AP PHYSICS 1 • EXERCISE SHEET

7.3 Representing and Analyzing SHM

Name: _____ Class: _____ Date: _____ **Total: 8 marks**

KEY WORDS equilibrium 平衡 • amplitude 振幅 • phase 相位 • oscillation 振动

Objective

Build the skills to answer exam questions on **representing and analyzing SHM**.

You must be able to:

- represent the displacement, velocity, and acceleration of an oscillator as functions of time
- explain that the speed is greatest at the **equilibrium** 平衡 position and zero at the **amplitude** 振幅
- relate the **phase** 相位 of the motion to graphs of position, velocity, and acceleration

1 Worked examples

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

> ■ **Where the speed is greatest**
>
> The oscillator moves **fastest at equilibrium** ($x = 0$) and is momentarily **at rest at the amplitude** ($x = \pm A$).
>
> ■ **Where the acceleration is greatest**
>
> Because $a = -\dfrac{k}{m}x$, the acceleration is **largest at the amplitude** and **zero at equilibrium** — the opposite of the speed.
>
> ■ **Phase**
>
> If $x = A\cos(\omega t)$, then velocity and acceleration are shifted in phase — the velocity peaks a quarter-cycle after the displacement passes through zero.

2 Practice

2.1 State where in the oscillation the speed is greatest. [1]

2.2 State where the acceleration is greatest. [1]

2.3 A mass oscillates with amplitude 0.10 m. State its displacement at the instant its speed is maximum. [1]

3 Exam-style questions

3.1 In SHM, the velocity is maximum at the [1]

- **A** amplitude
- **B** equilibrium position
- **C** turning point
- **D** highest point

3.2 In SHM, the acceleration is zero at the [1]

- **A** amplitude
- **B** equilibrium position
- **C** both ends
- **D** every point

3.3 A mass on a spring oscillates between $x = +8.0$ cm and $x = -8.0$ cm.

(a) State the amplitude. [1]

(b) State where the kinetic energy is greatest. [1]

(c) State where the elastic potential energy is greatest. [1]

Solutions

2.1 at the equilibrium position ($x = 0$).

2.2 at the amplitude ($x = \pm A$).

2.3 $x = 0$ (equilibrium).

3.1 B.

3.2 B.

3.3 (a) 8.0 cm. (b) at equilibrium, $x = 0$. (c) at the amplitude, $x = \pm 8.0$ cm.