1.1 Movement and position

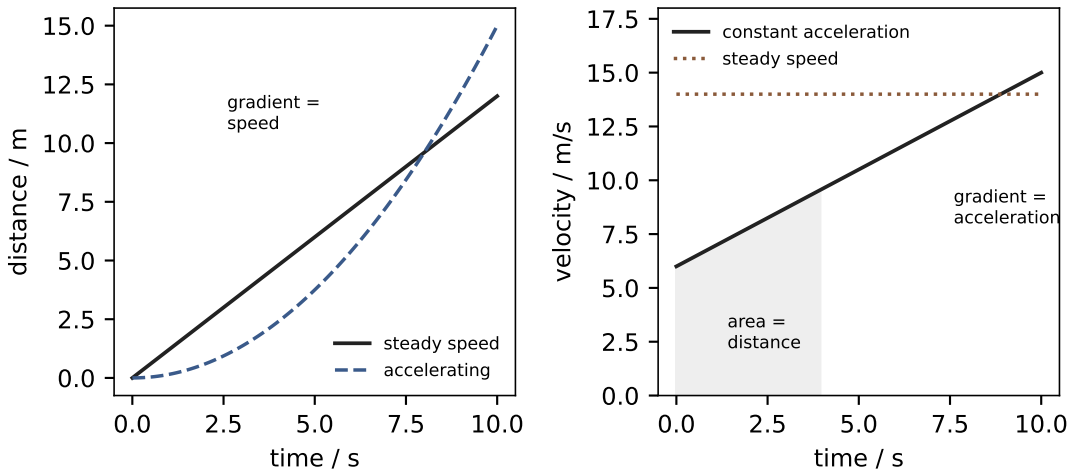
Name: _____ Class: _____ Date: _____ **Total: 28 marks**

Objective

Cover movement and position (1.3–1.10): distance-time and velocity-time graphs, average speed, acceleration, and $v^2 = u^2 + 2as$. Original IGCSE-level practice.

1 Key knowledge and worked examples

■ Two graphs, two gradients



Distance-time: gradient = **speed**; flat = at rest; curve = accelerating. Velocity-time: gradient = **acceleration**; flat = constant velocity; **area under the line = distance**.

Worked check. From the area rule, a line rising 4 → 16 m/s over 6 s covers $\frac{1}{2}(4 + 16) \times 6 = 60$ m; by $v^2 = u^2 + 2as$: $s = (256 - 16)/(2 \times 2) = 60$ m ✓.

2 Practice

2.1 State what the gradient of each graph represents: distance-time; velocity-time. [2]

2.2 A train travels 15 km in 12 minutes. Calculate the average speed in m/s. [3]

2.3 A ball rolls from 2 m/s to 8 m/s in 3 s. Calculate the acceleration. [2]

2.4 Use $v^2 = u^2 + 2as$ to find the distance a car needs braking from 20 m/s at 4 m/s^2. [3]

2.5 Describe the motion shown by a velocity-time graph that is flat at 12 m/s. [1]

3 Exam-style questions

3.1 Sketch and describe the distance-time graph for a car that speeds up steadily from rest, then travels at constant speed. [3]

3.2 A velocity-time graph rises from 0 to 25 m/s in 10 s, stays flat for 20 s, then falls to 0 in 5 s. Calculate the acceleration in each stage and the total distance travelled. [6]

3.3 A stone dropped down a well accelerates at 10 m/s^2 and hits water after 2 s. Calculate its final speed and the depth to the water. [4]

3.4 A bus travels the first 300 m of its route at a steady 10 m/s, then 450 m at a steady 15 m/s. Calculate the total time and the average speed for the whole journey. [4]

Solutions

2.1 Speed; acceleration.

2.2 Distance = 15 000 m, time = 720 s; $v = 15\,000/720 = 20.8$ m/s.

2.3 $a = (8 - 2)/3 = 2$ m/s^2.

2.4 $0 = 20^2 + 2 \times (-4) \times s$; $s = 400/8 = 50$ m.

2.5 Constant velocity of 12 m/s (zero acceleration).

3.1 A curve of increasing gradient from the origin, becoming a straight line of constant gradient; the changing gradient shows acceleration, the straight section steady speed.

3.2 Stage 1: $25/10 = 2.5$ m/s^2; stage 2: 0; stage 3: $(0 - 25)/5 = -5$ m/s^2. Distances: $\frac{1}{2} \times 10 \times 25 = 125$ m; $20 \times 25 = 500$ m; $\frac{1}{2} \times 5 \times 25 = 62.5$ m – total 687.5 m.

3.3 $v = 0 + 10 \times 2 = 20$ m/s; $s = \frac{1}{2}(0 + 20) \times 2 = 20$ m, or $v^2 = 0 + 2 \times 10 \times s \Rightarrow s = 400/20 = 20$ m.

3.4 Stage 1: $t = 300/10 = 30$ s; stage 2: $t = 450/15 = 30$ s; total time 60 s for 750 m; average speed = 750/60 = 12.5 m/s – equal time (30 s) at each speed, so here the average equals the mean of the two speeds; average speed must always come from total distance ÷ total time.