

1. Scalars and Vectors

Scalars are quantities that only have magnitude (size).
Examples include mass, time, speed, temperature, energy and distance.



Vectors are quantities that have both magnitude (size) and direction.

Examples include force, velocity, momentum, displacement, acceleration and weight.



2. Speed and Velocity

Speed (scalar) in a given direction is known as velocity (vector). Both speed and velocity are measured in metres per second (m/s).

Speed	<i>How fast an object moves</i>	The speed of a car is 30m/s. A car moves forward with a velocity of 30m/s.
Velocity	<i>Speed + direction</i>	

3. Distance and Displacement

Distance is how far an object has travelled and is a scalar. This can be measured in metres (m) or kilometres (km).



Displacement is the distance travelled in a straight line and is a vector.

An athlete runs once around an athletics track. This athlete has travelled a distance of 400m but the displacement of the athlete is 0m.

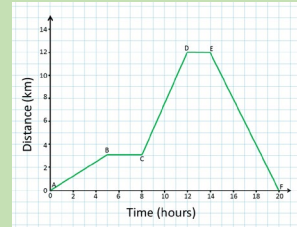
4. Distance Time Graphs

A distance time graph shows how far an object moves along a straight line.

The speed of an object can be calculated from the gradient of a line.

When the line goes flat or has no gradient, the object is stationary.

A steeper line means the object is travelling at a faster speed.



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6. Calculating Speed

Measure the distance between 2 points using a tape measure.

Measure the time taken for an object to move between the 2 points.

Use speed = distance / time

Usain Bolt runs the 100m in 9.58 seconds. Calculate his average speed.

$$\frac{100 \text{ metres}}{9.58 \text{ seconds}} = 10.44 \text{ m/s}$$



7. Acceleration

Acceleration is how quickly an object speeds up. It is also the change in velocity in a certain amount of time. It is measured in m/s/s which can be written as m/s².

Acceleration can be calculated by dividing the change in velocity (final velocity – initial velocity) by the time taken.

$$a = (v - u) \div t$$



A car accelerates from 13m/s to 31m/s in 12 seconds. Calculate the acceleration of the car.

$$\frac{31\text{m/s} - 13\text{m/s}}{12\text{s}} = 1.5\text{m/s}^2$$

5. Velocity Time Graphs

A velocity time graph shows the velocity of an object over a period of time. It simply shows how fast an object is moving.

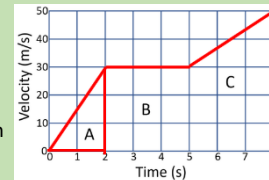
A flat line on the graph shows an object moving at constant (same) speed.

A steeper line shows the an object with greater acceleration.

A diagonal line going up shows constant acceleration (speeding up).

A diagonal line going down shows constant deceleration (slowing down).

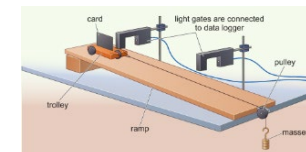
The area under a line is the distance travelled. This can either be a triangle or a rectangle.



8. Investigating acceleration

Acceleration is affected force and mass.

This can be investigated using light gates and a ramp. Light gates are used to calculate the speed at point A and the speed at point B. They also measure the time taken between point A and point B. The ramp is used to reduce the effect of friction.



Weights are added to the pulley to increase the force.

Masses are added to the trolley to increase the mass.

1. Resultant Forces

Free body diagrams are drawn to represent the forces acting on an object. The length of the arrow represents the size of the force. The resultant force is the overall effect of all the forces acting on an object.

To calculate resultant force:

- Add forces acting in the same direction
- Subtract forces acting in opposite directions



Resultant force = $5\text{N} - 2\text{N}$
= 3N left



Resultant force = $5\text{N} - 5\text{N}$
= 0N

2. Newton's first law

"A moving object will continue to move at the same speed and direction unless an external force acts on it."

"A stationary object will remain at rest unless an external force acts on it."

If the resultant force is 0N = balanced forces

If the resultant force is not 0N = unbalanced forces

Unbalanced forces change the speed and/or direction of an object.



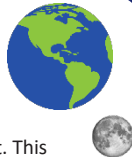
Balanced forces



Unbalanced forces

3. Mass and Weight

Mass is the quantity of matter there is in an object. Mass is measured in kilograms (kg).



Weight is a measure of the pull of gravity on an object. This depends on the size of gravity.

Weight is a force so is measured in Newtons.

Weight can be calculated by multiplying the mass by the gravitational field strength.

Weight (N) = mass (kg) x gravitational field strength (N/kg)

What is the weight of a 90kg astronaut on the surface of Earth.

Earth has a gravitational field strength of 10N/kg.

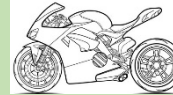
$90\text{kg} \times 10\text{N/kg} = 900\text{N}$

4. Newton's second law

"Acceleration depends on the size of the force and the mass of an object."

The force needed to accelerate a particular object can be calculated using the equation:

$$\text{Force (N)} = \text{mass (kg)} \times \text{acceleration (m/s}^2\text{)}$$



A motorcycle has a mass of 200kg.

What force is needed to give it an acceleration of 7m/s^2 ?

$$200\text{ kg} \times 7\text{m/s}^2 = 1400\text{N}$$

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6. Momentum (H)

Momentum is a measure of the tendency of an object to keep moving – or how hard it is to stop it moving.

The momentum of an object depends on its mass and its velocity.

