

# 4.2 Straight-Line Motion: Position, Velocity, and Acceleration

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

Total: 9 marks

## Objective

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Build the skills to answer exam questions on **straight-line motion: position, velocity, and acceleration**.

You must be able to:

- relate **position** 位置, **velocity** 速度, and **acceleration** 加速度 by differentiation
- find when an object is at rest

## 1 Worked examples

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

### ■ Straight-line motion

- velocity  $v(t) = x'(t)$ ;
- acceleration  $a(t) = v'(t) = x''(t)$ ;
- **speed** =  $|v(t)|$ .

The object is **at rest** when  $v = 0$ ; it moves in the positive direction when  $v > 0$ .

### ■ Example

$$x(t) = t^2 - 4t: v(t) = 2t - 4 = 0 \text{ at } t = 2.$$

## 2 Practice

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2.1 State velocity in terms of position. [1]

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2.2 State acceleration in terms of velocity. [1]

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2.3 For  $x(t) = t^2 - 4t$ , find  $v(t)$  and the time at rest. [2]

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### 3 Exam-style questions

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**3.1** Velocity is the derivative of [1]

- **A** acceleration
  - **B** position
  - **C** speed
  - **D** distance
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**3.2** The object is at rest when [1]

- **A**  $a = 0$
  - **B**  $v = 0$
  - **C**  $x = 0$
  - **D**  $t = 0$
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**3.3**  $x(t) = t^2 - 4t$ .

(a) Find  $v(t)$ . [1]

(b) Find  $a(t)$ . [1]

(c) Find when  $v = 0$ . [1]

### 4 Go further

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- work through the **4.2 Straight-Line Motion: Connecting Position, Velocity, and Acceleration** lesson on the **Learn** page;
- read the **Contextual Applications of Differentiation** section of the AP Calculus AB handout on the **Know** page.

## Solutions

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**2.1**  $v(t) = x'(t)$ .

**2.2**  $a(t) = v'(t)$ .

**2.3**  $v(t) = 2t - 4$ ; at rest when  $2t - 4 = 0$ , i.e.  $t = 2$ .

**3.1 B.**

**3.2 B.**

**3.3** (a)  $v(t) = 2t - 4$ . (b)  $a(t) = 2$ . (c)  $t = 2$ .