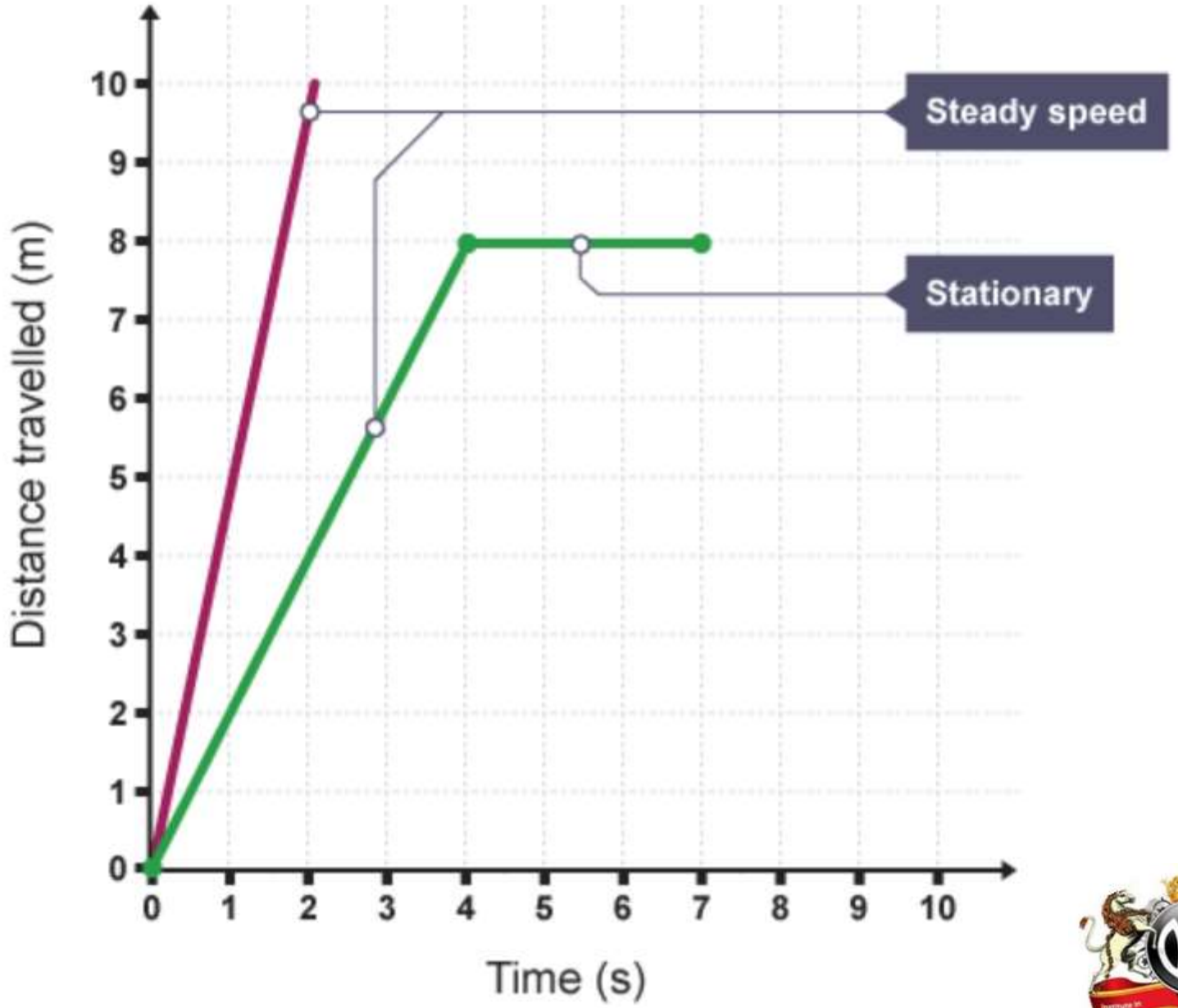
Motion

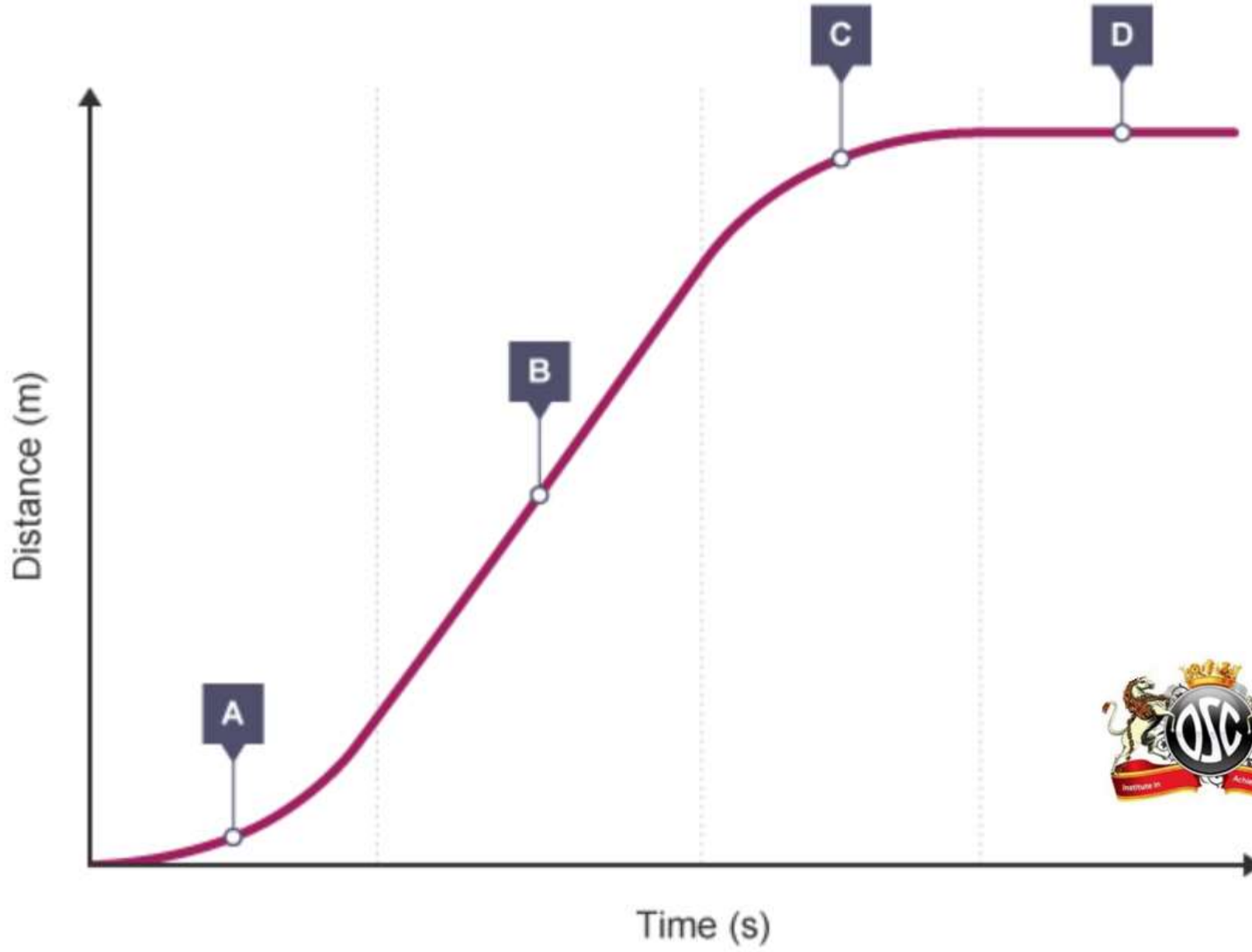
Speed, distance and time:

- **Distance** is how far an object moves. It does not include an associated direction, so distance is a **scalar** quantity.
- **Speed** is the **rate of change** of distance - it is the distance travelled per unit time. Like distance, speed does not have an associated direction, so it is a scalar quantity.

Distance-time graphs:

- In a distance-time graph, the gradient of the line is equal to the speed of the object. The greater the gradient (and the steeper the line) the faster the object is moving.
- If the speed of an object changes, it will be **accelerating** or **decelerating**. This can be shown as a curved line on a distance-time graph.


