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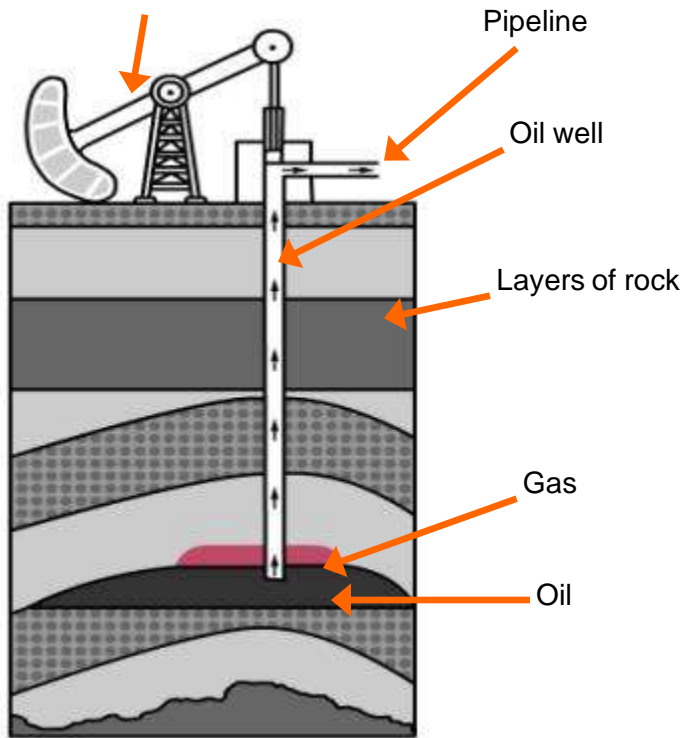
Plastic

Plastic materials were first used at around 2000BC.

Plastics can occur naturally in trees or even milk; amber is an example (a resin from trees and insects). Amber was used by early Egyptians to make jewellery and is still used for this purpose today.

Today, numerous different plastics are available. Some are still made from natural materials but most modern plastics are manufactured from chemicals obtained from crude oil. Plastics manufacturers convert chemicals into plastics.

**The word 'plastic'
means 'easily shaped
or moulded'.**



- We obtain crude oil from under ground, either on land or at sea.
- After it has been pumped, it is heated in a fractioning tower and broken down into chemicals.
- The chemicals consist of nitrogen, carbon, chlorine, sulfur and water.

As plastics are non-degradable in recent years new methods have been produced to produce plastics in response to the growing concerns with the environment, a degradable plastic has been produced, this plastic uses chemical reactions to naturally break down after a set amount of exposure to UV light. Many companies already use this types of plastic however it produces methane gas when it decomposes (not so good for the environment). Although more recently a new type of plastic Bio-plastic has been produced with the aid of genetically modified sugar cane plants and sweet potato plants instead of crude oil. These plastics are great as they don't use the diminishing supply of oil, they don't produce any gasses during production and they break down naturally when thrown away. Many companies in Japan have already begun using these and in Europe Ikea, Lego and Nike are just a few name brands using them.

Types of plastic and their abbreviations:

Recycling No. Recognised Abbreviation Full name and description

	PET	Polyethylene terephthalate - Fizzy drink bottles and oven-ready meal trays.
	HDPE	High-density polyethylene - Bottles for milk and washing-up liquids.
	PVC	Polyvinyl chloride - Food trays, cling film, bottles for squash, mineral water and shampoo.
	LDPE	Low density polyethylene - Carrier bags and bin liners.
	PP	Polypropylene - Margarine tubs, microwaveable meal trays.
	PS	Polystyrene - Yoghurt pots, foam meat or fish trays, hamburger boxes and egg cartons, vending cups, plastic cutlery, protective packaging for electronic goods and toys.
	OTHER	Any other plastics that do not fall into any of the above categories. - An example is melamine, which is often used in plastic plates and cups.

