



QUESTION WORKBOOK

SHM systems: pendulums and springs

Periodic motion · Year 13

AQA 3.6.1.3 · CIE 17.2.1, 17.2.2, 17.3.1, 17.3.2 · OCR A 5.3.1(c)(ii), 5.3.2(a), 5.3.2(b), 5.3.3(b)(i)

19 questions · 56 marks

PRINT EDITION

SECTION A · Warm-up

A1 State the equation for the period of a mass–spring system, defining each symbol. [2]

A2 Calculate the period of a simple pendulum of length 1.0 m ($g = 9.81 \text{ m s}^{-2}$). [2]

A3 State how the kinetic energy and potential energy of an oscillator vary during one oscillation. [2]

A4 State the condition under which the motion of a simple pendulum is simple harmonic. [1]

A5 The mass hanging on a spring is quadrupled. State the effect on the period of oscillation. [1]

A6 State two quantities that have no effect on the period of a simple pendulum.

[2]

SECTION B · Standard

B1 A 0.50 kg mass on a spring of spring constant 200 N m^{-1} oscillates with SHM. Calculate the period.

[2]

B2 Calculate the length of a simple pendulum that has a period of 2.0 s ($g = 9.81 \text{ m s}^{-2}$).

[3]

B3 A 0.20 kg mass on a spring oscillates with a period of 0.80 s. Calculate (a) the spring constant and (b) the frequency of oscillation.

[4]

- B4** A mass on a spring ($k = 50 \text{ N m}^{-1}$) oscillates with an amplitude of 0.10 m . Calculate the total energy of the oscillation. [3]

- B5** On a mountain expedition, a student sets up a simple pendulum of length 0.800 m and times 20 complete oscillations at 35.9 s . Determine the value of g at the site. [3]

- B6** A 0.30 kg mass hung from a spring stretches it by 0.045 m ($g = 9.81 \text{ m s}^{-2}$). Calculate the spring constant. Go on to calculate the period of small vertical oscillations of the mass on this spring. [4]

- B7** A mass on a spring of spring constant 80 N m^{-1} oscillates with amplitude 0.060 m . Calculate the total energy of the oscillation and the kinetic energy of the mass when its displacement is 0.030 m . [3]

SECTION C · Stretch

- C1** A simple pendulum of length 1.0 m is taken to the Moon, where $g = 1.62 \text{ m s}^{-2}$. Calculate its period there and compare it with its period on Earth (2.0 s). [4]

- C2** A 0.30 kg mass on a spring of spring constant 120 N m^{-1} oscillates with an amplitude of 0.050 m . Calculate its maximum speed. [3]

C3 Describe the effect of damping on an oscillation. [3]

C4 A grandfather clock keeps correct time using a simple pendulum of length 0.994 m where $g = 9.81 \text{ m s}^{-2}$; its period there is 2.000 s. The clock is moved to a city where $g = 9.78 \text{ m s}^{-2}$. Deduce whether the clock now runs fast or slow, determine the time it gains or loses per day, and suggest how the pendulum should be adjusted to correct it. [5]

C5 A student sets a mass-spring system oscillating vertically in air, then repeats the experiment with a large card attached to the mass to increase air resistance. Describe and explain how the displacement-time graph and the energy of the system differ between the two experiments. [6]

- C6** Liquid in a vertical U-tube oscillates with a period $T = 2\pi\sqrt{L/2g}$, where L is the total length of the liquid column. Calculate the period when $L = 0.30 \text{ m}$ ($g = 9.81 \text{ m s}^{-2}$), and state and explain what happens to the period if a denser liquid is used with the same column length. [3]