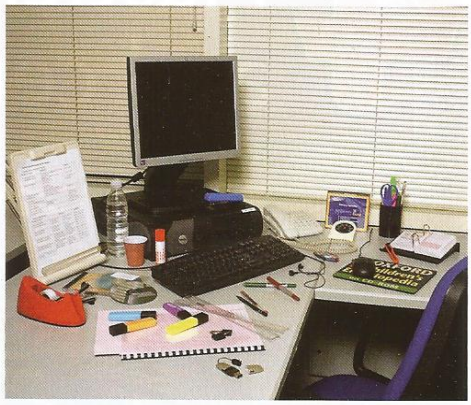
KEY WORDS

polymer: long molecule created by linking a series of simple molecules called monomers

latex: thick, white fluid extracted from tropical trees

sawdust: very fine wood particles produced when cutting wood

1 Plastics

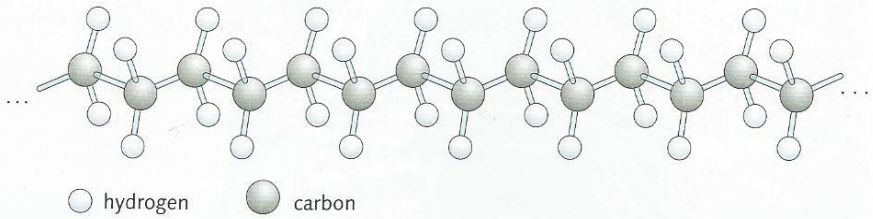


Plastics play a big part in our daily lives.

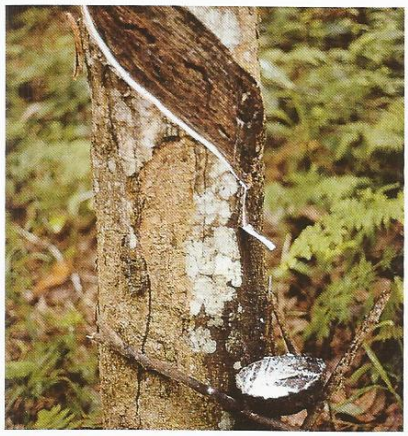
We all know they are used for making containers and packaging.

But we also use plastics in many economic and industrial sectors, for example: telecommunications, transport, construction, medicine, agriculture and information technology.

Plastics are materials formed by **polymers.** The polymers in plastics are made from long chains of carbon atoms.



Molecule chain found in polymers



Natural rubber is obtained from latex.

1.1. Origin and transformation of plastics

Depending on their origin, we can describe plastics as natural or synthetic:

- **Natural plastics** are obtained directly from raw vegetable materials – for example, cellulose or **latex,** or from animal proteins.
- **Synthetic plastics** are made from compounds extracted from petroleum, natural gas and carbon. The majority of plastics belong to this group.

The transformation of these raw materials and compounds into plastics is called **polymerisation.**

- During the manufacturing process, we can add materials such as fibreglass, textile fibres, paper, silica and **sawdust** to reduce production costs, and to develop certain characteristics.
- We can incorporate chemical **additives** to increase flexibility and to strengthen the polymers, and we can add **pigments** to give colour to the plastics.

Off-shore oil rig

Activities

1 What are plastics? What are the differences between natural and synthetic plastics? Write the answers in your exercise book.

2 Which raw materials do we use to produce plastics?

3 What can we add to plastics during the manufacturing process and why? Write the answers in your exercise book.

1.2. Properties of plastics

The properties of plastics depend on their type and on their composition.

Strength, elasticity, rigidity and **flexibility** are characteristics of many plastics, although they vary from one type to another.

However, there are other properties that are common to the majority of plastics:

- **mechanical:** malleability, ductility, mechanical resistance
- **acoustic:** acoustic insulation
- **electrical:** electrical insulation
- **thermal:** thermal insulation
- **other properties:** low density, impermeability

KEY WORDS

crushed: reduced to very small pieces by mechanical pressure

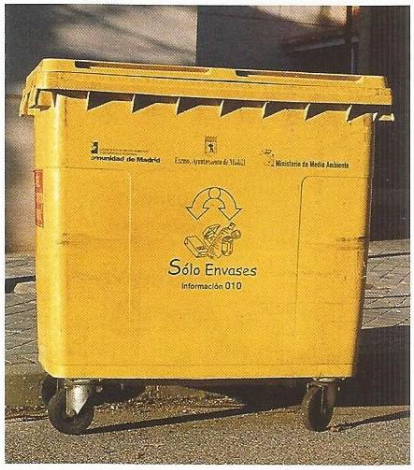
pellet: large grain of plastic (or other materials)

biodegradable: substances that decompose by a natural, biological process

1.3. Ecological properties

We can **recycle** plastics. There are three recycling processes: chemical, mechanical and energetic.

