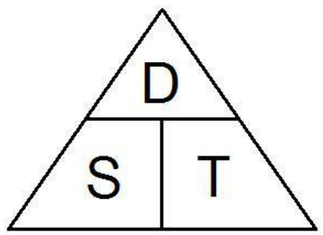
GCSE Science – Physics 2

2.1 – Speed

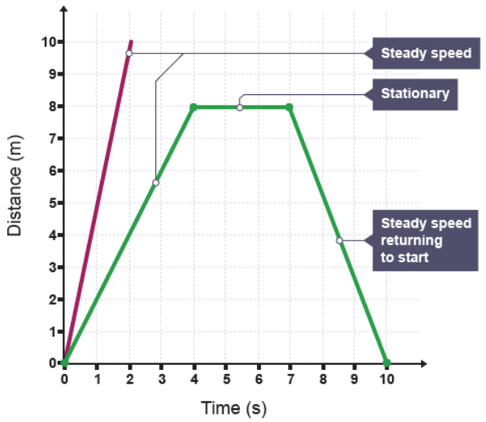
When an object moves in a straight line at a steady speed, you can calculate its average speed if you know how far it travels and how long it takes. The following equation shows the relationship between average speed, distance moved and time taken.

$$average\ speed = \frac{distance\ moved}{time\ taken}$$



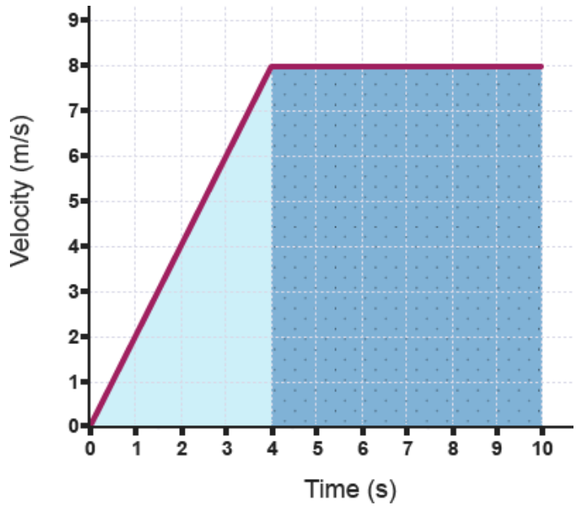
Speed time graph

Note that the steeper the line, the faster the object is travelling. The purple line is steeper than the green line because the purple line represents an object which is moving more quickly



2.2 – Velocity

The **velocity** of an object is **its speed in a particular direction**. Two cars travelling at the same speed but in opposite directions have different velocities.
When an object is moving with a constant velocity, the line on the graph is horizontal. When the horizontal line is at zero velocity, the object is at rest. When an object is undergoing constant **acceleration**, the line on the graph is straight but sloped.



2.3 – Newtons first law

Newton's First Law states that a body will continue in its state of rest or **uniform motion**, in a straight line unless a net or **resultant force** acts upon it.
This simply means that balanced forces will have no effect on the motion of an object.

- It could be still.
- It could be moving at constant velocity (a steady speed in a straight line).
- It could be hovering or floating

Newton's Second Law

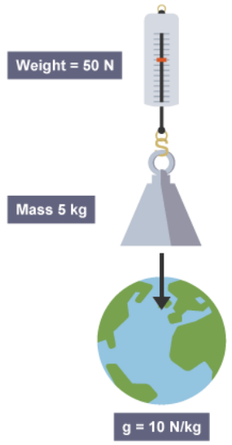
When the forces acting on an object do not balance, the **resultant force** will cause the object to **accelerate** in the direction of the resultant force.

Resultant force and acceleration are **directly proportional**. If the resultant force doubles, the acceleration of the vehicle also doubles if the mass of the vehicle is the same.

2.4 – Weight and mass

Mass is the amount of matter in an object. Mass is measured in **kilograms** (kg).

Weight is the force of gravity on your mass. **Gravity** is a force that attracts mass together.



