

Reading journeys from motion graphs

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer shows which feature of the graph is used, the substitution and the final result in bold with its unit. Check that you used gradient for rates and area for totals.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** IGCSE 1.2

Problem 1 Graph facts

1. **speed**.
2. **acceleration**.
3. **distance travelled**.
4. **stationary**.

Problem 2 Reading a straight line

1. The line passes through **25 m** at 10 s.
2. Speed = $50 \div 20 = \mathbf{2.5 \text{ m/s}}$.
3. $d = 2.5 \times 16 = \mathbf{40 \text{ m}}$.

Problem 3 Gradient from two points

1. $30 - 6 = \mathbf{24 \text{ m}}$.
2. $8 - 2 = \mathbf{6 \text{ s}}$.
3. Gradient = $24 \div 6 = \mathbf{4.0 \text{ m/s}}$, the speed.

Problem 4 Describe the sections

1. A: the object is **stationary**. B: it moves at a **high constant speed**. C: it moves at a **low constant speed**.
2. Section **B** has the steepest gradient, so it is the fastest.

Problem 5 Reading a velocity graph

1. At 3 s the line is at **6 m/s**.
2. $a = (12 - 0) \div 6 = \mathbf{2.0 \text{ m/s}^2}$.
3. The line is horizontal, so the bike moves at a **constant 12 m/s** with zero acceleration.

Problem 6 Rectangle area

1. A horizontal line at 5.0 m/s from 0 to 12 s.
2. Area = $5.0 \times 12 = 60 \text{ m}$.
3. It represents the **distance travelled**.

Problem 7 Triangle area

1. A straight line from the origin sloping up to 9.0 m/s at 6.0 s.
2. $a = 9.0 \div 6.0 = 1.5 \text{ m/s}^2$.
3. Area = $\frac{1}{2} \times 6.0 \times 9.0 = 27 \text{ m}$.

Problem 8 A walk in stages

1. Section 1: $30 \div 20 = 1.5 \text{ m/s}$. Section 2: **0 m/s**. Section 3: $(90 - 30) \div (90 - 50) = 60 \div 40 = 1.5 \text{ m/s}$.
2. Average speed = $90 \div 90 = 1.0 \text{ m/s}$.

Problem 9 Out and back

1. $120 \div 30 = 4.0 \text{ m/s}$.
2. The return is 120 m in $90 - 50 = 40 \text{ s}$: **3.0 m/s**.
3. Distance = $120 + 120 = 240 \text{ m}$. He is back home, so the displacement is **0 m**.

Problem 10 Trapezoid journey

1. $a = 6.0 \div 3.0 = 2.0 \text{ m/s}^2$.
2. $a = (0 - 6.0) \div 5.0 = -1.2 \text{ m/s}^2$.
3. Areas: $\frac{1}{2} \times 3 \times 6 = 9 \text{ m}$; $10 \times 6 = 60 \text{ m}$; $\frac{1}{2} \times 5 \times 6 = 15 \text{ m}$. Total = **84 m**.

Problem 11 From a table to a graph

1. The points lie on a **straight line through the origin**.
2. $a = 3 \div 2 = 1.5 \text{ m/s}^2$.
3. Area = $\frac{1}{2} \times 8 \times 12 = 48 \text{ m}$.

Problem 12 Two lines compared

1. A: $40 \div 10 = 4.0 \text{ m/s}$. B: $25 \div 10 = 2.5 \text{ m/s}$.

2. At 20 s A is at 80 m and B at 50 m, so the gap is **30 m**.

Problem 13 Slowing to rest

1. Gradient = $(0 - 18) \div 9.0 = -2.0 \text{ m/s}^2$.

2. The negative sign shows the velocity is decreasing, so the van decelerates.

3. Area = $\frac{1}{2} \times 9.0 \times 18 = 81 \text{ m}$.

Problem 14 Tangent to a curve

1. $(11.0 - 3.0) \div (3.0 - 1.0) = 8.0 \div 2.0 = 4.0 \text{ m/s}$.

2. It is the speed of the coconut at 2 s.

3. Yes: the curve gets steeper, so the gradient (speed) increases.

Problem 15 From distance to speed steps

1. 0-10 s: $50 \div 10 = 5.0 \text{ m/s}$. 10-30 s: $80 \div 20 = 4.0 \text{ m/s}$. 30-40 s: **0 m/s**.

2. Three flat steps: 5.0 m/s, then 4.0 m/s, then 0 m/s.

3. $130 \div 40 = 3.25$, so **3.3 m/s**.

Problem 16 Robot on a rail

1. Stage 1: $4.0 \times 5.0 = +20 \text{ m}$. Stage 2: 0 m. Stage 3: $-2.0 \times 6.0 = -12 \text{ m}$.

2. Displacement = $20 + 0 - 12 = +8 \text{ m}$. Distance = $20 + 12 = 32 \text{ m}$.

3. Total time = 14 s. Average speed = $32 \div 14 = 2.3 \text{ m/s}$. Average velocity = $8 \div 14 = 0.57 \text{ m/s}$.

Problem 17 Counting squares

1. One square is $1.0 \text{ m/s} \times 1.0 \text{ s} = 1.0 \text{ m}$.

2. Area $\approx 38 + 14 \div 2 = 38 + 7 = 45 \text{ squares}$.

3. The distance is about **45 m**.

Problem 18 Find the top speed

1. Triangle = $\frac{1}{2} \times 5.0 \times V = 2.5 V$. Rectangle = $15 \times V = 15 V$.

2. $2.5 V + 15 V = 17.5 V = 210$, so $V = 12 \text{ m/s}$.

3. $a = 12 \div 5.0 = 2.4 \text{ m/s}^2$.

Problem 19 Spot the graph errors

1. The distance from the start is decreasing, so the object is **moving back towards the start**. A straight line means constant speed, not slowing.
2. A horizontal line means **constant velocity**; the object is stationary only if the line is at 0 m/s.
3. A curve that **gets flatter** (decreasing gradient).

Problem 20 Overtaking scooter

1. Lorry: area of a rectangle = 12 t. Scooter: area of a triangle = $\frac{1}{2} \times t \times (2.0 \text{ t}) = t^2$.
2. $t^2 = 12 \text{ t}$, so $t = \mathbf{12 \text{ s}}$ (both are then 144 m from the start).
3. $v = a t = 2.0 \times 12 = \mathbf{24 \text{ m/s}}$, which is twice the lorry's speed.