Velocity–time calculations: area and gradient

Student activity • observation and reasoning

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The question

What do the area and gradient of the same graph tell you?

Break a velocity–time graph into simple shapes and keep displacement distinct from total distance.

Equipment

- Booklet, graph paper, ruler and calculator

Paper calculation activity only. All supplied data are a mathematical model.

Course coverage: Shared Physics / Double Award: 1.8–1.9. Acceleration and distance from a graph.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

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1. Replot the specified model journey: (0 s,0 m s^{-1}), (4 s,8 m s^{-1}), (7 s,8 m s^{-1}), (11 s,0 m s^{-1}).

2. Split the area above the time axis into two triangles and a rectangle. Label each base and height with units.

3. Calculate each area and add them to find the distance travelled while velocity remains non-negative. Explain why the result is in metres.

4. Use the first segment’s gradient to find acceleration, then compare that calculation with its triangular area. They answer different questions.

5. Extension: add the straight segment to (13 s,−4 m s^{-1}). Find its signed area, then calculate displacement and total distance separately for 0–13 s.

6. Check results against a rough estimate and explain why dividing final velocity by total journey time is not the acceleration of every segment.

Cleanup

- Keep corrected calculations and return rulers.

Record your evidence

Blank spaces are for your own work

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Reference and task data

For a velocity–time graph, signed area gives displacement. Total distance is the sum of the magnitudes of areas above and below zero. For the main journey velocity is never negative, so distance and displacement have the same magnitude. Triangle area = ½ × base × height; rectangle area = base × height.

Graph section	Shape / calculation	Area / m
0–4 s		
4–7 s		
7–11 s		
11–13 s extension		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Find the first triangle’s area.

2. Find the rectangle’s area.

3. Find the distance over 0–11 s.

4. Find the first segment’s acceleration.

5. For the extension, find displacement over 0–13 s.

6. For the extension, find total distance over 0–13 s.