InkPhysics

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

NAVY SCREEN EDITION

inkphysics.co.uk

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 $A = 0.15$ m and $\omega = 4.0$ rad s^{-1}. Calculate its displacement at $t = 0.20$ 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 $t = 0.40$ 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 $x = 0.020$ m, $a = -0.50$ m s^{-2}; at $x = 0.040$ m, $a = -1.00$ m s^{-2}; at $x = 0.060$ m, $a = -1.50$ 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 ωt. 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]