InkPhysics

ANSWER BOOK

SHM systems: pendulums and springs

Periodic motion · Year 13

AQA 3.6.1.3 · CIE 17.1, 17.2 · OCR A 5.3.1, 5.3.2

10 questions · 30 marks

NAVY EDITION

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SECTION A · Warm-up

A1 $T = 2\pi\sqrt{(m/k)}$, where T is the period, m the oscillating mass and k the spring constant. [2]

A2 $T = 2\pi\sqrt{(l/g)} = 2\pi\sqrt{(1.0/9.81)} = 2.01$ s. [2]

A3 They interchange: kinetic energy is greatest at the equilibrium position (where potential energy is least), and potential energy is greatest at the extremes (where kinetic energy is zero). The total energy stays constant. [2]

SECTION B · Standard

B1 $T = 2\pi\sqrt{(m/k)} = 2\pi\sqrt{(0.50/200)} = 0.314$ s. [3]

B2 From $T = 2\pi\sqrt{(l/g)}$: $l = g(T/2\pi)^2 = 9.81 \times (2.0/2\pi)^2 = 0.994$ m. [3]

B3 (a) $k = 4\pi^2 m/T^2 = 4\pi^2 \times 0.20/0.80^2 = 12.34$ N m^{-1}. (b) $f = 1/T = 1/0.80 = 1.25$ Hz. [4]

B4 Total energy = maximum elastic PE = $½kA^2 = ½ \times 50 \times 0.10^2 = 0.25$ J. [3]

SECTION C · Stretch

C1 $T = 2\pi\sqrt{(l/g)} = 2\pi\sqrt{(1.0/1.62)} = 4.94$ s. This is much longer than on Earth, because the weaker gravity gives a smaller restoring effect. [4]

C2 $\omega = \sqrt{(k/m)} = \sqrt{(120/0.30)} = 20$ rad s^{-1}. $v_{max} = \omega A = 20 \times 0.050 = 1.00$ m s^{-1}. [4]

C3 Damping (resistive forces such as friction or air resistance) removes energy from the oscillator, so the amplitude decreases with each cycle until the motion stops. Light damping barely changes the period; heavy damping can stop the system oscillating at all. [3]