Momentum is calculated using the following equation:

$$\text{Momentum (kg m/s)} = \text{mass (kg)} \times \text{velocity (m/s)}$$

When moving objects collide, the total momentum of both objects is the same before the collision as it is after the collision.

This is called **conservation of momentum**.

7. Stopping Distances

In order to stop a moving vehicle, the driver has to think about stopping before they press the brakes to actually stop the vehicle.

$$\text{Stopping distance (m)} = \text{thinking distance (m)} + \text{braking distance (m)}$$

A driver's reaction time will affect the distance travelled whilst thinking. Some factors that affect reaction time include:

- Tiredness
- Drugs
- Alcohol
- Distractions

The braking distance of a car is dependent on friction. Some factors that affect the braking distance include:

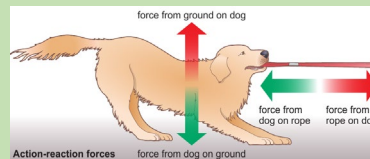
- Mass
- Road conditions
- Tyre conditions
- Brake conditions



5. Newton's third law

"Balanced forces act on the same object. Action-reaction forces act on 2 different objects."

Action reaction forces are always the same size and in opposite directions. They are also the same type of force (push or pull).



The rope pulls the dog to the right and the dog pulls the rope to the left.

8. Crash Hazards

In a car crash, the vehicles come to a stop very quickly in a short amount of time.

Slowing down is deceleration (negative acceleration).

Large decelerations can cause injury and unfortunately in some instances, death!

Modern cars have several safety features to reduce the size of the force on the driver and passengers.

1. Crumple zones
2. Seat belts
3. Air bags



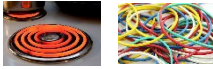
1. Energy stores

Energy is needed to make things happen or change. It is scalar quantity measured in Joules (J).

1. **Chemical** (food, fuel and batteries)



2. **Kinetic** (moving objects)



3. **Thermal** (hot objects)

4. **Elastic potential** (stretched, squashed or twisted objects)

5. **Gravitational potential** (objects in high positions)



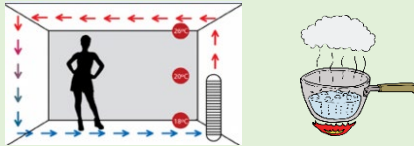
6. **Nuclear** (inside atoms)



4. Convection

Energy can be transferred by convection.

As particles in the liquid or gas state gain energy, they become less dense and start to rise. This generates convection currents and explains why an entire room heats up despite only having one radiator on one wall.



6. Stored Energies

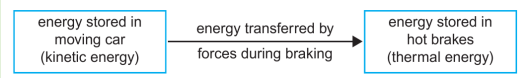
Objects stored at a height have the potential to fall. This is known as gravitational potential energy (GPE). This potential energy is then transferred to kinetic energy if the object falls towards Earth due to the force of gravity. If no energy is wasted $GPE=KE$.

$$\text{Change in gravitational energy (J)} = \text{Mass (kg)} \times \text{Gravitational field strength (N/kg)} \times \text{Change in vertical height (m)}$$

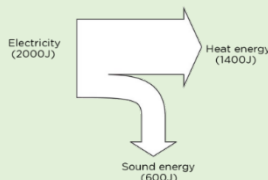
$$\text{Kinetic energy (J)} = \frac{1}{2} \times \text{Mass (kg)} \times (\text{velocity})^2$$

2. Energy efficiency

The law of conservation of energy states that energy cannot be created or destroyed. Sometimes energy is transferred to less useful stores such as the thermal energy. This energy is **dissipated**.



Sankey diagrams show the transfer of energy. This Sankey diagram shows the energy transfer in a kettle.



$$\text{Efficiency} = \frac{\text{useful energy}}{\text{total energy}}$$

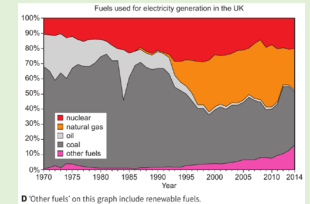
CP3 CONSERVATION OF ENERGY



7. Non-renewable Energy Sources

Non-renewable resources are those that generate electrical energy which are finite. This means they will run out one day. They include fossil fuels (coal, oil and natural gas) as well as nuclear fuel (uranium).

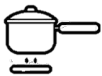
Fossil fuels release carbon dioxide and other greenhouse gases which contribute to climate change. As coal is the most damaging its use has been reduced in recent years.



3. Conduction

Energy can be transferred by conduction.

Conduction involves the transfer of energy in solids between neighbouring particles.



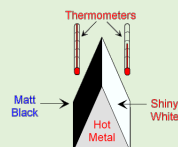
Metals are good thermal conductors and are said to have high thermal conductivity.

Wood and plastic are poor thermal conductors. These are examples of thermal insulators which have a low thermal conductivity.

5. Radiation

Energy can be transferred by radiation.

Infrared and ultraviolet radiation from the Sun travel through a vacuum (an area with no particles) before reaching Earth's atmosphere.



Infrared radiation can travel through gases and some solid materials. Infrared radiation is absorbed and emitted easily by dull, dark surfaces but absorbed and emitted poorly by light, shiny surfaces.

8. Renewable Energy Sources

Renewable resources are those that generate electrical energy that will not run out. They are generally better for the environment as they produce less greenhouse gases. However, renewable sources can have an environmental cost to install them.

They include biofuels, hydroelectricity, wind and solar. The use of these have increased in recent years.

