Test answers - Rates of change and areas under graphs

Year: Year 11 · Duration: 45 minutes · /20

Answer to Question 1 (4 marks)

a. $\frac{45}{1.5} = 30$ **km/h** (1) Speed is the gradient: distance divided by time.
b. Stationary (1) The graph is horizontal, so the distance from the start does not change.
c. $\frac{90}{3.5} = 25.7$ **km/h** (2) Divide the total distance, 90 km, by the total time, 3.5 hours, including the stop.

In (c), a common error is to average the speeds of the sections instead; the average speed is always total distance over total time. The last section has speed $45 \div 1.5 = 30$ km/h.

Answer to Question 2 (4 marks)

a. $90 \div 3.6 = 25$ **m/s** (2) Multiply by 1000 and divide by 3600, which is the same as dividing by 3.6.
b. $12 \times 3.6 = 43.2$ **km/h** (2) Multiply by 3.6 to change m/s into km/h.

In (a), 90 km is 90 000 m and one hour is 3600 s, so $90\,000 \div 3600 = 25$ m/s. In (b), 12 m/s means 43 200 m in 3600 s, which is 43.2 km in one hour. A quick sense check: m/s values are always smaller than the equivalent km/h values.

Answer to Question 3 (4 marks)

a. $\frac{18}{6} = 3$ **m/s²** (1) Acceleration is the gradient of the first section: 18 m/s gained in 6 seconds.
b. Trapezium: $\frac{1}{2}(20 + 8) \times 18 = 252$ **m** (3: 1 for parallel sides, 1 for formula, 1 for answer) The distance is the area under the graph. It is a trapezium with parallel sides 20 s and $14 - 6 = 8$ s, and height 18 m/s.

Splitting into a triangle, rectangle and triangle gives $54 + 144 + 54 = 252$ m as well.

Answer to Question 4 (4 marks)

a. **30** litres per minute (1) The rate is the gradient: 150 litres in 5 minutes.

b. $600 \div 30 =$ **20 minutes** (1) Divide the volume by the rate.
c. A greater rate of flow: more litres per minute (2)

In (c), a steeper line means the volume rises faster, so the tank fills in less time. A horizontal section would mean no water is flowing in. Check (b): $30 \times 20 = 600$ litres.

Answer to Question 5 (4 marks)

a. $\frac{1}{2} \times 3 \times (8) + \frac{1}{2} \times 3 \times (19) + \frac{1}{2} \times 3 \times (23) = 12 + 28.5 + 34.5 =$ **75 m** (3) Each trapezium has width 3 seconds; add the parallel sides of each strip, multiply by 3 and halve.
b. Underestimate if the curve is concave down (1) When the curve bends downwards, the straight tops of the trapezia lie below it, so the area is too small.

In (a), the parallel sides are $0 + 8$, $8 + 11$ and $11 + 12$. In (b), the speed increases by 8, then 3, then 1, so the graph flattens.