

How to use this worksheet. Thirty questions, about 35 minutes, with the answer key at the end. Read A and ω straight off the equation, then max velocity is $A\omega$ and max acceleration is $A\omega^2$. For a sum of harmonic terms the period is the **least common multiple**.

Formula sheet

$$x = A \sin(\omega t + \phi) \quad | \quad a = -\omega^2 x \quad | \quad \omega = 2\pi f = 2\pi/T$$

$$\text{Max velocity} = A\omega \quad | \quad \text{Max acceleration} = A\omega^2 \quad | \quad \text{Total energy} = \frac{1}{2}m\omega^2 A^2$$

$$\text{Spring-mass: } T = 2\pi\sqrt{m/k} \quad | \quad \text{Simple pendulum: } T = 2\pi\sqrt{l/g}, \text{ independent of mass}$$

$$\text{Velocity leads displacement by } \pi/2 \quad | \quad \text{acceleration is } \pi \text{ out of phase with displacement}$$

Section A · Level 1 — Definitions and standard formulas

Ten questions. None should take more than twenty seconds.

1. In simple harmonic motion, the acceleration is:

- (1) Constant (2) Proportional to the displacement and directed towards the mean position (3) Proportional to the velocity (4) Zero throughout

2. The time taken for one complete oscillation is called the:

- (1) Frequency (2) Amplitude (3) Time period (4) Phase

3. The maximum displacement of a body from its mean position is called the:

- (1) Wavelength (2) Amplitude (3) Frequency (4) Phase

4. The relation between angular frequency and time period is:

- (1) $\omega = T$ (2) $\omega = 2\pi T$ (3) $\omega = 2\pi / T$ (4) $\omega = T / 2\pi$

5. The time period of a spring-mass system is given by:

- (1) $2\pi\sqrt{k/m}$ (2) $2\pi\sqrt{m/k}$ (3) $2\pi(m/k)$ (4) $2\pi mk$

6. The time period of a simple pendulum is given by:

- (1) $2\pi\sqrt{g/l}$ (2) $2\pi\sqrt{l/g}$ (3) $2\pi(l/g)$ (4) $2\pi lg$

7. The time period of a simple pendulum does not depend on:

- (1) Its length (2) The value of g (3) The mass of the bob (4) Any of these

8. At the mean position of a body in SHM, the velocity is:

- (1) Zero (2) Maximum (3) Half its maximum (4) Negative

9. At the extreme position of SHM, the acceleration is:

- (1) Zero (2) Maximum (3) Half its maximum (4) Undefined

10. The total energy of a body in SHM is:

- (1) Maximum at the mean position (2) Maximum at the extremes (3) Constant throughout the motion (4) Zero at the extremes

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Amplitude, frequency and period calculations

Ten questions. Identify A and ω from the equation before substituting.

11. A body in SHM has amplitude 0.5 m and angular frequency 4 rad/s. Its maximum velocity is:

- (1) 0.125 m/s (2) 2 m/s (3) 8 m/s (4) 4 m/s

12. For the same body, the maximum acceleration is:

- (1) 2 m/s^2 (2) 4 m/s^2 (3) 8 m/s^2 (4) 16 m/s^2

13. A 2 kg mass on a spring of constant 800 N/m oscillates. Its angular frequency is:

- (1) 10 rad/s (2) 20 rad/s (3) 40 rad/s (4) 400 rad/s

14. For the same system, the time period is closest to:

- (1) 0.31 s (2) 0.62 s (3) 3.14 s (4) 1.00 s

15. If the length of a simple pendulum is made four times greater, its time period becomes:

- (1) Twice as long (2) Half as long (3) Four times as long (4) Unchanged

16. If the spring constant is made four times greater with the same mass, the time period becomes:

- (1) Twice as long (2) Half as long (3) Four times as long (4) Unchanged

17. A body completes 20 oscillations in 10 s . Its frequency is:

- (1) 0.5 Hz (2) 2 Hz (3) 10 Hz (4) 20 Hz

18. The phase difference between displacement and velocity in SHM is:

- (1) 0 (2) $\pi/4$ (3) $\pi/2$ (4) π

19. The phase difference between displacement and acceleration in SHM is:

- (1) 0 (2) $\pi/2$ (3) π (4) 2π

20. The kinetic energy of a body in SHM is maximum at the:

- (1) Extreme position (2) Mean position (3) Quarter position (4) It is constant

Working space — Questions 11 to 20 Write the formula before you substitute.

Section C · Level 3 — Effective gravity, energy, damping and resonance

Eight questions. Ask what happens to the restoring force in each case.

21. A simple pendulum is taken to the Moon, where g is smaller. Its time period will:

- (1) Increase (2) Decrease (3) Stay the same (4) Become zero

22. A pendulum clock is taken into a lift accelerating upward. Its time period will:

- (1) Increase (2) Decrease (3) Stay the same (4) Become infinite

23. A simple pendulum inside a freely falling lift will:

- (1) Oscillate faster (2) Oscillate slower (3) Not oscillate at all (4) Oscillate unchanged

24. The total energy of a body of mass m in SHM with amplitude A and angular frequency ω is:

- (1) $\frac{1}{2}m\omega A^2$ (2) $\frac{1}{2}m\omega^2 A^2$ (3) $m\omega^2 A$ (4) $\frac{1}{2}m\omega^2 A$

25. In damped oscillations, the quantity that decreases with time is the:

- (1) Frequency (2) Amplitude (3) Time period (4) Mass

26. Resonance occurs when the driving frequency equals the:

- (1) Amplitude (2) Natural frequency of the system (3) Damping constant (4) Phase

27. The displacement of a body in SHM is given by $x = A \cos \omega t$. At $t = 0$ the body is at:

- (1) The mean position (2) An extreme position (3) Half the amplitude (4) An undefined position

28. If a motion is a sum of several harmonic terms, its overall period is:

- (1) The shortest of the individual periods (2) The longest of the individual periods (3) The least common multiple of the individual periods (4) The sum of the periods

Working space — Questions 21 to 28

Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Two questions from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently re-solved.

29. A particle is moving in simple harmonic motion according to $x(t) = 2.0 \sin(40t)$, where x is in metres and t is in seconds. Its maximum velocity, in m/s, is: **[PYQ 2023 · Morning]**

(1) 80 (2) 160 (3) $80 \cos(40t)$ (4) $80 \sin(40t)$

30. A body is executing oscillatory motion. Its displacement from the origin as a function of time is given by $x(t) = 10[\cos(\omega t) + \sin(2\omega t) + \cos(4\omega t)]$. The period T of the body is: **[PYQ 2023 · Evening]**

(1) $2\pi / \omega$ (2) $1 / \omega$ (3) $\pi / 3\omega$ (4) $\pi / 2\omega$

Working space — Questions 29 to 30

Write the formula before you substitute.

Answer key

Check only after you have attempted every question. Full worked solutions for each one are on the worksheet page at aviatelearnings.com.

1. (2)	7. (3)	13. (2)	19. (3)	25. (2)
2. (3)	8. (2)	14. (1)	20. (2)	26. (2)
3. (2)	9. (2)	15. (1)	21. (1)	27. (2)
4. (3)	10. (3)	16. (2)	22. (2)	28. (3)
5. (2)	11. (2)	17. (2)	23. (3)	29. (1)
6. (2)	12. (3)	18. (3)	24. (2)	30. (1)

Stuck on any of these? Bring them to a live class.

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