

7.2 Frequency and Period of SHM

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS period 周期 • frequency 频率 • amplitude 振幅 • oscillation 振动

Objective

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

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

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Period and frequency

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

■ The two standard formulas

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

■ Amplitude does not matter

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

2 Practice

2.1 A pendulum has a period of 2.0 s. Find its frequency. [1]

2.2 A 0.20 kg mass oscillates on a spring of constant 80 N m^{-1} . Find the period. [2]

2.3 State how the period of a mass-spring system changes if the amplitude is increased. [1]

3 Exam-style questions

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

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

3.2 To double the period of a mass-spring system, the mass must be [1]

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

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

(a) Find its period. [2]

(b) Find its frequency. [1]

Solutions

2.1 $f = \frac{1}{T} = \frac{1}{2.0} = 0.50 \text{ Hz}.$

2.2 $T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.20}{80}} = 0.31 \text{ s}.$

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

3.1 C.

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

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