AP PHYSICS C: MECHANICS • EXERCISE SHEET

7.2 Frequency and Period of SHM

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS period 周期 • frequency 频率 • amplitude 振幅 • angular frequency 角频率 • simple pendulum 单摆

Objective

Build the skills to answer exam questions on **frequency and period of SHM**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ **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.

■ **Mass on a spring**

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

Heavier mass or a softer spring means a longer period.

■ **A simple pendulum**

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

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

2 Practice

Now apply the methods above.

2.1 An oscillator has a period of 0.5 s. Find its frequency. [2]

2.2 State how the period of a mass-spring system changes if the mass increases. [1]

2.3 A pendulum's length is quadrupled. By what factor does its period change? [2]

2.4 Does a larger swing amplitude change an ideal pendulum's period? Answer yes or no. [1]

3 Exam-style questions

3.1 The period of a simple pendulum depends on [1]

- **A** the bob's mass
- **B** the length and g
- **C** the amplitude
- **D** the colour

3.2 Quadrupling the mass on a spring changes the period by a factor of [1]

- **A** 2
- **B** 4
- **C** 16
- **D** 1/2

3.3 A 0.2 kg mass hangs on a spring with $k = 50$ N m^{-1}.

(a) Find the period. [2]

(b) Find the frequency. [1]

3.4 A pendulum of length 1.0 m swings ($g = 9.8$ m s^{-2}).

(a) Find its period. [2]

(b) State the effect on the period of doubling the bob's mass. [1]

Solutions

2.1 $f = 1/T = 1/0.5 = 2$ Hz.

2.2 The period increases.

2.3 $T \propto \sqrt{L}$, so $\sqrt{4} = 2$ times longer.

2.4 No.

3.1 B — the length and g.

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

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

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