

1.3 Representing Motion

Name: _____ Class: _____ Date: _____

Total: 15 marks

Objective

Build the skills to answer exam questions on **representing motion** with graphs.

You must be able to:

- read **velocity** 速度 as the slope of a position-time ($x-t$) graph
- read **acceleration** 加速度 as the slope of a velocity-time ($v-t$) graph
- read **displacement** 位移 as the area under a $v-t$ graph
- match the shapes of $x-t$, $v-t$, and $a-t$ graphs for the same motion

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

■ Slopes give the next quantity down

- Slope of $x-t$ = velocity.
- Slope of $v-t$ = acceleration.

A straight, rising $x-t$ line has constant slope, so constant velocity and zero acceleration.

■ Areas give the previous quantity up

- Area under $v-t$ = displacement.
- Area under $a-t$ = change in velocity.

A $v-t$ triangle rising from 0 to 10 m s⁻¹ over 4 s has area $\frac{1}{2}(4)(10) = 20$ m.

■ Matching graph shapes

For constant acceleration: $x-t$ is a parabola (curving), $v-t$ is a straight sloped line, $a-t$ is a flat horizontal line.

2 Practice

Now apply the methods above.

2.1 What does the slope of a position-time graph represent?

[1]

2.2 What does the area under a velocity-time graph represent? [1]

2.3 A v - t graph holds a constant 6 m s^{-1} for 5 s. Find the displacement. [2]

2.4 A v - t graph rises straight from 0 to 8 m s^{-1} over 2 s. Find the acceleration. [2]

3 Exam-style questions

3.1 The acceleration of an object equals the slope of its [1]

- **A** position-time graph
- **B** velocity-time graph
- **C** acceleration-time graph
- **D** force-time graph

3.2 For motion with constant acceleration, the velocity-time graph is a [1]

- **A** horizontal line
- **B** straight sloped line
- **C** parabola
- **D** circle

3.3 A v - t graph is a triangle: velocity rises straight from 0 to 12 m s^{-1} over 6 s.

(a) Find the acceleration. [2]

(b) Find the displacement (the area). [2]

3.4 An x - t graph is a horizontal straight line for 10 s.

(a) State the velocity. [1]

(b) State the acceleration. [1]

4 Go further

You are ready for more on this subtopic:

- work through the interactive **1.3 Representing Motion** lesson on the **Learn** page;
- read the **Kinematics** section of the AP Physics C: Mechanics handout on the **Know** page for the full explanation and worked diagrams.

Solutions

2.1 The velocity.

2.2 The displacement.

2.3 Displacement = area = $6 \times 5 = 30$ m.

2.4 $a = \frac{\Delta v}{\Delta t} = \frac{8}{2} = 4 \text{ m s}^{-2}$.

3.1 B —acceleration is the slope of the velocity-time graph.

3.2 B —constant acceleration gives a straight sloped v - t line.

3.3 (a) $a = 12/6 = 2 \text{ m s}^{-2}$. (b) area = $\frac{1}{2}(6)(12) = 36$ m.

3.4 (a) $v = 0$ (the position is constant). (b) $a = 0$.