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Metals

KEYWORDS

alloy
aluminium
casting

ferrous
galvanising
ore

steel
zinc

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

- Stone Age: 300,000–2,000 BC
- Bronze Age: 2,000–500 BC
- Iron Age: 500–51 BC

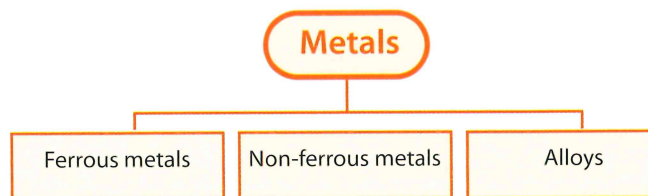
Metals are found in the earth and on its surface. Metal ores, such as gold, copper and silver, among the first metals used by humans. Early man discovered that when heated these metals became pliable and could be moulded using stone hammers. They created jewellery from gold and silver, and made tools and weapons from iron and copper.

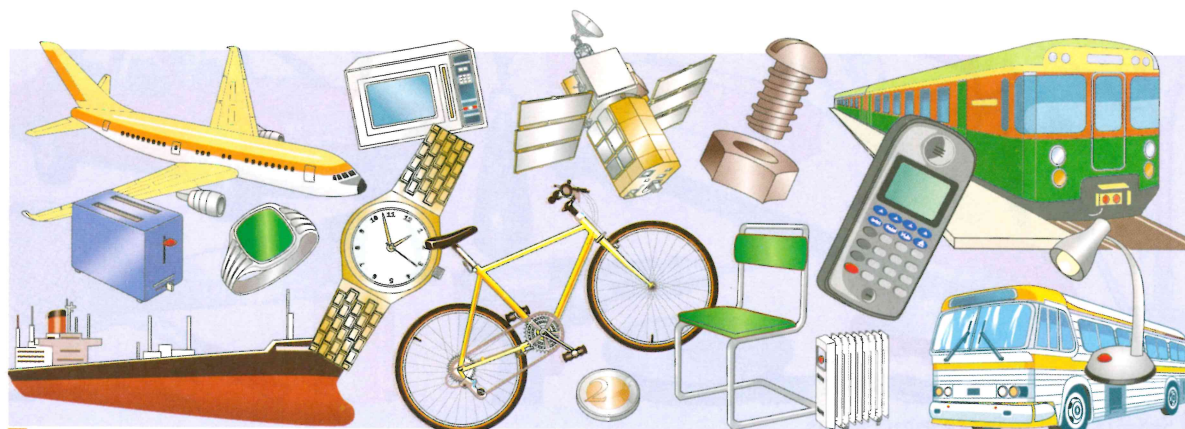
Properties of metals

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

GROUPS OF METALS

Metals are divided into three groups:





Metals are used in many ways

Ferrous metals

Ferrous metals contain some iron. Iron occurs 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 called pig iron.

Cast iron

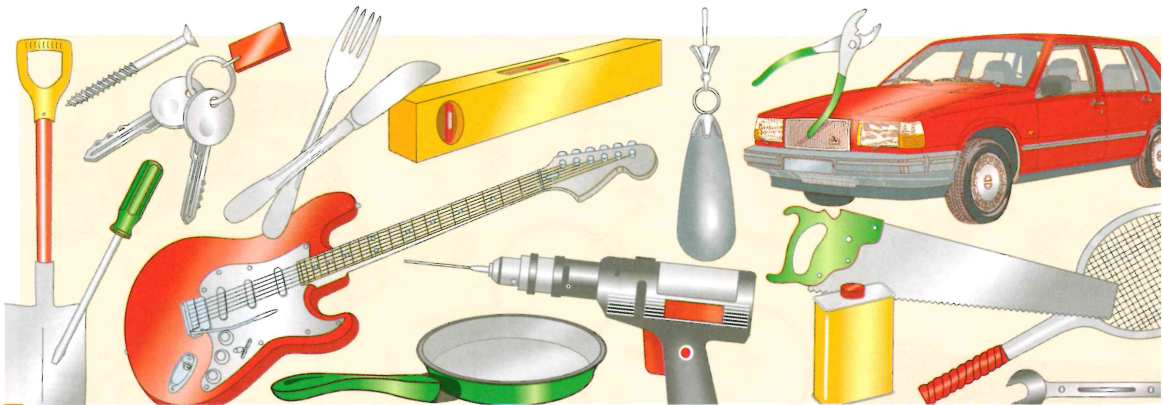
Pig iron is put into moulds to produce items such as gates and railings. The process is called **casting** and this is where the name **cast iron** comes from.

Steel

Steel is a mixture of iron and carbon. It is produced in a basic oxygen furnace. In this type of furnace, scrap steel is melted down and mixed with molten pig iron. A maximum of 30 per cent of scrap metal is used.

Carbon gives the steel its strength. Carbon is an element that exists in many forms. Graphite is its most common form. This is a black, shiny substance used in the lead of pencils. Adding carbon to the steel in different amounts results in different properties. These slightly different steels have many uses.

