Yr 9 Science P2.1 Motion

Section P2.1.1- Distance, Speed and Time

Speed is measured in **metres per second (m/s)** and is how far something moves in a certain time.

$$\text{speed (m/s)} = \frac{\text{distance travelled (m)}}{\text{time taken (s)}}$$

$$\textbf{average speed (m/s)} = \frac{\text{total distance (m)}}{\text{total time (s)}}$$

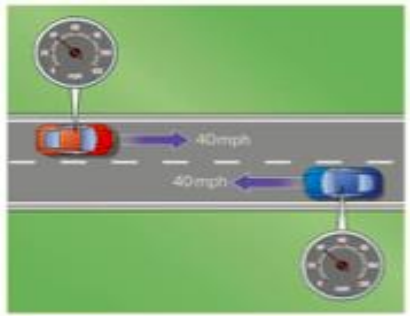
Moving object	How to measure the distance	How to measure the time
trolley moving down a ramp	use a ruler	use a stopwatch or light gates
falling object	use a ruler	use light gates

To convert km into m multiply by 1000
There are 1609 m in a mile (1609m/mile)
To convert hour into minutes multiply by 3600
To convert minutes into second multiply by 60

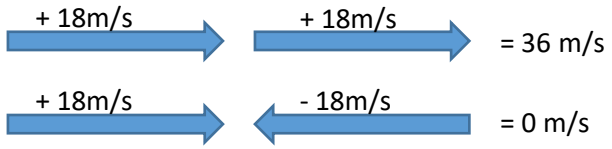
Section P2.1.2 - Scalars and Vector Quantities

Scalar quantities have magnitude (size)
e.g. speed, distance, mass, temperature and energy.
Vector quantities have magnitude (size) and direction e.g. velocity, displacement, force and acceleration.

Speed is scalar e.g. 40mph (18m/s) is a measurement of speed
Velocity is a vector e.g. 40mph (18m/s) east or west (left / right or up / down)



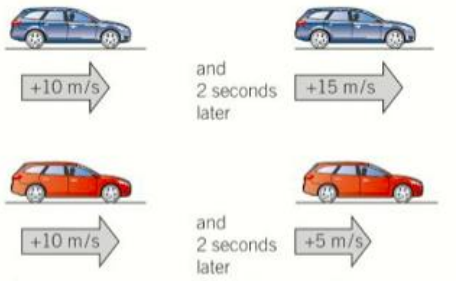
You can add vectors by taking into account direction



If you run round a 400m track you will have covered a **distance** of 400m. You will finish wear you started so your **displacement** is 0m

Section P2.1.3 - Acceleration

Acceleration is a vector quantity as it is the rate of change of velocity



$$\text{acceleration (m/s}^2\text{)} = \frac{\text{change in velocity (m/s)}}{\text{time (s)}}$$

$$\text{acceleration (m/s}^2\text{)} = \frac{\text{final velocity (m/s)} - \text{initial velocity (m/s)}}{\text{time (s)}}$$

Acceleration can be positive (+/ve) increasing velocity or negative (-/ve) decreasing velocity

	Initial velocity (m/s)	Final velocity (m/s)	Change	Change in velocity after 2 seconds (m/s)	Acceleration (m/s²)
Blue car	+10	+15	speeding up	+5	+2.5
Red car	+10	+5	slowing down	−5	−2.5

Vehicle	Time to get from 0 to 60 mph (s)
motorcycle (Suzuki)	2.4
car (Porsche)	5.0
aeroplane (777)	5.9

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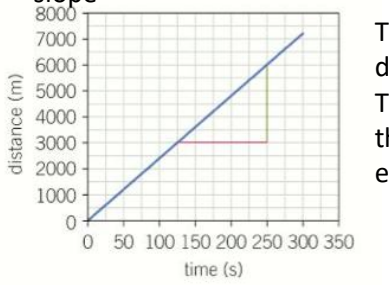
Section 2.1.4 – Distance and Displacement -Time Graphs

A **distance-time graph** can be used to calculate speed by calculating the gradient of the line or slope

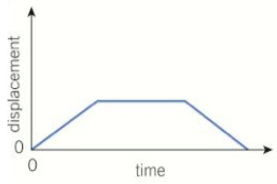


This is a simple distance-time graph. The object is moving the same distance every second.