Below is a list of **Types of plastic and their melting points** (when deforming or reforming plastics **make sure you heat them to just below their melting points**)

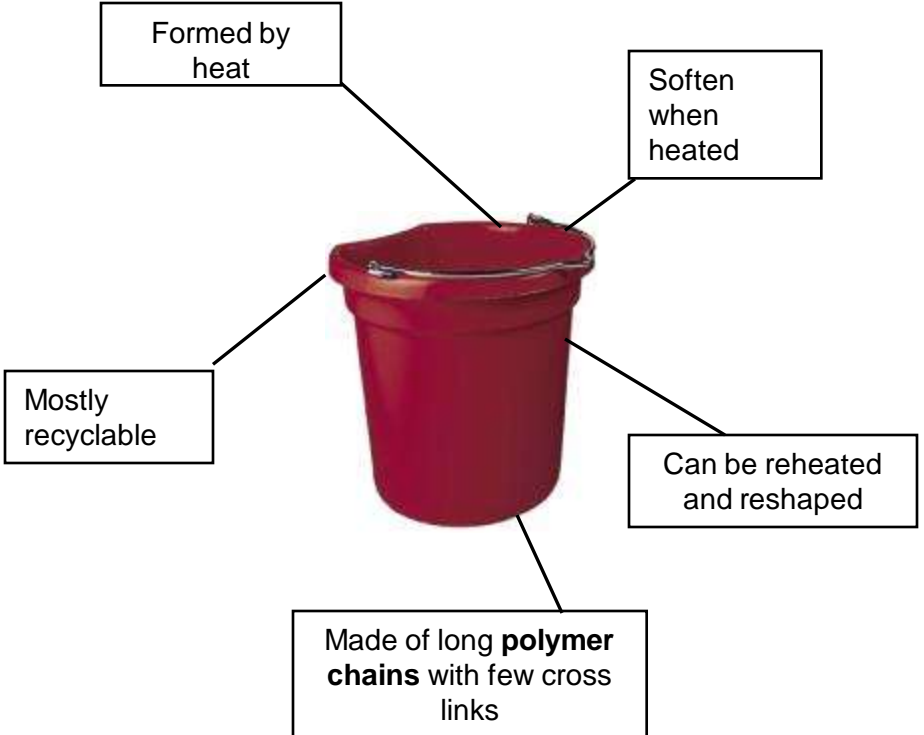
Name of plastic	Melting Point (°C)
Acetal Copolymer	200
Acetal Copolymer + 30% Glass Fiber	200
Acrylic	130
Nylon 6	220
Nylon 6 + 30% Glass Fiber	220
Polyethylene, HDPE	130
Polyethylene Terephthalate (PET)	250
PET + 30% Glass Fiber	250
Polypropylene	160
Polypropylene + 30% Glass Fiber	170
Polystyrene	N/A
Polycarbonate	N/A

Remember when shaping plastic heat them to just under their melting point.

There are two main groups of plastics:

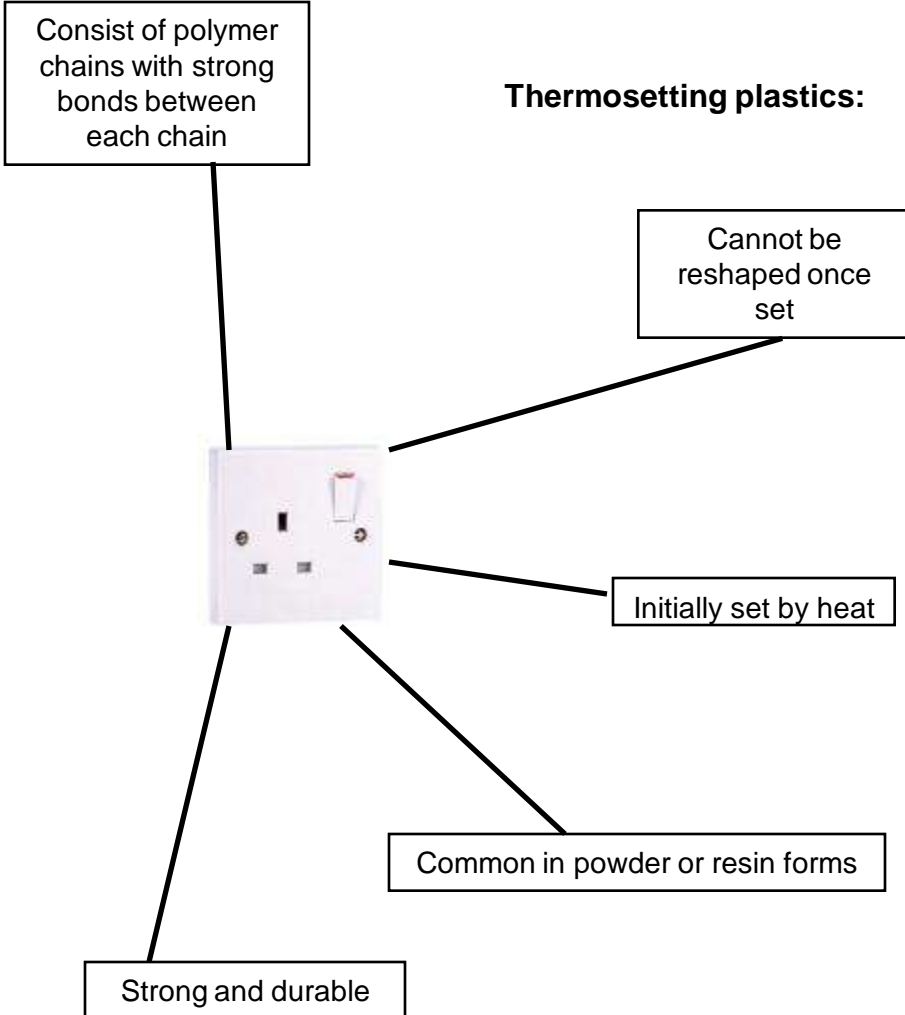
- **thermosetting plastics**
- **thermoplastics**

