

Exercise walk-through

Representing and Analyzing SHM ■ 7.3

eXercise

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

Method — Where the speed is greatest

The oscillator moves **fastest at equilibrium** ($x = 0$) and is momentarily **at rest at the amplitude** ($x = \pm A$).

Method — 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.

Method — 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.

Practice 2.1 ■ 1 mark

State where in the oscillation the speed is greatest.

Solution 2.1

Worked steps

at the equilibrium position ($x = 0$) **B1**.

Practice 2.2 ■ 1 mark

State where the acceleration is greatest.

Solution 2.2

Method: Where the acceleration is greatest

Worked steps

at the amplitude ($x = \pm A$) **B1**.

Practice 2.3 ■ 1 mark

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

Solution 2.3

Worked steps

$x = 0$ (equilibrium) **B1**.

Exam-style 3.1 ■ 1 mark

In SHM, the velocity is maximum at the

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

Solution 3.1

A amplitude

B equilibrium position 

C turning point

D highest point

Worked steps

B.

Exam-style 3.2 ■ 1 mark

In SHM, the acceleration is zero at the

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

Solution 3.2

A amplitude

B equilibrium position



C both ends

D every point

Worked steps

B.

Exam-style 3.3 ■ 1 mark

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

- (a) State the amplitude.
- (b) State where the kinetic energy is greatest.
- (c) State where the elastic potential energy is greatest.

Solution 3.3

Worked steps

(a) 8.0 cm **B1**. (b) at equilibrium, $x = 0$ **B1**. (c) at the amplitude, $x = \pm 8.0$ cm **B1**.