

## Using Materials

### You must be able to:

- Compare the properties of a range of materials
- Explain how metals corrode
- Suggest ways to prevent or reduce the corrosion of metals.

## Properties of Materials

- Materials are chosen for a specific purpose because of their physical properties, e.g. teapots are made from materials that can hold boiling water without melting.

## Metals

- Metals are generally easy to manipulate and extract and can be made into alloys with different properties to the original metals.
- Some metals are very hard and strong.
- For example, iron (when mixed with other elements to form steels) is used in cars, machine tools and buildings.
- Others metals, such as copper and silver, are **ductile** and can be used to make wires.

## Corrosion

- Most metals will react with oxygen to form a metal oxide. This process is called **corrosion**.
- Corrosion is an expensive problem, because corroded metal has to be replaced.
- The corrosion of iron (an oxidation reaction) is called **rusting** – it costs billions of pounds per year worldwide.



- Rusting occurs even faster when iron comes into contact with salt water or acid rain.
- Aluminium is very reactive, but it does not corrode in air and water.
- Atoms on the surface quickly react to form aluminium oxide, which creates a protective barrier.



- There are two ways of preventing corrosion:
  - a physical barrier between the metal and water and oxygen
  - **sacrificial protection**.
- Choosing a material to protect a metal depends upon the intended use.
- Painting metal is a common solution (e.g. an iron bridge), as long as the paint is not likely to get chipped.
- Coating metal in plastic is more durable (e.g. chain linked fences).
- Oil and grease is used on objects that move (e.g. bicycle chains).

### Key Point

Corrosion damages metals and can make objects unsafe. Finding cheap and effective ways to reduce corrosion preserves the metal and saves money.

- Sacrificial protection involves attaching a more reactive metal to the surface of the metal being protected, e.g. attaching zinc or magnesium to iron.
- With the hulls of ships, a block of zinc is attached.
- The more reactive metal reacts and corrodes first, protecting the main metal.
- Galvanising is the process of covering a metal with a layer of zinc.
- This provides a physical barrier and sacrificial protection.

## Glass and Clay Ceramics

- Glass is a non-crystalline solid that is transparent or translucent.
- It is made by heating silica with lime and sodium carbonate.
- Glass is unreactive, so it can be used to make bottles to store reactive chemicals, windows and tableware.
- Clay **ceramics** are made by shaping clay and then heating at a high temperature in an oven.
- Fine clays are used to make plates in a dinner service.
- Clays with a larger particle size are used to make the separators that provide electrical insulation in power lines.

## Polymers

- There is a huge range of polymers that are created for different purposes.

Polymer	Properties	Uses
Polythene or poly(ethene)	<ul style="list-style-type: none"> <li>• Light</li> <li>• Flexible</li> <li>• Easily moulded</li> <li>• Can be printed on</li> </ul>	<ul style="list-style-type: none"> <li>• Plastic bags – the plastic is flexible and light.</li> <li>• Moulded containers – the plastic is easily moulded.</li> </ul>
Polystyrene	<ul style="list-style-type: none"> <li>• Light</li> <li>• Poor conductor of heat</li> </ul>	<ul style="list-style-type: none"> <li>• Insulation – the plastic is a poor conductor of heat.</li> </ul>
Polyester	<ul style="list-style-type: none"> <li>• Lightweight</li> <li>• Waterproof</li> <li>• Tough</li> <li>• Can be coloured</li> </ul>	<ul style="list-style-type: none"> <li>• Clothing – the plastic can be made into fibres, is lightweight, tough, waterproof and can be coloured.</li> <li>• Bottles – the plastic is lightweight and waterproof.</li> </ul>

## Composites

- **Composites** are mixtures or layers of different materials that are chemically bonded together.
- They are often very strong and durable.
- Examples of composites include:
  - concrete (a mixture of aggregates, sand and cement)
  - carbon composites, used for re-entry shields on spacecraft
  - Kevlar™, used to make bulletproof vests.

### Quick Test

1. Why are blocks of zinc attached to ships' hulls?
2. Why are iron nails galvanised?
3. Suggest why poly styrene is used to make cups.

### Key Point

There is an extremely large variety of materials available. However, not all will be environmentally friendly and meet the requirements of a life cycle assessment.

### Key Words

ductile  
corrosion  
rusting  
sacrificial protection  
ceramics  
composites