



QUESTION WORKBOOK

Simple harmonic motion

Periodic motion · Year 13

AQA 3.6.1.2 · CIE 17.1.1, 17.1.2, 17.1.3, 17.1.4, 17.1.5
OCR A 5.3.1(a), 5.3.1(b), 5.3.1(c)(i), 5.3.1(d), 5.3.1(e), 5.3.1(f), 5.3.1(g)

19 questions · 55 marks

PRINT EDITION

SECTION A · Warm-up

A1 State the defining condition for simple harmonic motion. [2]

A2 A body oscillates with a frequency of 2.0 Hz. Calculate its angular frequency. [2]

A3 An oscillator has an angular frequency of 10 rad s^{-1} and an amplitude of 0.050 m. Calculate its maximum speed. [2]

A4 An oscillator has an angular frequency of 7.0 rad s^{-1} . Calculate the magnitude of its acceleration when its displacement is +0.030 m, and state the direction of this acceleration. [2]

- A5** For a body in simple harmonic motion, state the displacement at which (a) the acceleration is greatest and (b) the speed is greatest. [2]

- A6** A vibrating machine panel completes 50 oscillations in 40 s. Calculate the frequency and the period of the oscillation. [2]

SECTION B · Standard

- B1** A body performs SHM at 3.0 Hz with an amplitude of 0.020 m. Calculate its maximum acceleration. [3]

- B2** A glider on an air track performs SHM with amplitude 0.10 m and angular frequency 8.0 rad s^{-1} . Calculate its speed when its displacement is 0.060 m. [3]

- B3** An oscillator moves as $x = A \cos \omega t$ with $A = 0.15 \text{ m}$ and $\omega = 4.0 \text{ rad s}^{-1}$. Calculate its displacement at $t = 0.20 \text{ s}$. [3]

- B4** An oscillator has an angular frequency of 6.28 rad s^{-1} . Calculate its frequency and its period. [2]

- B5** A buoy bobbing on water performs SHM with amplitude 0.12 m and frequency 0.50 Hz . Timing starts as the buoy passes upwards through its equilibrium position, so its displacement is $x = A \sin \omega t$. Calculate its displacement at $t = 0.40 \text{ s}$. [3]

- B6** A loudspeaker cone reproducing a test tone vibrates in SHM at 250 Hz with amplitude 0.35 mm. The manufacturer claims the cone's maximum acceleration exceeds $50g$ ($g = 9.81 \text{ m s}^{-2}$). Deduce whether the claim is correct. [4]

- B7** An oscillator is released from rest at its amplitude of 0.080 m and has a period of 1.2 s, so $x = A \cos \omega t$. Calculate the time at which its displacement first falls to 0.020 m. [3]

SECTION C · Stretch

- C1** A body performs SHM with amplitude 0.080 m and period 0.50 s. Calculate (a) its angular frequency, (b) its maximum speed and (c) its maximum acceleration. [4]

- C2** An object performs SHM of amplitude 0.10 m. Calculate the displacement at which its speed is half of its maximum speed. [4]

- C3** Describe the phase relationship between the displacement, velocity and acceleration in SHM. [3]

- C4** A student measures the acceleration of an oscillating trolley at three displacements. At $x = 0.020 \text{ m}$, $a = -0.50 \text{ m s}^{-2}$; at $x = 0.040 \text{ m}$, $a = -1.00 \text{ m s}^{-2}$; at $x = 0.060 \text{ m}$, $a = -1.50 \text{ m s}^{-2}$. Deduce whether the motion is simple harmonic and, if it is, determine the angular frequency. [4]

- C5** An oscillator of period T passes through its equilibrium position at $t = 0$, so $x = A \sin \omega t$. Show that the time it takes to travel from the equilibrium position to a displacement of $A/2$ is $T/12$. [3]

- C6** A component in a machine oscillates with SHM. Sensors record a maximum speed of 0.90 m s^{-1} and a maximum acceleration of 14 m s^{-2} . Determine the angular frequency, the amplitude and the frequency of the oscillation. [4]