# SP1 Motion

## 1. Vectors and Scalars

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| **Magnitude** | The size of something, such as the size of a force or the measurement of a distance. |
| **Scalar quantity** | A quantity that has a magnitude (size) only, but not a direction. |
| **Scalar examples** | Distance – 10 m<br>Speed – 25 m/s<br>Mass – 50 kg<br>Energy – 300 J |
| **Vector quantity** | A quantity that has both a magnitude (size) and a direction. |
| **Vector examples** | Displacement – 10 m north<br>Velocity – 25 m/s east<br>Force – 30 N left<br>Acceleration – 3 m/s$^2$ south<br>Momentum – 400 N m/s right<br>Weight – 600N down |
| **Vector arrows** | Vectors can be represented by arrows, with the length of the arrow representing the magnitude. |
| **Displacement** | The distance travelled in a particular direction. |
| **Velocity** | The speed of an object in a particular direction. |

## 2. Speed

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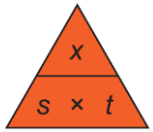
| **Speed** | A measure of the distance an object travels in a given time. |
| **Units of speed** | Metres per second (m/s) |
| **Some typical speeds** | Walking – 1.4 m/s<br>Cycling – 6 m/s<br>Speed limit in towns – 10.5 m/s<br>Ferry 18 m/s<br>Motorway speed limit – 31 m/s<br>Commuter train – 55 m/s<br>High speed train – 90 m/s<br>Airliner – 250 m/s |
| **Speed – word equation** | Speed = distance / time<br>Speed (m/s)<br>Distance (m)<br>Time (s)<br>  |
| **Speed – symbol equation** | v = x/t<br><br>v = speed<br>x = distance<br>t = time |
| **Instantaneous speed** | The speed at one particular moment in a journey. |
| **Average speed** | The speed worked out from the total distance travelled divided by the total time taken for a journey. v = x/t. |
| **Calculating distance travelled – word equation** | Distance = average speed x time<br>x = v x t<br><br>Distance (m)<br>Average speed (m/s)<br>Time (s) |
| **Measuring speed** | Measure the distance between two points and time how long an object takes to pass, then calculate using v = x/t. |
| **Light gates** | A piece of apparatus containing an infrared beam that is transmitted from a source onto a detector. If the beam is cut, the light gate measures how long it is cut for, giving a reading for time. |

## 3. Distance-Time Graphs

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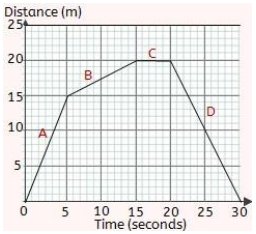
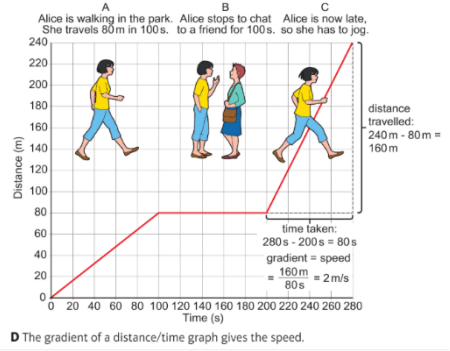
| **Distance-time graph** | A graph showing the distance travelled against time for a moving object.<br>Time is on the x-axis and distance on the y-axis. |
| **Distance-time graphs – stationary** | Horizontal line<br><br>**C** on diagram below |
| **Distance-time graphs – constant speed** | Forwards – line sloping up<br>**A and B** on diagram below<br>Backwards – line sloping down<br>**D** on diagram below |
| **Distance-time graphs – line gradient** | A measurement describing the steepness of the line on a graph.<br>Steeper line = faster, so<br>**A** is faster than **B** below |
| **Calculating speed from the gradient of a distance-time graph** | Speed = change in distance/ change in time =gradient<br><br>gradient = change in y / change in x |




