InkPhysics

ANSWER BOOK

Simple harmonic motion

Periodic motion · Year 13

AQA 3.6.1.2 · CIE 17.1 · OCR A 5.3.1

10 questions · 30 marks

NAVY EDITION

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SECTION A · Warm-up

A1 The acceleration is directly proportional to the displacement from the equilibrium position and is always directed towards it: $a = -\omega^2 x$ ($a \propto -x$). [2]

A2 $\omega = 2\pi f = 2\pi \times 2.0 = 12.57$ rad s^{-1}. [2]

A3 $v_{max} = \omega A = 10 \times 0.050 = 0.50$ m s^{-1}. [2]

SECTION B · Standard

B1 $\omega = 2\pi \times 3.0 = 18.85$ rad s^{-1}. $a_{max} = \omega^2 A = 7.11$ m s^{-2}. [3]

B2 $v = \pm\omega\sqrt{(A^2 - x^2)} = 8.0 \times \sqrt{(0.10^2 - 0.060^2)} = 0.64$ m s^{-1}. [4]

B3 $x = 0.15 \times \cos(4.0 \times 0.20) = 0.15 \times \cos(0.80) = 0.105$ m. [3]

B4 $f = \omega/2\pi = 6.28/(2\pi) = 1.00$ Hz. $T = 1/f = 1.00$ s. [3]

SECTION C · Stretch

C1 (a) $\omega = 2\pi/T = 12.57$ rad s^{-1}. (b) $v_{max} = \omega A = 1.01$ m s^{-1}. (c) $a_{max} = \omega^2 A = 12.6$ m s^{-2}. [4]

C2 $v = \frac{1}{2}v_{max}$: $\frac{1}{2}\omega A = \omega\sqrt{(A^2 - x^2)}$, so $\frac{1}{4}A^2 = A^2 - x^2$, giving $x = (\sqrt{3}/2)A = 0.087$ m. [4]

C3 Velocity is a quarter of a cycle (90°) ahead of displacement, and is greatest when displacement is zero. Acceleration is exactly out of phase (180°) with displacement, being greatest and opposite when displacement is at a maximum. [3]