Thermoplastic plastics:



When thermoplastics are heated the bonds between the molecules are weakened and can slid easily into new positions (or towards their original position)

Thermosetting plastics:

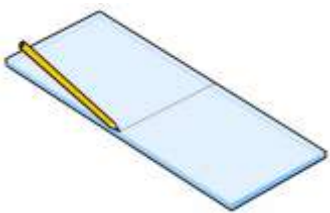


When thermosetting plastics are heated the molecules can not move because when these plastics are formed they go through an irreversible process called 'curing' this links all the molecules together so they can not move.

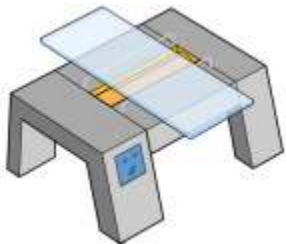
There are many ways to shape plastics below is a short list of some of the most common methods used in schools and industry though not limited to:

- Injection moulding
- Blow moulding
- Vacuum forming
- Line bending

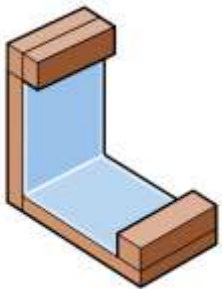
Line bending (strip heating)



The line to be heated is marked on the plastic (for thick pieces over 3mm mark the line on both sides as the plastic will need to be heated on both sides).



The sheet is placed over the heating element and turned frequently if necessary.

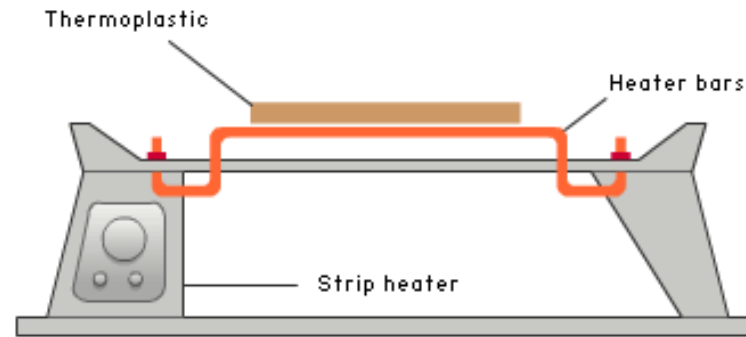


When the plastic becomes elastic along the bend line it can be folded round a former and held in place to cool.

The line bender is a simple but effective way of getting a straight line in a piece of plastic.

The machine is a nickel-chrome wire stretched in a straight line with a table rest for the plastic, the nickel-chrome heats up and softens the plastic just along the strip that is directly above the wire.

To avoid burning from the hot plastic or the open heater always wear heat proof gloves.



