

Exercise walk-through

Frequency and Period of SHM ■ 7.2

eXercise

You must be able to

- define the **period** 周期 T and **frequency** 频率 f and relate them by $f = 1/T$
- state that for SHM the period is **independent of amplitude** 振幅
- use $T = 2\pi\sqrt{m/k}$ for a mass-spring system and $T = 2\pi\sqrt{L/g}$ for a simple pendulum

Method — Period and frequency

T is the time for one full oscillation; $f = \frac{1}{T}$ is the number per second (Hz).

Method — The two standard formulas

$$T = 2\pi\sqrt{\frac{m}{k}} \quad (\text{mass-spring}), \quad T = 2\pi\sqrt{\frac{L}{g}} \quad (\text{pendulum}).$$

Method — Amplitude does not matter

For SHM the period does **not** depend on the amplitude — a wider swing simply moves faster.

Practice 2.1 ■ 1 mark

A pendulum has a period of 2.0 s. Find its frequency.

Solution 2.1

Worked steps

$$f = \frac{1}{T} = \frac{1}{2.0} = 0.50 \text{ Hz} \quad \text{B1}.$$

Practice 2.2 ■ 2 marks

A 0.20 kg mass oscillates on a spring of constant 80 N m^{-1} . Find the period.

Solution 2.2

Method: The two standard formulas

Worked steps

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.20}{80}} = 0.31 \text{ s} \quad \text{M1} \quad \text{A1}.$$

Practice 2.3 ■ 1 mark

State how the period of a mass-spring system changes if the amplitude is increased.

Solution 2.3

Worked steps

it does not change — the period is independent of amplitude **B1**.

Exam-style 3.1 ■ 1 mark

The period of a simple pendulum depends on

- A** its mass
- B** its amplitude
- C** its length
- D** the material of the bob

Solution 3.1

- A its mass
- B its amplitude
- C its length 
- D the material of the bob

Worked steps

C.

Exam-style 3.2 ■ 1 mark

To double the period of a mass-spring system, the mass must be

- A** doubled
- B** quadrupled
- C** halved
- D** left unchanged

Solution 3.2

Method: The two standard formulas

- A doubled
- B quadrupled** 
- C halved
- D left unchanged

Worked steps

B — $T \propto \sqrt{m}$, so a factor of 2 in T needs a factor of 4 in m .

Exam-style 3.3 ■ 2 marks

A simple pendulum has length 1.0 m (take $g = 9.8 \text{ m s}^{-2}$).

- (a) Find its period.
- (b) Find its frequency.

Solution 3.3

Worked steps

$$(a) \ T = 2\pi\sqrt{\frac{1.0}{9.8}} = 2.0 \text{ s} \quad \text{M1 A1.} \quad (b) \ f = \frac{1}{2.0} = 0.50 \text{ Hz} \quad \text{B1.}$$