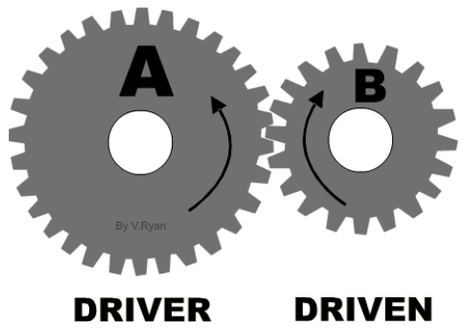
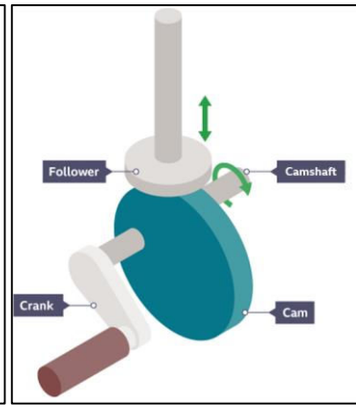
Year 9

Knowledge organiser 1: Resistant Materials

Physical property	Usage example
Density - amount of matter a material has to its volume	Low-density foams, eg low density polyethylene (LDPE), can be used as low-weight, shock absorbing packaging materials to protect fragile items
Absorbency - ability to retain heat, light or water in a structure	Paper towels are absorbent and are used to soak up liquid spills or dry wet hands
Conductivity - ability of heat (thermal) or an electric charge (electrical) to pass through	Wooden handles are used on saucepans as they are poor thermal (heat) conductors, and copper is used for wires in power cables as they are good electrical conductors
Corrosive resistance - ability to withstand chemicals, water and weather conditions, eg snow	Glass is used in external windows as it maintains its transparency for a long time in most weather conditions
Flammability - ability to ignite (catch on fire) or combust (burn)	Specially engineered ceramics are used in brake pads for high-performance motorbikes as they have low flammability, and can be used in places where high-friction occurs

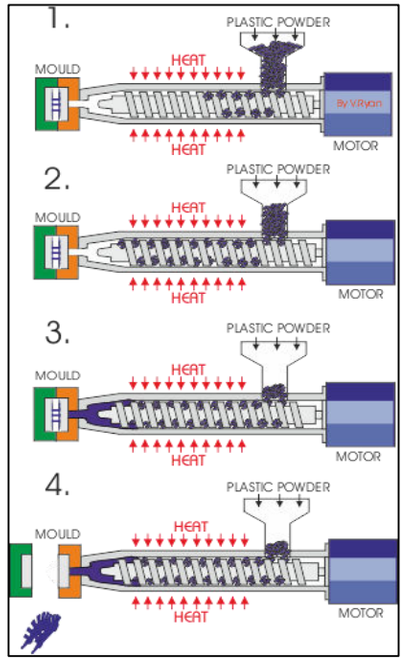




The gears shown below are called spur gears because they mesh together. Gear 'A' is called the 'driver' because this is turned by a motor. As gear 'A' turns it meshes with gear 'B' and it begins to turn as well. Gear 'B' is called the 'driven' gear.

To find out more:
https://www.bbc.co.uk/bitesize/guides/zh4g4qt/revision/1

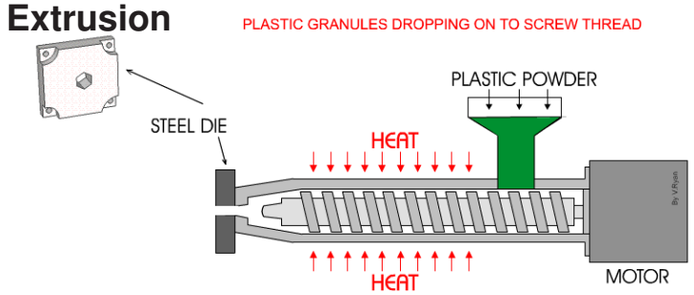
Injection moulding



Injection moulding
Injection moulding is used in industry to produce most **mass-produced** polymer parts using the following process:
1.granular plastic is held in a hopper
2.it is moved via an **Archimedean screw** along a heated tube, called the heating chamber
3.once the polymer has been melted, it is pushed **into a mould** with a **hydraulic ram** - the use of the hydraulic ram ensures just enough material is injected into the mould each time
4.the mould is then cooled so that the moulded plastic can be removed

Extrusion
Extrusion works in a very similar way to injection moulding:
1.granular plastic is held in a hopper
2.it is moved by Archimedean screw along a heated tube, called the heating chamber
3.once the polymer has been melted it is pushed **through a die mould,** which will form the shape of the extrusion
4.because there is no hydraulic ram in this process, molten plastic can be fed through the die continuously

Extrusion



Thermosetting: Also called 'thermoset'. Can only be formed once as it cannot be reheated and therefore cannot be recycled.

Thermoforming: Also called 'thermoplastic'. Can be reformed when heated, and therefore can often be recycled.

Scales of production

Prototype and one-off production
In one-off production an individual item is designed and made to meet a client's specification. At this level both time and material costs are high, and a high level of design and manufacturing skills is required. An example of a one-off product is a specialist powered wheelchair for a user with specific disabilities, which may require skills like the **soldering** of switches to allow for operation of the controls for specific movements.

