InkPhysics

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

NAVY SCREEN EDITION

inkphysics.co.uk/physics/ · youtube.com/@InkPhysics

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 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 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 m s^{-2}; its period there is 2.000 s. The clock is moved to a city where g = 9.78 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 $L = 0.30$ m ($g = 9.81$ m s^{-2}), and state and explain what happens to the period if a denser liquid is used with the same column length. [3]