

Metals



People have used metal as a material for thousands of years:

- Stone age 300 000 – 1900 BC
- Bronze age 1900 – 500 BC
- Iron age 500 – 51 BC

Metals are found naturally in the earth and on its surface in the form of metal ores.

Some metals, such as gold, copper and silver, have been found in an almost pure state. These were, therefore, among the first metals to be used by humans, who found that when they were hot they could be moulded by using stone hammers. Metals such as gold and silver were used for jewellery. Other metals – iron and copper, for instance – were used for tools and weapons.

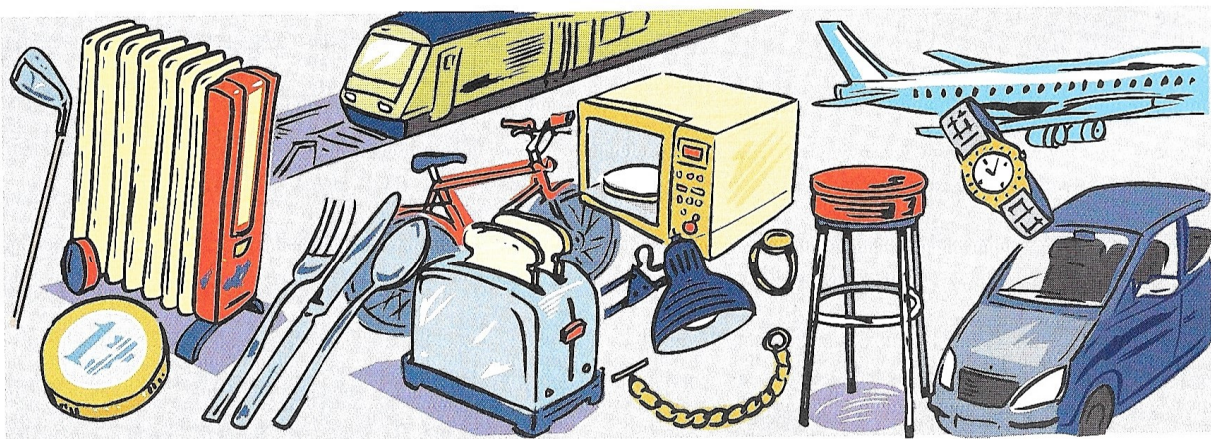
● Properties of metals:

- Most metals are solids
- They are generally good conductors of heat
- They are good conductors of electricity
- They are generally quite dense
- Most can be worked and shaped, either cold or with heat
- They expand when heated
- Some metals can be bent quite easily.

■ ■ ■ Groups of Metals

Metals can be divided into three groups:

- Ferrous metals
- Non-ferrous metals (pure metal)
- Alloys (mixture of metals).



© Metals are used in many items

◎ FERROUS METALS

Ferrous metals are metals that contain a certain amount of iron. Iron is found naturally as a red-coloured ore. It is processed in a furnace at a smelting works. The iron is extracted in a blast furnace. Air is blown into the furnace through a pipe. The raw iron produced is known as **pig iron**.

● Cast Iron

Pig iron can be cast into moulds to produce different items, such as gates, railings, etc.

The process is known as casting and this is where the name cast iron comes from.

● Steel

Steel is a mixture of iron and carbon. It is produced in a basic **oxygen furnace**.

In this type of furnace, scrap steel can be melted down and mixed with molten pig iron. A maximum of 30% of scrap can be used.

Carbon is an element that can exist in many forms. **Graphite** is its most common form. This is a black, shiny substance which is used in the lead of pencils. It was known as **black lead** long ago and this is where pencil lead got its name. It is carbon which gives steel its strength.

There are other forms of steel, formed by mixing different amounts of carbon with iron, and also by mixing in other metals to form alloys of steel:

- **High carbon steel** (tool steel) is used in blades of chisels, planes, etc
- High speed steel is an alloy of steel which is a combination of steel and tungsten (18%). This is a very hard steel
- Stainless steel is another alloy, combining steel with 8% chromium and 18% nickel.

● Hardening and tempering

Steel that is used in chisels and other tool blades needs to be hard in order to stay sharp. The steel is hardened by first heating it to 720°C. It is then quenched by placing the metal in water. This hardening process makes the steel hard, but also brittle. In this state the steel is liable to chip when used in a tool.

To make the steel more usable it is tempered. The metal is gently reheated and then quenched again. This takes some of the hardness away and makes the steel tougher.



