

5.6 Describing motion along a line

Name: _____ Class: _____ Date: _____ **Total: 29 marks**

KEY WORDS Distance • Displacement • Speed • Velocity
• Acceleration • terminal velocity

Objective

Distinguish distance/displacement and speed/velocity, recall typical speeds, and read distance–time and velocity–time graphs (gradient, tangent, area). Original questions for spec statements 4.5.6.1.1–4.5.6.1.5.

1 Key knowledge and worked examples

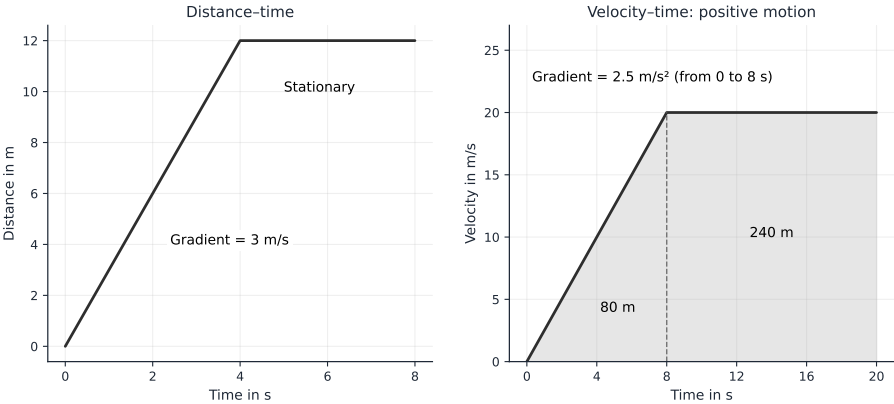
Scalar		Vector	
distance	– how far	displacement	– straight-line distance AND direction
speed		velocity	– speed in a given direction

Typical values to recall: walking ≈ 1.5 m/s, running ≈ 3 m/s, cycling ≈ 6 m/s, **sound in air ≈ 330 m/s**. Speed varies with age, terrain, fitness, distance; sound and wind speeds vary too.

$s = vt$ (constant speed)

$a = \frac{\Delta v}{t}$

$v^2 - u^2 = 2as$



Steepness means speed on one, acceleration on the other.

Graph rules:

Graph	Gradient	Flat section	(HT) Area under
distance–time	speed	stationary	–
velocity–time	acceleration	constant velocity	signed area gives displacement

(HT) On a curved d–t graph, draw a **tangent** at the time and take its gradient for instantaneous speed. On a v–t graph, **count squares** for the area. Add signed areas for displacement; add their magnitudes for total distance. Area is distance directly only while velocity remains positive.

Free fall near Earth: $a \approx 9.8$ m/s². Deceleration means slowing down; with the initial motion taken positive, acceleration is negative.

Worked example (v–t graph). The graph rises from 0 to 20 m/s in 8 s, then flat for 12 s.

- Acceleration: $a = \Delta v/t = 20/8 = 2.5$ m/s².
- (HT) Positive-velocity areas: $s = \frac{1}{2}\Delta t_1 v + v\Delta t_2 = \frac{1}{2} \times 8 \times 20 + 20 \times 12 = 320$ m.

2 Practice

2.1 A person walks 300 m in 240 s. Calculate the average speed and state whether it matches a typical walking value. [3]

2.2 A car travels 5 km east, then 5 km west in 40 minutes total. State the distance travelled and the displacement. [3]

2.3 A v–t graph is flat at 12 m/s for 25 s. State the acceleration and (HT) the distance travelled. [2]

3 Exam-style questions

3.1 A cyclist's distance–time graph rises in a straight line from 0 to 900 m in 6.0 minutes.

(a) Show the graph's gradient and calculate her speed. [3]

(b) She then stops for 4.0 minutes. Describe the graph for that section and state her speed. [2]

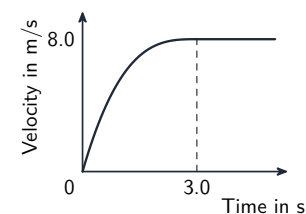
(c) Compare her motion with a typical cyclist's speed of 6 m/s. [1]

3.2 A ball is dropped and its v–t graph curves: steep at first, flattening to a constant 8.0 m/s after 3.0 s.

(a) Describe the forces on the ball in the first 3 seconds and after. [3]

(b) State what the constant final speed is called and the condition for it. [2]

(c) Estimate the distance fallen in the first 3 s if the supplied average velocity was 6.0 m/s. [2]



3.3 A train's velocity–time graph: $0 \rightarrow 30$ m/s over 600 s at uniform acceleration, then 30 m/s constant for 1200 s, then decelerating uniformly to rest in 300 s.

(a) Calculate the three accelerations (m/s^2). [3]

(b) (HT) Calculate the total distance travelled. [3]

(c) Calculate the average speed for the whole journey. [2]