Distance travelled (m)
0
1
2
3
4
5
6
7
8
9
10
Time (s)
0
1
2
3
4
5
6
7
8
9
10
Steady speed
Stationary


C
D
B
A
Distance (m)
Time (s)

Section of graph	Gradient	Speed
A	Increasing	Increasing
B	Constant	Constant
C	Decreasing	Decreasing
D	Zero	Stationary (at rest)

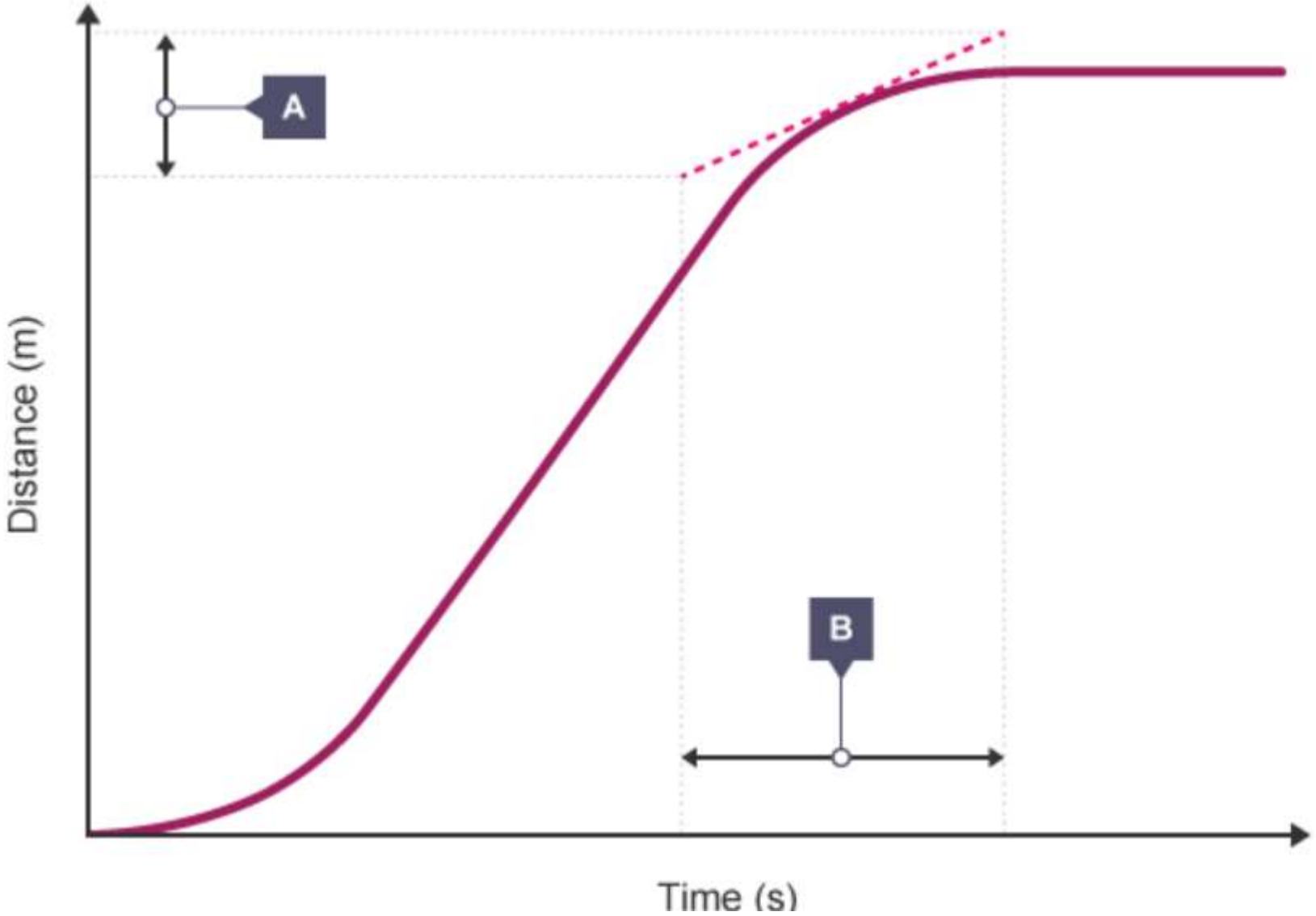
Distance-time graphs:

If an object is accelerating or decelerating, its speed can be calculated at any particular time by:

- drawing a **tangent** to the curve at that time
- measuring the gradient of the tangent