- **Chemical recycling.** We apply chemical processes to make new materials from the original components of plastic residues.
- **Mechanical recycling.** We make new products from plastic granules. The process has five stages:
  1. **Separation and crushing.** We separate the plastics according to type and then they're **crushed.**
  2. **Floating.** We wash the plastics and then dry them by centrifugal force.
  3. **Agglutination.** The material is compacted and then incorporated into other materials.
  4. **Extrusion.** We melt the material, and then it's extruded into long filaments.
  5. **Pelletising.** The filaments are then reduced to granules that we call **pellets.**
- **Energetic recycling.** We can incinerate plastics and the energy that is produced is used in industry, for heating or producing electricity.



Plastic waste should be put into yellow containers.

The majority of plastics are not yet **biodegradable,** but thanks to new technologies, we're increasingly able to produce biodegradable materials. For example:

- plastics that decompose on contact with certain bacteria and biological agents
- plastics that dissolve in hot or cold water.

Activities

4 Are the following sentences true or false? Correct the false sentence(s) in your exercise book.

a) The hardness and elasticity of plastics varies a lot.

b) In general, plastics are good thermal and electrical conductors.

5 Describe the process of recycling plastics mechanically.

KEY WORDS

sole: the bottom part of a shoe, which comes in contact with the floor

hosepipe: flexible plastic tube used for carrying water, such as in gardens to water plants

goggles: special glasses for protecting the eyes

wrapping: thin, flexible material used to fold around food, presents and parcels

2 Classification of plastics

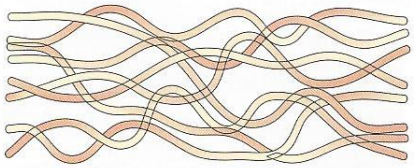
2.1. Thermoplastics

We manufacture thermoplastics from compounds acquired from petroleum.

They're made up of weakly formed molecular chains.

When we heat them, they become soft, which allows them to be formed into different shapes.

The heating and cooling process can be repeated many times.



Structure of thermoplastic

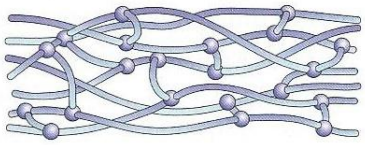
Name		Properties	Uses
Polyvinyl chloride (PVC) ♳		• strong • waterproof • durable	• tubes and pipes • shoe soles • gloves • waterproof clothing • hosepipes
Polystyrene (PS) ♶	hard	• transparent • can be coloured	• CD cases • coat hangers • dairy products containers • egg boxes
	expanded (porexpan)	• porous • soft	• packaging • thermal and acoustic insulation
Polythene (PE)	high density HDPE ♲	• rigid • resistant • transparent	• domestic utensils (buckets, containers) • toys
	low density LDPE ♴	• soft • light • transparent	• transparent packing film • bags • cups and plates
Polypropylene (PP) ♵		• flexible • resistant to chemicals • hard surface	• bottles and containers • ropes • bags
Polymethyl methacrylate (PMMA) (Plexiglas®) ♷		• transparent	• car headlights • windows • illuminated signs • goggles • watches
Teflon® (fluorocarbon) ♶		• non-stick • high heat resistance	• kitchen utensils • paints • aircraft and rocket exteriors
Cellophane (biodegradable)		• transparent • flexible • resistant • shiny • adhesive	• packaging • wrapping
Nylon (PA or polyamide) (damaged by light)		• translucent • shiny • resistant • flexible • waterproof	• fabrics • toothbrushes • tennis racket strings

2.2. Thermostable plastics

These plastics are made from compounds derived from petroleum.

They are formed by strongly-linked chains running in different directions.

When heated, they become soft and can be shaped. When cooled, they cannot be remoulded by applying heat.