The steeper the gradient the faster an object is travelling
A zero gradient flat means the object is stationary.

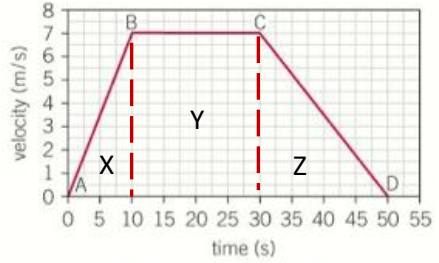
Don't forget you may have to convert mm into cm or m or even km

Distance-time graph showing total distance travelled. The object travels at constant speed away from the start then stays stationary before continuing at constant speed further from the start.



Displacement-time graph for the same journey showing total displacement. The object travels at constant velocity away from the start then stays stationary before returning at constant velocity to the start. Velocity ca be calculated by calculating the gradient of the line or slope

Section 2.1.5 – Velocity -Time Graphs



You can determine the **Acceleration** of an object from a velocity-time graph by calculating the gradient of the slope/line by applying the formula: The steeper the gradient the greater the acceleration

$$\text{acceleration (m/s}^2\text{)} = \frac{\text{change in velocity (m/s)}}{\text{time (s)}}$$

$$\text{acceleration (m/s}^2\text{)} = \frac{\text{final velocity (m/s)} - \text{initial velocity (m/s)}}{\text{time (s)}}$$

Important – you need to understand what the initial and final velocities are from the graph and the time taken to accelerate. Between A and B the initial velocity is 0 m/s and the final velocity is 7 m/s and the time taken to accelerate is 10 seconds. Between B and C the velocity is constant for 20s. Between C and D the initial velocity is 7m/s and the final velocity is 0m/s and the time taken to decelerate is 20s.

You can determine the **distance** an object travels whilst acceleration, from a velocity-time graph by calculating the area under the graph.

In the above graph you should able to make out three shapes.
Two triangles **X** and **Z** and a rectangle **Y** and shown with dotted line.
You need to find the area of each section and add them together.

Remember the area of a triangle is 0.5 x base x height

Graphs you can plot knowing what measurement you have

If you measure…	you can plot a…	… and the gradient is equal to…	…so then you can plot…	… and the gradient is equal to…
distance travelled and time	distance–time graph	speed	speed–time graph	acceleration (magnitude only)
distance from a starting point and time	displacement–time graph	velocity (speed + direction)	velocity–time graph	acceleration (magnitude + direction)

Section 2.1.6 – Equations of Motion and Kinetic Energy

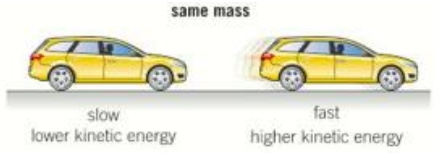
An **equation of motion** is an equation that allows you to predict the motion of an object over time. For certain conditions you can determine distance moved, acceleration, initial and final velocities. The equation you need to understand and apply is:

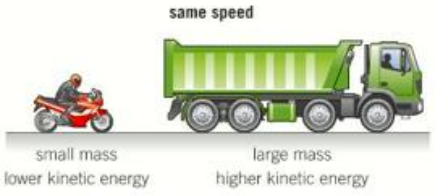
(final velocity (m/s))^2 – (initial velocity (m/s))^2 = 2 x acceleration (m/s^2) x distance (m)

You know that energy can be transferred from one store to another store. For example, a chemical energy store in petrol can be transferred to a **kinetic energy** store in a vehicle. The kinetic energy of an object is the product of half of its mass and its speed^2 . The equation to use is:

Kinetic energy (J) = 0.5 x mass (kg) x speed (m/s))^2

Important is you double the speed you quadruple the kinetic energy





Study tips

Remember that you have to square quantities *first* before you multiply, divide, add, or subtract.

If the question says 'at rest' then it means that the initial velocity is zero.