

# 7.3 Representing and Analyzing SHM

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 8 marks

## Objective

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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

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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  $a = -\frac{k}{m}x$ , 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

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

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**2.2** State where the acceleration is greatest. [1]

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

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### 3 Exam-style questions

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

- **A** amplitude
  - **B** equilibrium position
  - **C** turning point
  - **D** highest point
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**3.2** In SHM, the acceleration is zero at the [1]

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

### 4 Go further

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- work through the **7.3 Representing and Analyzing SHM** lesson on the **Learn** page;
- read the **Oscillations** section of the AP Physics 1 handout on the **Know** page.

## Solutions

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**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.