◎ Uses of steel

◎ NON-FERROUS METALS

Non-ferrous metals are metals that contain no iron. There are four main non-ferrous metals in use today. Together with their many alloys, they account for much of the metals used:

- Aluminium
- Copper
- Zinc
- Lead.

● **Aluminium**

Aluminium is the most plentiful metal on earth. It is mined in the form of **bauxite**, the aluminium ore. This is then refined to a white powder called **alumina**. Alumina is produced in Aghinish Island, on the Shannon Estuary in county Limerick.

It is produced using **electrolysis**. Much aluminium is used in pure form, but more is alloyed with other metals such as copper and manganese. There are more than 70 aluminium alloys in common use today. They are used in electric wires, pots, pans, windows, doors, cars, boats, aerals, drink cans and even spacecrafts.



● **Copper**

Copper is reddish brown in colour and can be highly polished. It is a pure metal. Copper is a good conductor of heat and electricity and therefore is widely used in electrical cables. It is easily worked (cut and filed) which makes it highly suitable for a wide variety of uses, particularly in project work. It is resistant to corrosion, which is why it is used in water pipes and also on the roofs of some buildings.



⊙ *Copper pipe being worked*

⊙ *Oxidated copper turned green on the domed roof of this building*



⊙ **ALLOYS OF COPPER**

● **Brass**

Brass is an alloy of copper, produced by mixing copper with zinc. It is a yellowish metal, but the precise colour depends on the amount of zinc. Brass is widely used for ornamental work, for example door handles and letter boxes. It is also used for making screws and other fittings that



are used in damp conditions, since brass is resistant to corrosion. Brass can be highly polished and is very attractive.



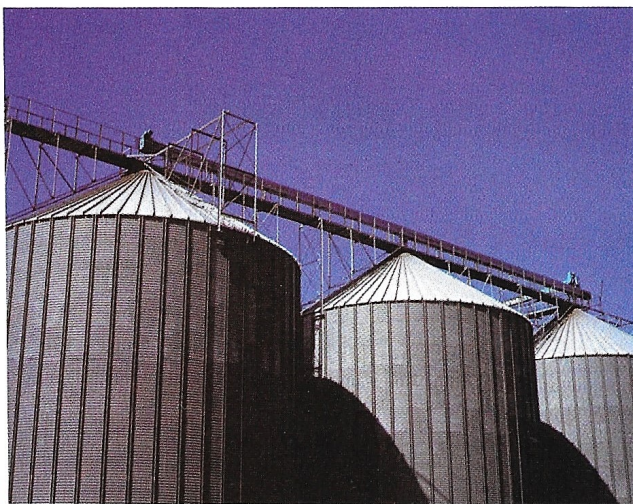
© Everyday brass objects

● **Bronze**

Bronze is another alloy of copper, produced when copper is mixed with tin. It is a strong metal which resists corrosion well. Bronze is used widely for casting statues, machine parts and ship fittings.

● **Zinc**

Zinc is a dull silvery metal which is used in alloys with copper to produce brass. It is used also for



© Galvanised sheeting in use in industry

coating steel to prevent rusting; this process is called **galvanising**. This is where the item is dipped into a bath of hot zinc to coat it.

● **Lead**

Lead is a dull, grey metal. It is very heavy, soft and malleable. Lead is used in car batteries and in the construction industry (for gutters and around chimneys to keep out water). It does not corrode.

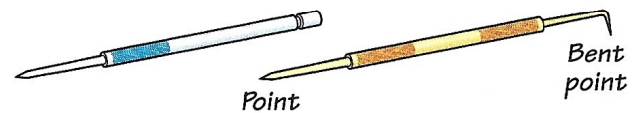
■■■ **Working with metals**

Metals cannot easily be marked out with a pencil because of their hard shiny surfaces, so other ways of drawing lines, curves and joints on the surfaces must be used. The processes for making these lines are very similar to those used for marking timber.

Some of the more common tools are:

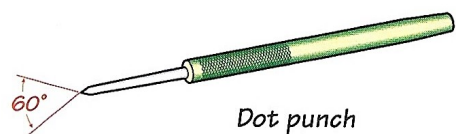
● **Scriber**

Used for scratching the surface of a metal, instead of a pencil.