Structure of thermostable plastic

KEY WORDS

crash helmet: strong, solid and padded protective head covering

bodywork: the main external structure or 'body' of a vehicle

steering wheel: used by a driver to control the direction of a vehicle

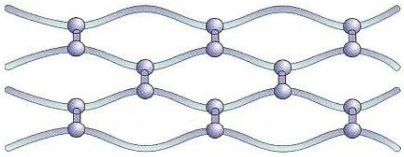
Name	Properties	Uses	
Polyurethane (PUR)	• porous and flexible • soft and dense • elastic and adhesive	• foam rubber for cushions • sponges • thermal and acoustic insulation • glues and varnishes	
Phenolic resins (PH) (Bakelite)	• shock resistant • dark colours • electric insulator • heat resistant	• kitchen utensil handles • covers for electrical appliances • electric plugs and switches	
Melamine Formaldehyde (MF)	• light • hard and resistant • tasteless and odourless • thermal insulator	• small electrical objects • thermal and acoustic insulation • kitchen surfaces • plates and food containers	
Polyester resins (UP)	• heat resistant • reinforced by fibre-glass for strength and rigidity	• crash helmets • bodywork for cars and boats • fishing rods	

2.3. Elastomers

Made by **vulcanisation:** mixing sulphur and rubber, and heating to 160°C.

They are hard, resistant and very elastic – **stretching easily under force.**

They're formed by chains linked laterally and then folded over themselves, like a ball of wool or string.



Structure of elastomer

Name	Properties	Uses	
Natural rubber	• resistant • inert	• thermal and electrical insulation • mattresses • tyres	
Synthetic rubber (polymer)	• resistant to chemicals	• tyres, steering wheels and shock absorbers • tubes and pipes • gloves • mattresses	
Neoprene (a particular form of synthetic rubber)	• harder and more resistant than synthetic rubber • waterproof	• diving suits • hosepipes • gloves	

Activities

6 Listen to the following descriptions of everyday objects. What are they? Talk with a partner to see if you agree. Now decide together which type of plastic we use to make them. Check your answers with the tables above.

KEY WORDS

resin: thick, viscous substance obtained from plants

nozzle: a tube projecting from a container or hosepipe that controls the flow of liquids or gas

coating: a thin layer of something that covers the outer surface of a material

worktop: flat, horizontal surface on which people can work, for example in kitchens or workshops

3 Formation techniques

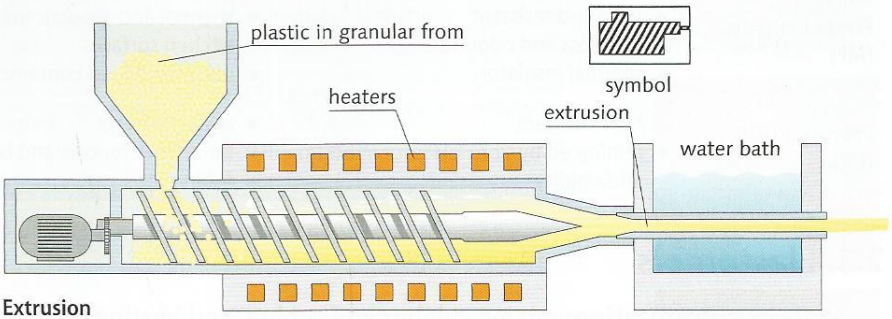
When we manufacture plastic objects in industry, the plastic is available in three different forms: powder, granules and **resins**.

We use different formation techniques depending on the type and use of the plastic.

3.1. Extrusion

This technique has four stages:

1. We put thermoplastic, in granular form, into a previously heated cylinder.
2. We apply pressure by means of a large, rotating screw, which forces the melted material out, through a **nozzle**.
3. We cool the shaped material slowly in a refrigerated water bath until it's solid.
4. Finally, we collect the pieces of plastic through a feeder system.



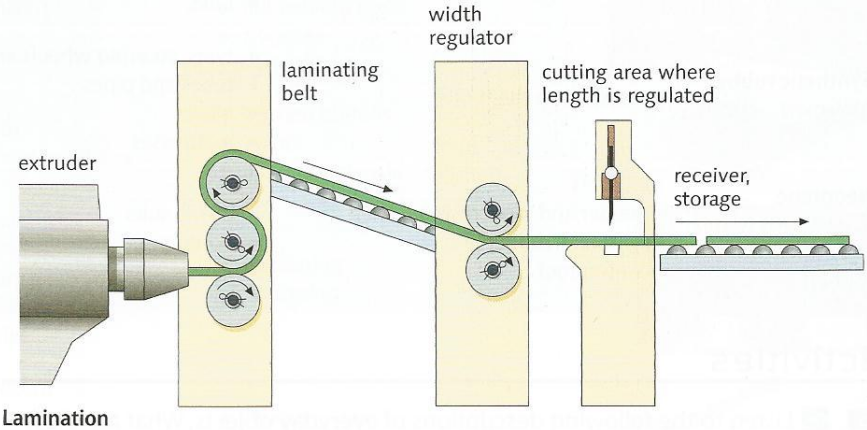
Extrusion

Used to form: wrapping, lining for electric cables, tubes and pipes.

3.2. Lamination

Thermoplastic produced by the extrusion method is passed through a series of hot cylinders to produce sheets of varying thickness.

With this technique, we can produce different finishes, for example, glossy, matt or textured. This depends on the outer **coating** applied by the final cylinder.



Lamination

Used to form: **worktops**, to cover surfaces of kitchen cupboards and drawers.

3.3. Vacuum forming

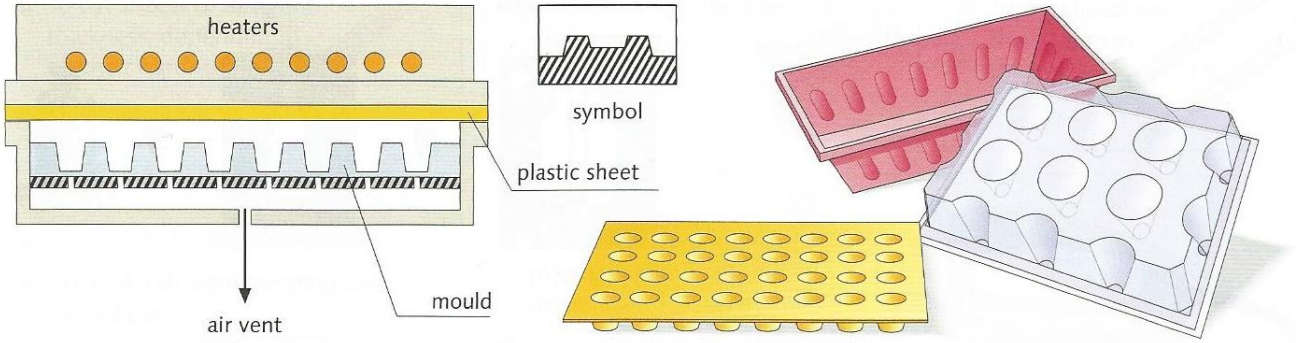
We use plastic sheets with a large surface for this technique.

1. We put thermoplastic into a mould.
2. We then use a **heater** to heat the mould and soften the plastic.
3. We extract the air below the sheet so that the plastic is pulled against the inside walls of the shaped mould, and the desired form is created.
4. We leave the mould to cool, then remove the object.

KEY WORDS

dashboard: instrument panel in a car, boat or aircraft

bucket: round container with a flat bottom for water and other fluids



Vacuum forming

Used to form: bathtubs, **dashboards**, shop signs and egg boxes.

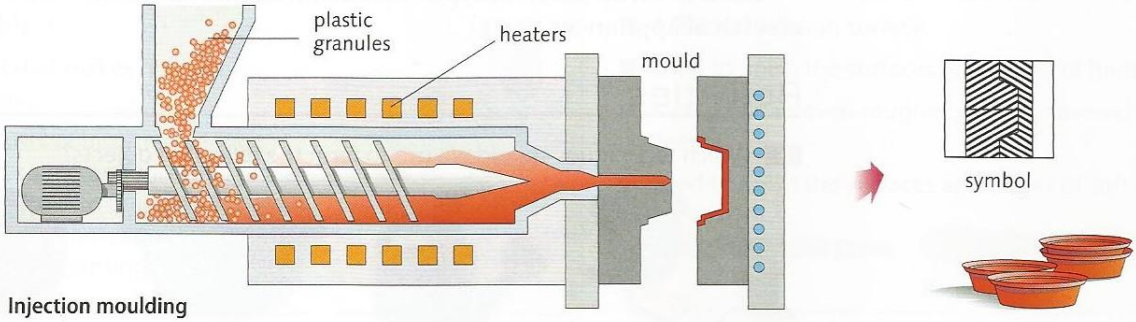
3.4. Moulding

There are three principal techniques:

- injection
- blow moulding
- compression.

Injection moulding

1. We inject melted thermoplastic into a mould.
2. When the material has cooled and solidified, we extract it from the mould.



Injection moulding

Used to form: domestic utensils such as **buckets** and containers, vehicle and aircraft components.

Activities

7 Work in pairs, take turns to say the following key words: *dashboard, worktop, nozzle, resin.* Now listen to check that your pronunciation is correct.

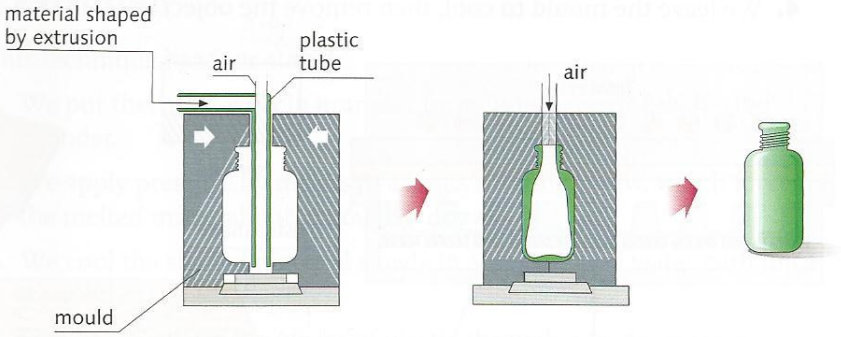
KEY WORDS

hollow: object that has an empty space or cavity inside

electrical appliance: machine in the home powered by electricity such as fridges, washing machines and toasters

Blow moulding

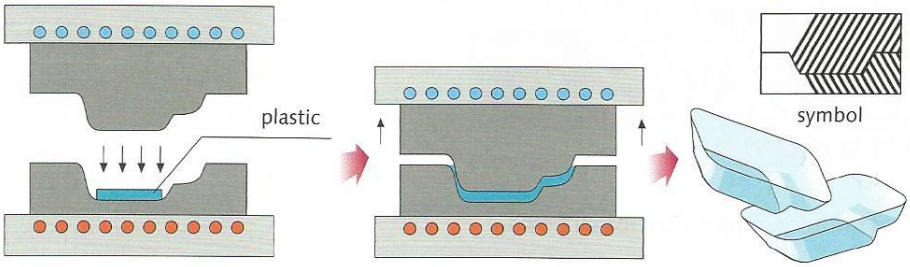
1. We put a tubular-shaped piece of plastic into a **hollow** mould which has the same shape as the object that we want to make.
2. We close the mould and blow pressurised air into it, so that the plastic adheres to the sides of the mould and takes its shape.
3. When the object is cold, we remove it from the mould.



Blow moulding

Used to form: hollow objects, for example bottles and flasks.

Compression



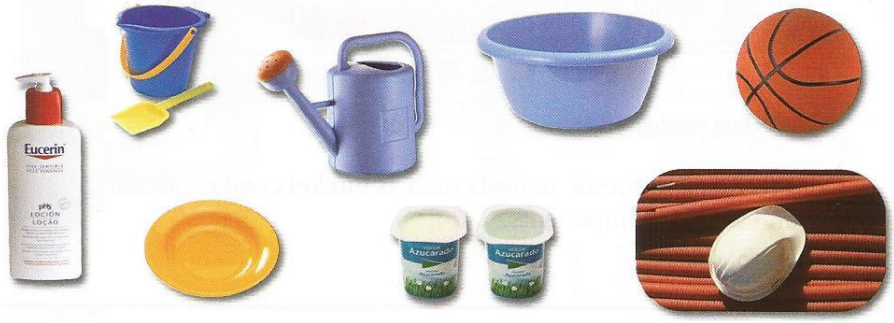
Compression moulding is done in a machine called a press.

1. We put thermostable plastic, which can be in granular form, into the base of a cavity mould.
2. The outer part of the cavity mould, shaped the same, is closed to compress the material inside. We then heat it and it becomes soft and malleable.
3. The plastic adapts to the shape of the cavity between the two parts of the mould.
4. We extract the object when the plastic has cooled and solidified.

Used to form: different types of containers, machine bodywork and electrical appliances.

Activities

8 Which techniques should we use to form the following objects?



9 Work in pairs. Think of five plastic objects and talk about which technique you think we use to make each of them. Check your ideas on the Internet.