On Earth, the gravitational field strength (g) is 10 N/kg which means that the mass of the Earth attracts every 1 kilogram mass with a weight force of 10 Newtons. Therefore, 1 kg mass has a weight on Earth of 10 N and a 5 kg mass will weigh 50 N.

$$weight\ (N) = mass\ (kg) \times gravitational\ field\ strength\ (N/kg)$$

2.5 – Work done

Work is done when a force acts on a moving body. Work is done whenever a force moves something.
Whenever work is done, energy is transferred from one place to another. The total amount of energy remains constant.

$$Work\ done = Force \times Distance$$

W is measured in joules, J
F is measured in newtons, N
d is measured in metres, m

So in the example above 10N of force is applied over 2m.

Work done = Force x Distance

Work done = 10 x 2 = 20J

2.6 – Car safety

When there is a car crash, the car, its contents and the passengers **decelerate** rapidly. They experience great **forces** because of the change in **momentum**, which can cause injuries. Modern cars have safety features that absorb **kinetic energy** in collisions.

Seat belts

Seat belts stop you tumbling around inside the car if there is a collision. However, they are designed to stretch a bit in a collision. This increases the time taken for the body's momentum to reach zero, and so reduces the forces on it.

Airbags

Airbags increase the time taken for the head's momentum to reach zero, and so reduce the forces on it. They also act as a soft cushion and prevent cuts.

Crumple zones

Crumple zones are areas of a vehicle that are designed to crush in a controlled way in a collision. They increase the time taken to change the momentum of the driver and passengers in a crash, which reduces the force involved.

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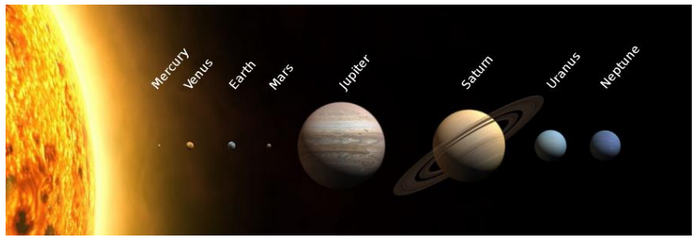
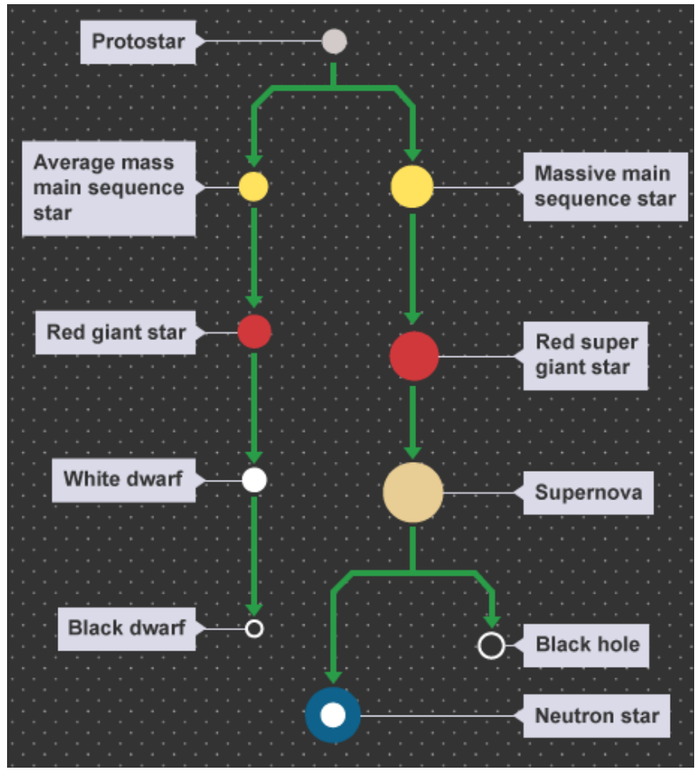
2.7 – Solar system



The Sun is our nearest **star**. The planets **orbit** the Sun.
The time taken to orbit the Sun **increases with distance** from the Sun.
Gravity keeps the planets in orbit around the Sun and the moons in orbit around their planets.
The **planets** go around the Sun in slightly squashed circular **elliptical orbits**.
Pluto is classified as a **dwarf planet** or planetoid. It has a highly elliptical or **eccentric orbit**.