Batch production
Batch production is where many items of the same product are produced. It will involve the use of some **automation** to reduce labour costs and will require the design engineer to consider how materials can be used efficiently and how samples can be tested to ensure quality. An example of a batch produced product would be the **etching** of a printed circuit board (PCB) for a small team of specialist racing drones.

Mass production
Manufacturing in huge numbers is categorised as mass production. This level of production involves standardised production methods, **production lines** and the extensive use of automation. Because of the high set-up costs, mass production systems tend to be inflexible. An example of a mass produced item would be a polyethylene terephthalate (PET) drinks bottle made using a blow moulding system.

Some Products Aren't Designed to Last but Some Are

1) Some products are designed to become obsolete (useless) quickly. E.g. a disposable razor becomes blunt after a few uses and its blade can't be sharpened or changed. This is planned obsolescence.
2) Products with up-to-the-minute designs or technology become obsolete quickly because they go out of fashion. E.g. people often replace their mobile phone when a new, fancier model comes out.
3) Built-in obsolescence is generally bad for the environment — because more materials and energy are used to make replacement products.
4) However, products can be designed to last and have less of an impact on the environment. This involves making the product durable, and designing it so that parts can be maintained and repaired or replaced. This is known as design for maintenance.

- Most household appliances are designed to be maintained and repaired — this makes sense as they're expensive and just replacing them when they break would be wasteful as they are made of lots of parts.
- For example, washing machines can be maintained (e.g. cleaning filters) and they can be repaired by trained technicians when they break, e.g. by installing a new part rather than having to replace the whole thing.

- Another example is the idea of making modular electronics. This has been proposed for mobile phones and other electronics that are often updated like tablets, laptops, cameras and music players.
- The idea is that electronics are made up of different parts (or modules) that are designed so that they can be individually upgraded and replaced. E.g. with a modular phone you could replace the processor for a faster one when it starts to get a bit slow or the battery when it wears out. This is an alternative to getting a completely new phone when only one part of it breaks down, which cuts down a lot of electronic waste (which often ends up going to landfill because it's difficult to recycle).

Aesthetics relate to the way a material looks, and each example of timber has a different pattern on the grain and texture. The way a timber looks can be altered through several methods:
•staining
•varnishing
•oiling
•waxing
•painting
•laminating

Stain: To alter the colour.

Laminating: Bonding layers of material together to improve strength.

Varnish: A protective treatment.

Oil: A high carbon and hydrogen liquid that does not mix with water. Oil is usually rubbed into the surface of a timber to protect it and enhance the aesthetic quality.

Wax: A solid compound at room temperature that contains fat. Wax is usually rubbed or brushed into the surface of a timber to protect it and enhance the aesthetic quality

Paint: A pigment suspended in a liquid. Solid forms need to be mixed with oil or water. Paint is usually brushed or sprayed onto a surface to alter the colour of the material.

Finishing metals

Metals can also be affected by different environmental elements such as temperature and moisture and ferrous metals, such as iron, can oxidise and **rust** if left exposed. Finishing procedures are often applied to metal to protect them. Finishing is also often applied for aesthetic reasons to make it more pleasing to look at or to touch. Because metal surfaces can be cold and slippery, sometimes they are given a coating a certain type of finish to change this.

Paint is a common finish applied to bare metal surfaces. Once the surface is smooth the painting process can start, very much like painting timber:
1.a basecoat or primer is applied first, which will show blemishes that would only stand out more with paint
2.rubbing down again before painting is important
3.once the primer coat is perfect, a layer of paint can be brushed or sprayed on
4.layers can be built up until the colour is even
5.a final **lacquer coat** can be added so that the paint is protected, and the final finish is shiny

Paint:

Dip coating is a popular finish for the handles of many tools and coat hooks. It is a straightforward process:
1.a piece of metal is heated up to around 250°C
2.once hot, it is then dipped into a **polyethylene** in powder form
3.this has air blown through it so an even coating of the powder is dusted onto the hot metal, resulting in a smooth and shiny coating on the dipped metal

Powder coating is a method of attracting paint in a powder form towards an electrically charged object:
1.paint that is in powder form is sprayed from a paint gun
2.the paint is attracted to the electrically charged object
3.a fine and even coat of powdered paint covers the surface of the product and, once heated, the powder melts and produces a 'run free' paint finish

Lacquering is a method of applying a clear varnish that prevents the metal rusting or oxidising while allowing the natural finish of the metal to be on show. It is a straightforward process:
1.the surface is cleaned and polished so it is free of imperfections
2.a varnish is sprayed onto the surface
3.the varnish is cured using UV light
Some metal products that are made from **steel**, such as watering cans and lamp posts, would **rust** if they were not protected. A common process that is used to protect such products is **galvanising**. Steel products are given a zinc coating by dipping them into the molten **zinc**. For example, corrugated steel roofs of farm buildings and sheds are often made from steel that has been galvanised. After a few decades, the galvanised coating will wear because of acid in the rain and the steel will start to rust, so the roof will need replacing one day.

Powder coating: