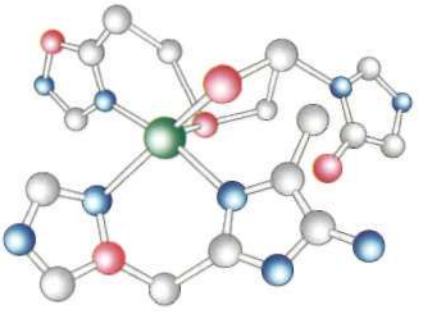
Polymers

Natural and synthetic polymers

The web page below, from a website for engineering students, provides an introduction to polymers.

With names such as polytetrafluoroethyline and polyethyleneteraphthalate, it's not surprising that polymers are usually called by their more common name, **plastic**. But what, exactly, is a polymer or a plastic?

Polymers are compounds made up of several elements that are chemically bound. Most compounds consist of large numbers of tiny **molecules**, which each contain just a few **atoms**. For example, a water molecule – H_2O – contains two hydrogen atoms and one oxygen atom. But the molecules of polymers contain huge numbers of atoms, joined together in long **chains**.



A polymer chain

Rubber, thanks to its many uses from rubber bands to car tyres, is one of the best-known polymers. It comes from **latex**, a **natural** liquid which comes from rubber trees. Rubber is therefore a **natural polymer**. However, most of the polymers used in industry are not natural, but **synthetic**. The term 'plastic' is generally used to refer to **synthetic polymers** – in other words, those that are **manmade**.

Note: Rubber can be natural (natural rubber) or synthetic (synthetic rubber).

Thermoplastics and thermosetting plastics

The page goes on to look at types of polymer.

Synthetic polymers can be divided into two main categories:

Thermoplastics can be melted by heat, and formed in shaped containers called **moulds**. After the liquid plastic has cooled, it **sets** to form a solid material. A thermoplastic is a type of plastic that can be heated and **moulded** numerous times. Examples of thermoplastics that are common in engineering include:

- **ABS** (acrylonitrile butadiene styrene) – stiff and light, used in vehicle bodywork
- **polycarbonate** – used to make strong, transparent panels and vehicle lights
- **PVC** (polyvinylchloride) – a cheaper plastic used for window frames and pipes.

Thermosetting plastics, also called **thermosets**, can be heated and moulded like thermoplastics. They may also be mixed from cold ingredients. However, during cooling or mixing, a chemical reaction occurs, causing thermosets to **cure**. This means they set permanently, and cannot be moulded again. If a thermoset is heated after curing, it will burn. Examples of thermosets used in engineering are:

- **epoxy resins** – used in very strong adhesives
- **polyimides** – strong and flexible, used as insulators in some electric cables.

Two more categories of polymer are **engineering plastics** and **elastomers**. Engineering plastics are mostly thermoplastics that are especially strong, such as ABS and polycarbonate. Elastomers are very elastic polymers which can be stretched by force to at least twice their original length, and can then return to their original length when the force is removed.

1 Circle the correct words to complete the text. Look at A opposite to help you.

A lot of rubber is made from latex, a (1) *natural/synthetic* polymer which comes from rubber trees. However, not all rubber comes from trees. Synthetic rubber is a (2) *manmade/natural* polymer with similar properties to latex. Plastics are also polymers. Like rubber, they consist of long chains of (3) *atoms/molecules* which form extremely large (4) *atoms/molecules*.

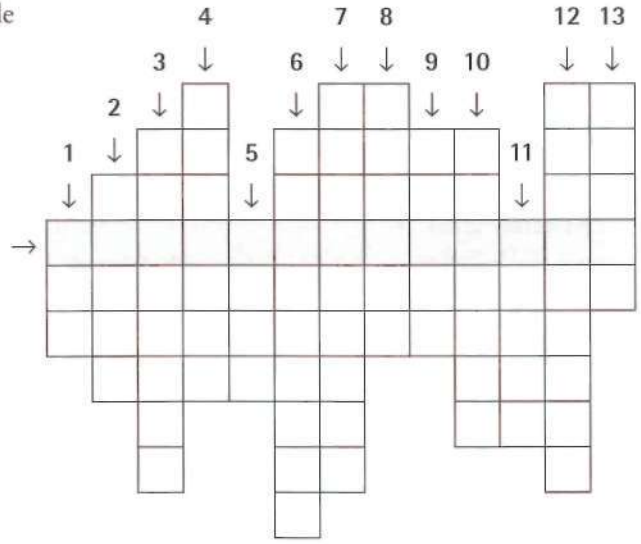
2 Read the extract describing a plastic panel manufacturing process. Then decide whether the sentences below are true or false, and correct the false sentences. Look at B opposite to help you.

By this stage of the process, the plastic is solid, and has fully cooled. Selected panels can now undergo quality-control testing, to check they are strong enough to cope with the tough conditions they will be exposed to in use. Tests include tensile testing, where narrow lengths of panel are subjected to high tension loads to check they do not stretch or fracture. More tests are carried out to check the panels' resistance to impacts and scratching. Any products that fail the tests are returned to the beginning of the production process, melted down, and their material is reused.

1 The plastic was heated earlier in the process.
2 The plastic has now set.
3 The plastic is now liquid.
4 To pass one of the tests, the plastic must be an elastomer.
5 The description suggests the plastic is a type of engineering plastic.
6 The material is a thermosetting plastic.
7 The material is a thermoplastic.

3 Complete the word puzzle and find the word going across the page. Look at A and B opposite to help you.

1 a shorter name for polyvinylchloride
2 used for forming melted plastic
3 a group of atoms
4 a long chain of atoms
5 to set permanently
6 a very elastic polymer
7 a plastic that sets permanently
8 a natural polymer
9 a very strong thermoset resin
10 not natural
11 particles that form molecules
12 another word for 'not natural'
13 material used to make rubber



Over to you

Talk about specific types of polymer that are used in your industry, or an industry you're familiar with. How are they used? Which of the categories mentioned in A and B opposite do the polymers belong to?