## 4. Acceleration

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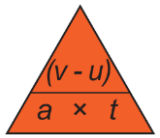
| **Acceleration** | A measure of how quickly the velocity of something is changing. Rate of change of velocity. It is positive if an object is speeding up and negative if it is slowing down. A vector quantity. |
| **An object accelerates when it…** | - Speeds up<br>- Slows down<br>- Changes direction |
| **Units of acceleration** | Metres per second squared (m/s$^2$) |
| **Positive and negative acceleration** | Positive acceleration = speeding up<br>Negative acceleration = slowing down |
| **Deceleration** | Slowing down, negative acceleration. |
| **Acceleration – word equation** | Acceleration = change in velocity / time<br><br>Acceleration (m/s$^2$)<br>Change in velocity (m/s)<br>Time (s) |
| **Acceleration – symbol equation** | a = (v – u)/ t<br>  <br>a = acceleration<br>v = final velocity<br>u = initial velocity<br>t = time |
| **Linking acceleration and distance travelled** | Use the equation:<br>$v^2 - u^2 = 2ax$ to find distance<br><br>$x = (v^2 - u^2) / 2a$<br><br>x = distance travelled<br>a = acceleration<br>v = final speed<br>u = initial speed |
| **Acceleration due to gravity (free fall)** | 10 m/s$^2$ |

## 5. Velocity-Time Graphs

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| **Velocity-time graph** | A graph of velocity against time for a moving object.<br>Time is on the x-axis, velocity is on the y-axis. |
| **Velocity-time graphs – constant speed** | Horizontal line |

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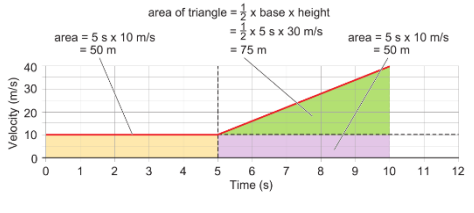
| **Velocity-time graphs – acceleration** | Speeding up – line sloping up<br><br>Slowing down – line sloping down |
| **Velocity-time graphs – stationary** | Horizontal line on the x-axis |
| **Velocity-time graphs – line gradient** | Steeper line = greater acceleration |
| **Calculating acceleration on a velocity-time graph** | Acceleration = change in velocity / change in time = gradient<br><br>gradient = change in y / change in x |
| **Calculating distance travelled from a velocity-time graph** | Distance = area under the graph.<br><br>Divide the graph into rectangles and triangles, find the area of each and add them together. |




The total distance travelled by the object in graph D is the sum of all the areas.

total distance travelled = 50 m + 50 m + 75 m = 175 m

| 6. Calculating instantaneous speed (HIGHER ONLY) | |
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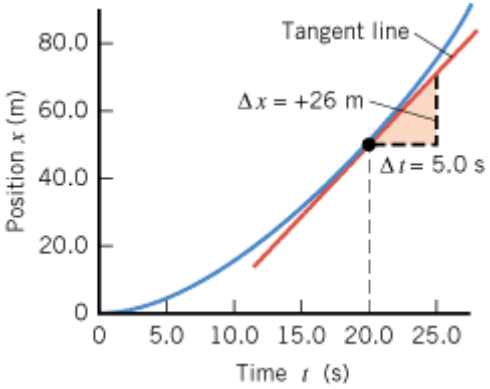
| Instantaneous speed | Draw a tangent to the curve of the graph at the time you want to calculate the instantaneous speed for.<br><br>Find the gradient of the tangent line by calculating the change in distance on the y axis and the change in time on the x axis.<br><br>Instantaneous speed = gradient of tangent = change in distance / change in time |




| Lesson | Memorised? |
|---|---|
| 1. Vectors and Scalars | |
| 2. Speed | |
| 3. Distance-Time Graphs | |
| 4. Acceleration | |
| 5. Velocity Time Graphs | |
| 6. Calculating instantaneous speed (HIGHER ONLY) | |