$$gradient = \frac{vertical\ change(A)}{horizontal\ change(B)}$$

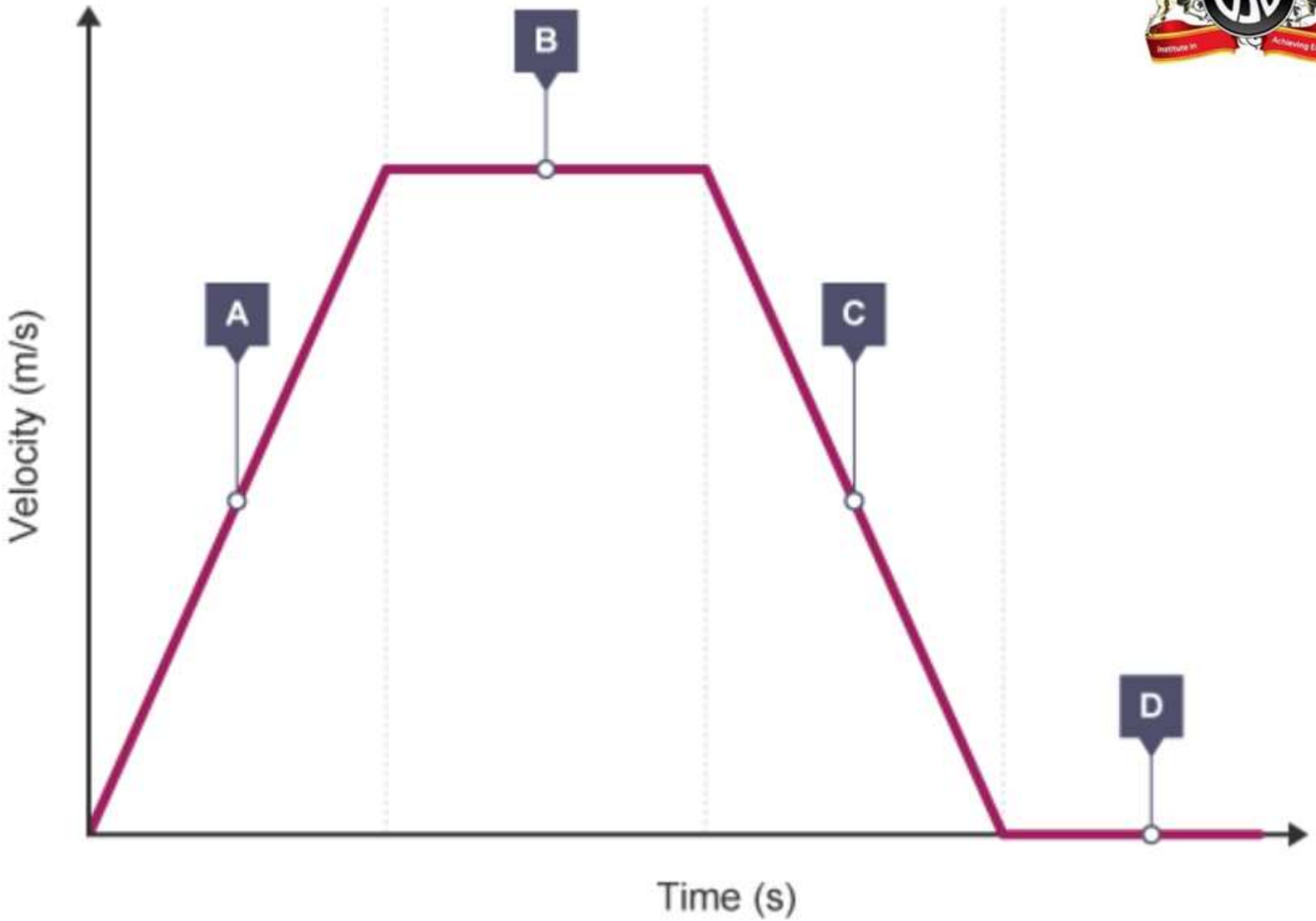
$$gradient = \frac{vertical\ change(A)}{horizontal\ change(B)}$$



Velocity-time graphs:

- If an object moves along a straight line, its motion can be represented by a velocity-time graph. The gradient of the line is equal to the **acceleration** of the object.

Section of graph	Gradient	Velocity	Acceleration
A	Positive	Increasing	Positive
B	Zero	Constant	Zero
C	Negative	Decreasing	Negative
D ($v = 0$)	Zero	Stationary (at rest)	Zero


B
A
C
D
Velocity (m/s)
Time (s)

Calculating Displacement:

- **The displacement of an object can be calculated from the area under a velocity-time graph.**

The area under the graph can be calculated by:

- using geometry (if the lines are straight)
- counting the squares beneath the line (particularly if the lines are curved)

Velocity, acceleration and distance

- This equation applies to objects in uniform acceleration:

$$v^2 - u^2 = 2\,a\,s$$

This is when:

- final velocity (v) is measured in metres per second (m/s)
- initial velocity (u) is measured in metres per second (m/s)
- acceleration (a) is measured in metres per second squared (m/s^2)
- displacement (s) is measured in metres (m)