  $\theta$  and restoring torque is proportional to angle.

**Final answer: Small angular displacement.**

## Question 15

Working:  $\omega = \sqrt{k/m} = \sqrt{200/0.5} = \sqrt{400} = 20 \text{ rad/s}$ .  $T = 2\pi/\omega = 2\pi/20 = 0.314 \text{ s}$ .

**Final answer:  $\omega = 20 \text{ rad/s}$ ;  $T \approx 0.314 \text{ s}$ .**

#### Question 16

Working:  $v_{\text{max}} = A\omega = 0.1(4) = 0.4 \text{ m/s}$ .  $a_{\text{max}} = A\omega^2 = 0.1(16) = 1.6 \text{ m/s}^2$ .

**Final answer:  $0.4 \text{ m/s}$  and  $1.6 \text{ m/s}^2$ .**

#### Question 17

Working:  $T = 2\pi \sqrt{l/g} = 2\pi \sqrt{1/9.8} = 2.01 \text{ s}$ .

**Final answer: approx  $2.01 \text{ s}$ .**

#### Question 18

Working: At equilibrium, speed and kinetic energy are maximum while spring/gravitational potential energy is minimum. At extremes, speed is zero and potential energy is maximum. In undamped SHM their sum remains constant.

**Final answer:  $K_{\text{max}}/U_{\text{min}}$  at equilibrium;  $U_{\text{max}}/K_{\text{zero}}$  at extremes; total energy constant without damping.**

#### Question 19

Working: Total energy  $E = 0.5kA^2 = 0.5(50)(0.2^2) = 1 \text{ J}$ . At  $x = 0.1 \text{ m}$ ,  $U = 0.5kx^2 = 0.5(50)(0.1^2) = 0.25 \text{ J}$ .

**Final answer:  $E = 1 \text{ J}$ ;  $U = 0.25 \text{ J}$ .**

#### Question 20

Working: Air resistance, friction and internal losses dissipate mechanical energy as heat and sound. The amplitude decreases (damping), so the oscillation eventually dies away.

**Final answer: Damping transfers mechanical energy into heat/sound and reduces amplitude.**

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