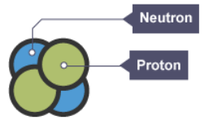
Comets are balls of rock and ice. The ice melts as the comet gets closer to the Sun, producing its 'tail'. They have highly elliptical or eccentric orbits.	**Asteroids** are large rocks that are mainly found in a belt between Mars and Jupiter. A dwarf planet called Ceres can be found in this asteroid belt. The rocks in the asteroid belt may be remnants of a planet that failed to form due to the strong gravitational attraction of Jupiter.

2.8 – Life cycle of a star



2.9 – Radioactive emissions

There are three main types of **ionising radiation** emitted from the unstable **nuclei** of **radioactive atoms**. These are alpha, beta and gamma radiation.



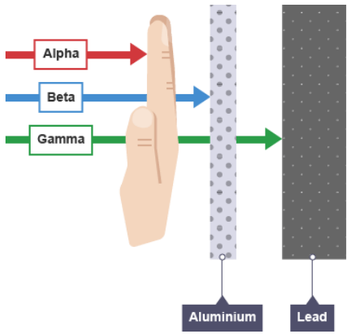
- Alpha radiation consists of **alpha particles**. An alpha particle has two **protons and** two **neutrons**.
- **Beta radiation** consists of high-energy **electrons** emitted from the nucleus. These electrons have not come from the electron shells or energy levels around the nucleus. Instead, they form when a neutron splits into a proton and an electron. The electron then shoots out of the nucleus at high speed, leaving the new proton behind in the nucleus.
- Gamma **radiation** is very short **wavelength**, high **frequency electromagnetic radiation**. This is similar to other types of electromagnetic radiation, such as visible light and X-rays, which can travel long distances.

2.10 – Properties of radiation

Alpha radiation
Alpha radiation is the least penetrating. It can be stopped (or absorbed) by a human hand.

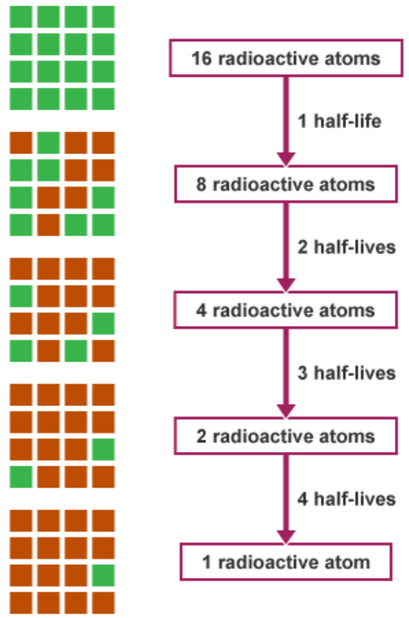
Beta radiation
Beta radiation can penetrate air and paper. It can be stopped by a thin sheet of aluminium.

Gamma radiation
Gamma radiation is the most penetrating. Even small levels can penetrate air, paper or thin metal. Higher levels can only be stopped by many centimetres of lead or many metres of concrete.



2.11 – Half life

When an **unstable nucleus** gives out an alpha or beta particle, the nucleus turns into the nucleus of a new element. This process is called **radioactive decay**.
Although radioactive decay is a **random** process, statistically, over a time called the **half-life**, half of the parent radioactive nuclei will have decayed.



In this decay model, the green squares represent the parent unstable nuclei. They decay into the red squares – the **daughter nuclei**.
The process is random. You can't tell when a green will turn into a red, or which green will decay, but after every half-life, half of the green parents will have decayed into red daughters.

6 – Uses of radiation

Sterilizing medical instruments and prolonging the life of fruit
Gamma radiation kills microbes and can be used to sterilize medical instruments and kill the bacteria on fruit and vegetables so they stay fresh longer.

Smoke alarms
An isotope of americium which emits **alpha particles** is used in smoke alarms. Alpha radiation **ionises** the air and this allows a small current to flow between two electrodes. Alpha is weakly penetrating so smoke stops it, the current drops and the alarm goes off.

Blood and fluid tracers
A tracer is something that shows how an object moves. **Radioactive tracers** are added to liquids to show if they are flowing correctly. They can show the movement of pollution, eg sewage or waste oil from factories. However, they are used mainly in medicine to monitor blood flow.