Oscillations Questions – OCR A Level Physics

Praneel Physics

1. Define simple harmonic motion. **(P)**

Working and Answer:

Acceleration is directly proportional to displacement and acts towards the equilibrium position.

2. What is the unit of angular frequency ω? **(P)**

Working and Answer:

Radians per second (rad/s).

3. Write the equation linking angular frequency and period. **(P)**

Working and Answer:

$$\omega = \frac{2\pi}{T}$$

4. State the condition for simple harmonic motion in terms of force. **(P)**

Working and Answer:

The restoring force must be proportional to displacement and act in the opposite direction.

5. Write the equation for displacement in SHM. **(P)**

Working and Answer:

$$x(t) = A\cos(\omega t) \quad \text{or} \quad x(t) = A\sin(\omega t)$$

6. What is the phase difference between displacement and velocity in SHM? **(PP)**

Working and Answer:

They are out of phase by $\pi/2$ radians or 90°.

7. Explain what is meant by free oscillations. **(PP)**

Working and Answer:

Oscillations that occur without external forces or damping.

8. What is the maximum acceleration in SHM? **(PP)**

Working and Answer:

$$a_{\max} = \omega^2 A$$

9. Sketch a graph of displacement against time for an object in SHM. **(PP)**

Working and Answer:

(Sketch of a sine or cosine wave starting at max or zero depending on choice.)

10. A mass oscillates with amplitude 0.05 m and angular frequency 4 rad/s. Calculate the maximum speed. **(PPP)**

Working and Answer:

$$v_{\max} = \omega A = 4 \times 0.05 = 0.2\,\text{ms}^{-1}$$

11. The time period of a pendulum is 2.0 s. Calculate the frequency. **(PPP)**

Working and Answer:

$$f = \frac{1}{T} = \frac{1}{2.0} = 0.5\,\text{Hz}$$

12. A spring-mass system oscillates with a period of 0.8 s. Calculate the angular frequency. **(PPP)**

Working and Answer:

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.8} \approx 7.85\,\text{rad/s}$$

13. A mass in SHM has equation $x = 0.10\cos(5t)$. What is the maximum acceleration? **(PPP)**

Working and Answer:

$$a_{\max} = \omega^2 A = 25 \times 0.10 = 2.5\,\text{ms}^{-2}$$

14. Derive the expression for the total energy in SHM. **(PPPP)**

Working and Answer:

$$E = \frac{1}{2}m\omega^2 A^2$$

This remains constant and is shared between kinetic and potential energy.

15. Explain the effect of damping on amplitude in an oscillating system. **(PPPP)**

Working and Answer:

Damping causes energy loss, typically as heat, reducing the amplitude over time.

16. What is resonance and when does it occur? **(PPPP)**

Working and Answer:

Resonance occurs when the driving frequency equals the natural frequency, resulting in maximum amplitude.

17. Describe the energy changes in one complete oscillation of SHM. **(PPPP)**

Working and Answer:

Energy transfers between kinetic energy (maximum at equilibrium) and potential energy (maximum at extreme displacement).

18. A mass-spring system with $m = 0.2\,\text{kg}$ and $k = 10\,\text{Nm}^{-1}$ oscillates. Calculate its period. **(PPPPP)**

Working and Answer:

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.2}{10}} \approx 0.89\,\text{s}$$

19. A pendulum has length 0.8 m. Calculate its period using $g = 9.81\,\text{ms}^{-2}$. **(PPPPP)**

Working and Answer:

$$T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{0.8}{9.81}} \approx 1.79\,\text{s}$$

20. A damped oscillator has its amplitude halved every 10 seconds. What type of damping is this an example of? **(PPPPP)**

Working and Answer:

This is light (underdamped) exponential damping.

21. Sketch and explain the velocity–time graph for SHM. **(PPPPP)**

Working and Answer:

A cosine or sine graph, phase-shifted by $\pi/2$ from displacement. Maximum speed at equilibrium, zero at amplitude.