● **Dot punch**

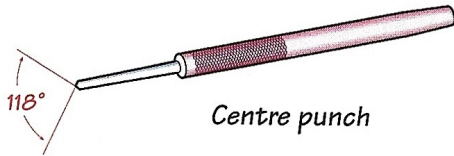
Used to punch small dots in the surface of metal through which lines can be drawn.



Dot punch

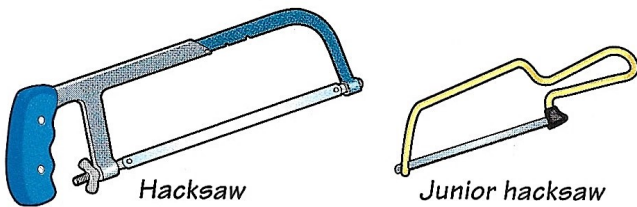
● **Centre punch**

Used to make a small hole in the surface of the metal before drilling so that the drill bit will not slip. It ensures that the hole is accurately drilled.



● **Hacksaws**

Used to cut small sections of metal.



● **Files**

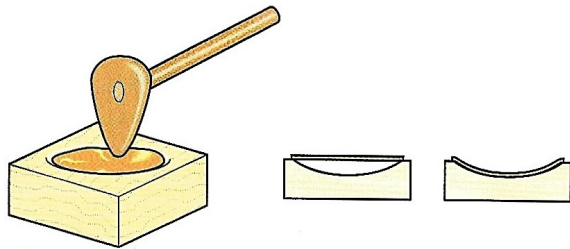
Various types – used to shape edges of metal, making them smooth and square. They are also used for working with plastics.

■ ■ ■ **Metalwork**

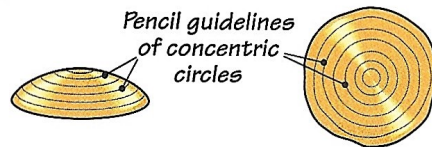
Decorative shapes can be formed in sheet metal such as gold, silver, copper and brass sheet. A cold hammering process is used. Bowls and other decorative shapes can be formed in copper sheet and brass sheet by this process.

Beware: All sheet metals should be handled with care. Protective gloves should be worn at all times because sheet metal often has sharp edges.

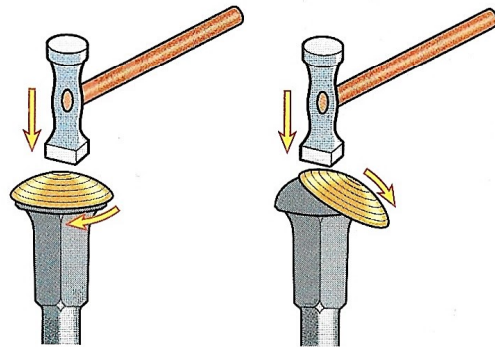
First, the sheet metal is hollowed or sunk to form the basic curved shape. This is done with a wooden block or a sandbag and a mallet. Once the basic shape has been formed, the metal bowl can be planished, to give a final finish.



● *Hollowing out the piece using a wooden block*



● *Hollowing leaves slightly rough finished surfaces*



● *Planishing smooths out the surfaces leaving an even finish*

⊙ *Making a small bowl in metal*

⊙ **METAL FINISHES**

Metals, like other materials, will decay over time. They get dirty and scratched; some are corroded by rain and other elements. Many metals we use are not very attractive. Metals are often finished to give them a protective coating (from rust) and to give them a decorative finish. Metals can be finished in three different ways depending on the



metal and its final use. These finishes are:

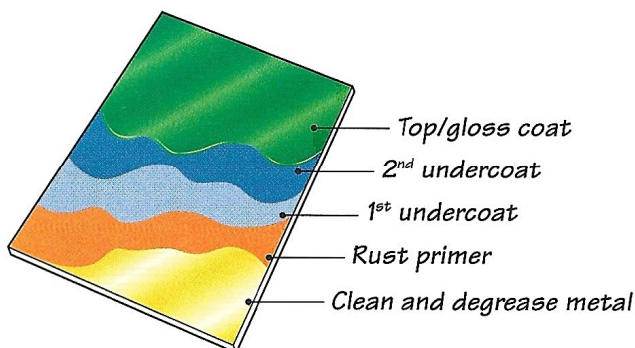
- Polishing – for quality metals in decorative situations
- Painting – general finishing of steel, etc
- Coating – protective coating of non-corroding metal (galvanising) or plastic.

