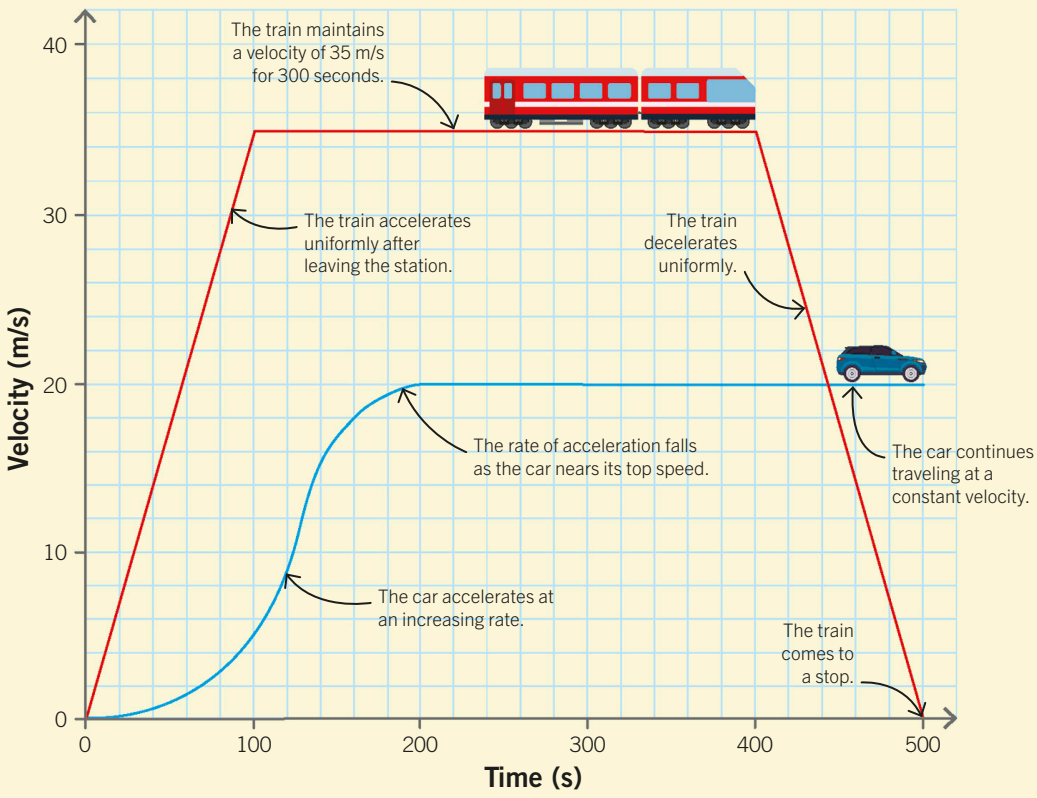
Velocity–time graphs

A velocity–time graph shows how an object's velocity changes over time. The gradient (steepness) of the line represents the object's acceleration or deceleration (negative acceleration). The graph can also show whether or not an object's acceleration is uniform.

Key facts

- ✓ **A velocity–time graph shows how an object's velocity changes over time.**
- ✓ **The horizontal axis shows time and the vertical axis shows velocity.**
- ✓ **You can work out acceleration from the gradient (slope) of the line.**
- ✓ **The area under the line is the displacement (total distance traveled).**

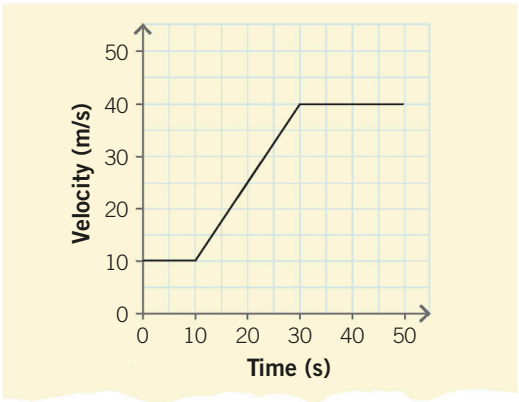
Understanding velocity–time graphs
This velocity–time graph shows two different journeys. Slopes with a straight line represent uniform acceleration, whereas curved lines represent changing acceleration. Flat horizontal lines represent constant velocity.



Calculating acceleration

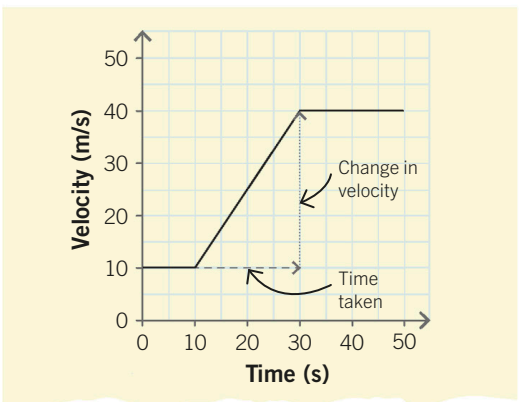
Question

The graph below shows a car's journey. What was the car's acceleration between 10 and 30 seconds?



Answer

1. Acceleration is change in velocity divided by time taken, so work these out by drawing a triangle under the sloped part of the graph.



2. Change in velocity = final velocity – initial velocity
= 40 m/s – 10 m/s
= 30 m/s

3. Time taken = 30 s – 10 s
= 20 s

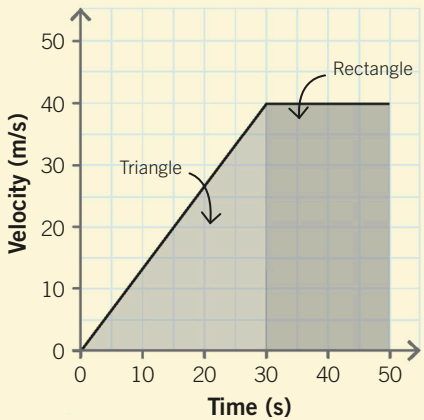
4. Acceleration = $\frac{30 \text{ m/s}}{20 \text{ s}}$
= 1.5 m/s^2

Calculating displacement

You can use a velocity–time graph to work out the displacement of a moving object—the total distance it has traveled. You do this by finding the area under the graph. This works because distance traveled = velocity × time.

Question

The graph shows a 50-second train journey. How far did the train travel?



Answer

1. Start by separating the space under the line into a triangle and a rectangle.

2. Next, work out the triangle's area using the formula for the area of a triangle:

area = $\frac{\text{base} \times \text{height}}{2}$

= $\frac{30 \text{ s} \times 40 \text{ m/s}}{2}$

= 600 m

The units are meters because the area under the line represents distance.

3. Now work out the area of the rectangle:
area = base × height
= 20 s × 40 m/s
= 800 m

4. Add the two values to find the displacement:
displacement = 600 m + 800 m
= 1400 m