Injection moulding:

The process is used to produce large quantities of identical plastic items. One of the most common types of **thermoplastics** used in injection moulding is **high impact polystyrene** (HIPS) though nylon, polypropylene and polythene can also be used.

Injection Moulding can produce such small products as bottle tops; sink plugs, children's toys and also used to manufacture larger items such as dustbins, and milk crates. The process can even mould such large items as dingy hulls and kit car body shell parts.

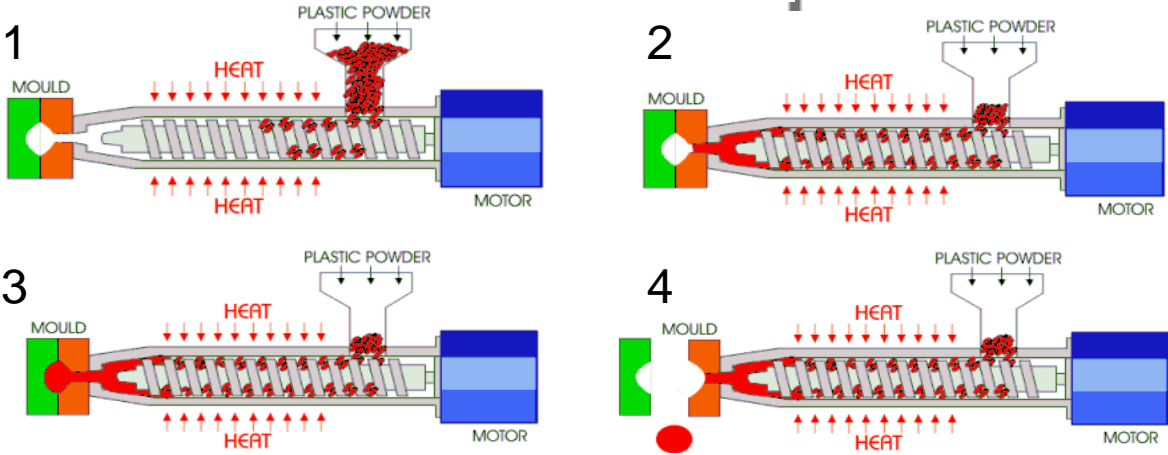
Due to the high cost of the machines and the moulds the process is only suitable for long term production runs, once the machines are in place the production method is relatively cheap.

When injection moulding its important to make sure that the mould is warm or hot before injection moulding otherwise the cold metal mould can cool the liquid plastic down quickly so the liquid sets before the mould is full. This results in a partially formed mould (not good)

For this process the plastic is heated to **VERY HOT** temperatures so **gloves** must be worn at all times and

You **should leave the mould** for a **few minutes** to **cool down** before taking it out

The Steps



1. Granules of plastic powder (note the plastics listed above) are poured or fed into a hopper which stores it until it is needed.
2. A heater heats up the tube and when it reaches a high temperature a screw thread starts turning.
3. A motor turns a thread which pushes the granules along the heater section which turns the plastic to a liquid.
4. The liquid is forced into a mould where it cools into the shape (in this case a sphere).
5. The mould then opens and the sphere is removed

Blow moulding

PVC, polythene and polypropylene are commonly used in blow-moulding.

this process is mainly used for making bottles, plastic buckets and similar shapes. A tube of softened (heated) plastic called a parison is extruded into a mould, then the mould is clamped closed at one end. Air is then blown under pressure into the interior of the parison, which expands to fill the mould and create the desired shape.

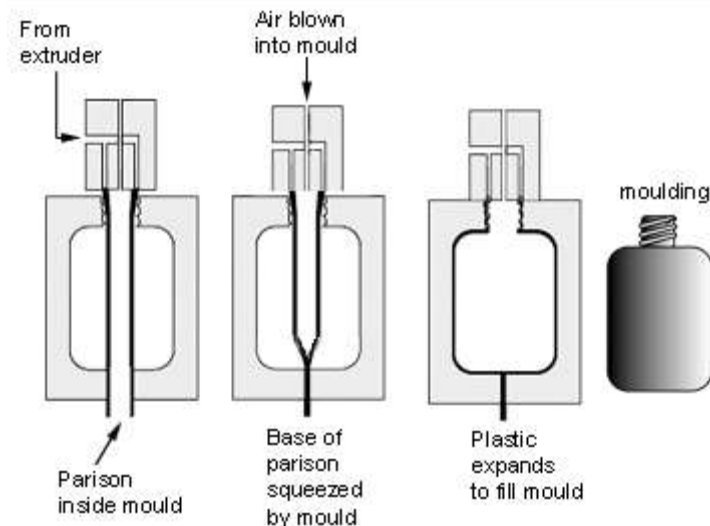
In general there are three main types of blow moulding:

