Exercise walk-through

Frequency and Period of SHM ▪ 7.2

eXercise

You must be able to

- use the **period** 周期 T, **frequency** 频率 $f = 1/T$, and **angular frequency** 角频率 $\omega = 2\pi/T$
- use $T = 2\pi\sqrt{m/k}$ for a mass-spring system
- use $T = 2\pi\sqrt{L/g}$ for a simple pendulum
- state that the period is independent of amplitude

Method — Period, frequency, angular frequency

$$T = \frac{1}{f}, \qquad \omega = 2\pi f = \frac{2\pi}{T}.$$

A period of 0.25 s gives $f = 4$ Hz.

Method — Mass on a spring

$$T = 2\pi\sqrt{\frac{m}{k}}.$$

Heavier mass or a softer spring means a longer period.

Method — A simple pendulum

$$T = 2\pi\sqrt{\frac{L}{g}}.$$

The mass of the bob does not appear – only the length matters.

Practice 2.1 ▪ 2 marks

An oscillator has a period of 0.5 s. Find its frequency.

Solution 2.1

Method: Period, frequency, angular frequency

Worked steps

$f = 1/T = 1/0.5 = 2$ Hz M1 A1.

Practice 2.2 ▪ 1 mark

State how the period of a mass-spring system changes if the mass increases.

Solution 2.2

Method: Mass on a spring

Worked steps

The period increases B1.

Practice 2.3 ▪ 2 marks

A pendulum's length is quadrupled. By what factor does its period change?

Solution 2.3

Method: A simple pendulum

Worked steps

$T \propto \sqrt{L}$, so $\sqrt{4} = 2$ times longer M1 A1.

Practice 2.4 ▪ 1 mark

Does a larger swing amplitude change an ideal pendulum's period? Answer yes or no.

Solution 2.4

Method: A simple pendulum

Worked steps

No B1.

Exam-style 3.1 ▪ 1 mark

The period of a simple pendulum depends on

A the bob's mass

B the length and g

C the amplitude

D the colour

Solution 3.1

Method: A simple pendulum

A the bob's mass

B the length and g ✓

C the amplitude

D the colour

Worked steps

B — the length and g.

Exam-style 3.2 ▪ 1 mark

Quadrupling the mass on a spring changes the period by a factor of

A 2

B 4

C 16

D $1/2$

Solution 3.2

Method: Mass on a spring

A 2 ✓

B 4

C 16

D $1/2$

Worked steps

A — $T \propto \sqrt{m}$, so $\sqrt{4} = 2$.

Exam-style 3.3 ▪ 2 marks

A 0.2 kg mass hangs on a spring with $k = 50$ N m^{-1}.
(a) Find the period.
(b) Find the frequency.

Solution 3.3

Worked steps

(a) $T = 2\pi\sqrt{m/k} = 2\pi\sqrt{0.2/50} = 0.40$ s M1 A1. (b) $f = 1/T = 2.5$ Hz B1.

Exam-style 3.4 ▪ 2 marks

A pendulum of length 1.0 m swings ($g = 9.8$ m s^{-2}).
(a) Find its period.
(b) State the effect on the period of doubling the bob's mass.

Solution 3.4

Method: A simple pendulum

Worked steps

(a) $T = 2\pi\sqrt{1/9.8} \approx 2.0$ s M1 A1. (b) No change (mass does not appear) B1.