● Oxidation

Oxidation, or rusting, is the process of corroding metal. Rust is formed when oxygen in the air combines with the surface of the metal. It is a chemical reaction. Rust corrodes the metal and gradually eats its way through the material. Most other metals, such as copper, aluminium, zinc, lead and brass are not as badly affected by oxidation because the oxide forms a protective coat. This is the green patina of copper, for example.

● Painting

Metal is painted in a similar way to wood. Ferrous metals are often painted because they rust easily, and paint gives good protection against oxidation.



© Painting metals

Dust, rust and grease are first cleaned off the metal surface. Then the first coat, a special rust priming coat, is applied. When this is dry, one or sometimes two undercoats are applied. The finishing coat is painted on when the undercoat is dry.

Although paint will eventually allow rust to develop, it has the advantage that colours can be used and they can be changed each time you have to paint.

● Plastic coating

Metals can also be treated with a coating of plastic. This often allows bright colours to be used.

The method uses a thermoplastic powder, such as polystyrene. The metal is heated in an oven to a temperature of about 180°C. The metal is then picked up with a tongs and dipped into a container of the powder, which melts onto the metal surface. The workpiece is briefly reheated to ensure that the powder has completely fused to the surface of the metal.

● Metal coating

Metal objects can be coated with another metal by one of two processes: dipping or electroplating.

– Dipping

The piece of metal is dipped into a bath of molten metal such as zinc. This is generally used as a means of weatherproofing a metal that corrodes easily. **Galvanising** is the process of dipping steel into zinc to protect it. It is used on nails, gates, dustbins and corrugated roofing.

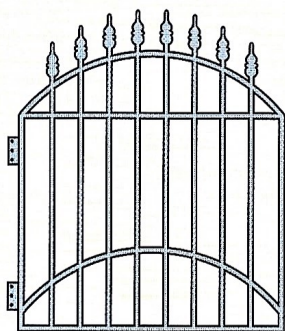
– Electroplating

This process gives a protective or decorative coat to a base metal. It is used to coat cheaper metals with thin layers of more expensive metals (gold). The process uses a direct electrical current. It is an expensive process and is used on very fine work. The work must be very well finished because the electroplating process will highlight scratches and other flaws in it.



Exercises

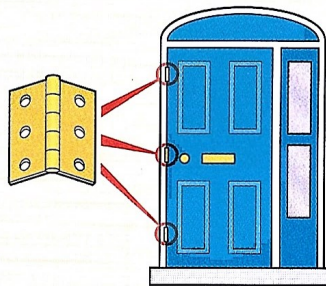
- Complete the following sentence: A ferrous metal is one which _____.
- What is an alloy? Give an example of an alloy in common use.
- List three properties common to most metals.
- Describe the type of metal used in the manufacture of the blades of chisels.
- Describe the steps necessary for the preparation and finishing of this metal gate with a paint finish.



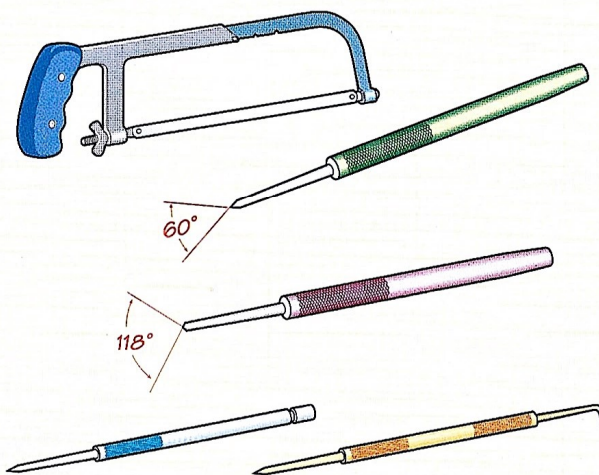
- Copy this box into your exercise book and show, by putting a tick in the box, what will happen to the following metals if they are left outside in the rain:

	Will not rust	Will rust
Steel		
Copper		
Brass		
Bronze		
Iron		

- Shown in the diagram is a front door which is hung using brass hinges. Why is brass a suitable material for these hinges?



- Name the tools shown in the diagram below and state what each is used for:



- In the case of each metal below state whether it is a pure metal or an alloy:

	Type (Alloy/Pure)
Lead	
Copper	
Iron	
Tin	
Brass	
Bronze	