blow moulding; Extrusion Blow Moulding, Injection Blow Moulding, and Stretch Blow Moulding.

The diagram below shows Stretch blow moulding:

In the Stretch Blow Moulding process, the plastic is first moulded into a "preform" using the Injection Moulding Process. These preforms are produced with the necks of the bottles, including threads (the "finish") on one end. These preforms are packaged, and fed later (after cooling) into the blow moulding machine. Then heated, then blown using high pressure air into bottles using metal blow moulds. Usually the preform is stretched with a core rod as part of the process. The stretching of some polymers, such as PET (Polyethylene Terephthalate) results in strain hardening of the resin, allowing the bottles to resist deforming under the pressures formed by carbonated beverages, which typically approach 60 psi.

With this process you are handling hot plastic so care must be taken to, and heat resistant gloves are to be worn.



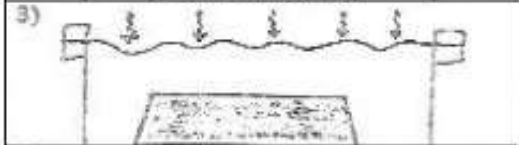
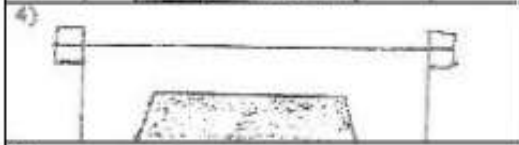

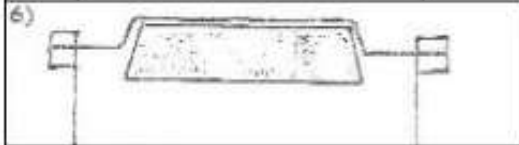




Vacuum forming

Suitable thermoplastics for vacuum forming include acrylic, polystyrene and PVC.

This process normally uses a wooden mould called a form though it doesn't have to be made from wood.

A sheet of thermoplastic is heated, then shaped by creating a vacuum underneath it. Air pressure then forces the plastic over the form. Vacuum forming is often used for food and confectionary packaging, trays, shop fittings and baths.

1) 	Mould is placed inside machine.
2) 	Plastic is clamped in place.
3) 	Plastic is heated, you will notice a rippling or sagging effect in the plastic when it is hot enough for forming.
4) 	The rippling effect will subside, and the plastic will appear straight. Now the heat is removed.
5) 	Quickly the mould (form) needs to be raised to the plastic.
6) 	The vacuum is turned on causing the air pressure to force the plastic round the form.
7) 	A short burst of air is blown in through the form to separate it from the plastic.
8) 	The plastic is now ready to be cut into shape and used.

Polishing Plastic

1



You must first clean and flatten (or shape) the surface this can be done with a file, usually you will start with very rough files and work down to the finer ones.

2



Next you will work through the various types of wet and dry paper starting with the roughest then gradually working down to the finest paper to get a smooth finish.... To keep the surface flat wrap the wet and dry paper round a file.

3



By applying some special plastic polish or even metal polish it is possible to get a professional finish

As plastic is toxic you must never sand acrylic on an electric sander or blow acrylic dust.

References:

Design Technology Resistant materials GCSE
Revision guide

Author: Letts

ISBN: 1-84315-020-4

[Http://i16.ebayimg.com/03/i/05/33/9f/28_1.JPG](http://i16.ebayimg.com/03/i/05/33/9f/28_1.JPG)

<http://www.bbc.co.uk/schools/gcsebitesize/design/resistantmaterials/>

<http://www.matweb.com/reference/deflection-temperature.asp>

Software: boardworks Ltd 2005 resistant
materials (support materials for teachers)