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



Steel is used to make many items

Non-ferrous metals

Non-ferrous metals contain no iron. There are four main non-ferrous metals in use today:

- Aluminium
- Copper
- Zinc
- Lead

Together with their many alloys, they account for much of the metals used.

Aluminium

Aluminium is the most plentiful metal on earth. It is mined in the form of bauxite, aluminium ore. This is then refined to a white powder called alumina from which aluminium is made.

Alumina is produced in Aughinish Island, on the Shannon Estuary in Co. Limerick.

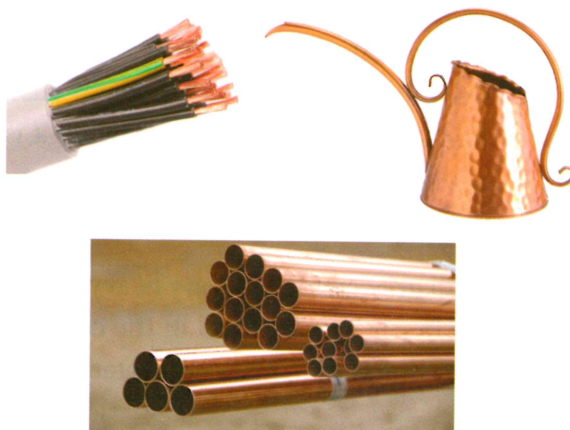
Much aluminium is used in its pure form, but there are many alloys of aluminium also. These alloys are used in electric wires, pots, pans, windows, doors, cars, boats, aerals, drink cans and even spacecrafts.



Products made from aluminium

Copper

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



Products made from copper

Alloys

Alloys are mixtures of two or more metals. Some of the most common are brass, zinc and lead.

Brass

Brass is an alloy (mixture) of copper and zinc. It is a yellow-coloured metal. Brass is widely used for ornamental work, e.g. door handles and letterboxes. It is also used for making screws and other fittings that are used in damp conditions, because brass is resistant to corrosion. Brass can be highly polished and is very attractive.



Objects made from brass

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.



Bronze is used in statues



Zinc

Zinc is a dull metal, silver in colour. As well as being used to make brass, zinc is used for coating steel to prevent rusting; this process is called **galvanising**. An object is galvanised when it 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 toxic and is used in car batteries and in the construction industry (for gutters and around chimneys to keep out water). It does not corrode.

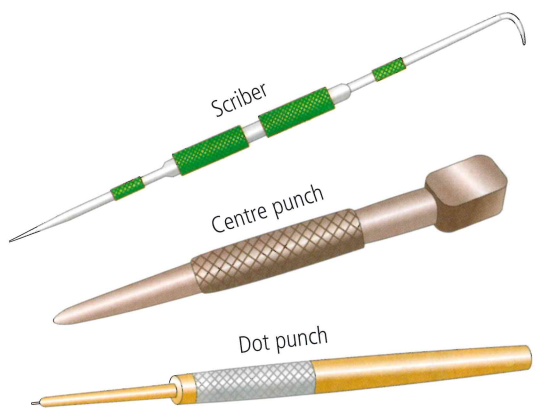


Zinc-coated met.

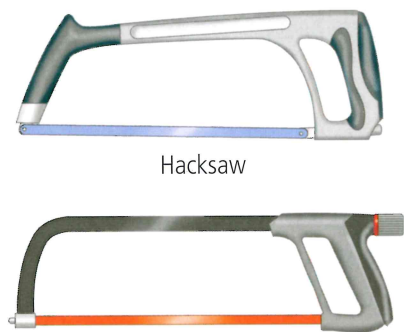
Working with metals

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 :

- **Scriber:** Used for scratching the surface of a metal, instead of a pencil
- **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



Metalwork marking tools



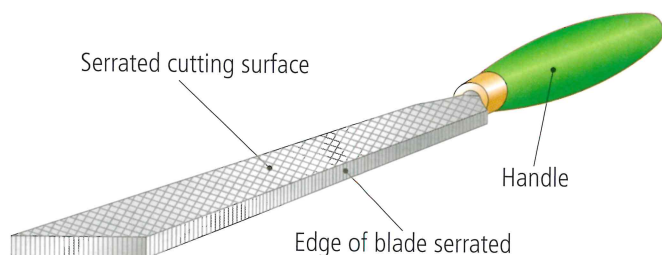
Hacksaws



Junior hacks

Junior hacks

- **Files:** Used to shape edges of metal, making them smooth and square. They are also used for working with plastics.



Metal file



Various types of files

METAL FINISHES

Metals, like other materials, decay over time. They get dirty and scratched; some are corroded by rain and other elements. Metals corrode or rust due to **oxidation**.

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 into the material. Ferrous metals, such as steel and iron, are very prone to rust. Many non-ferrous metals, such as copper, aluminium, zinc, lead and brass are not as badly affected by oxidation as ferrous metals, because the oxide forms a protective coat. This is the green patina of copper, for example.

Metals are unattractive. 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:

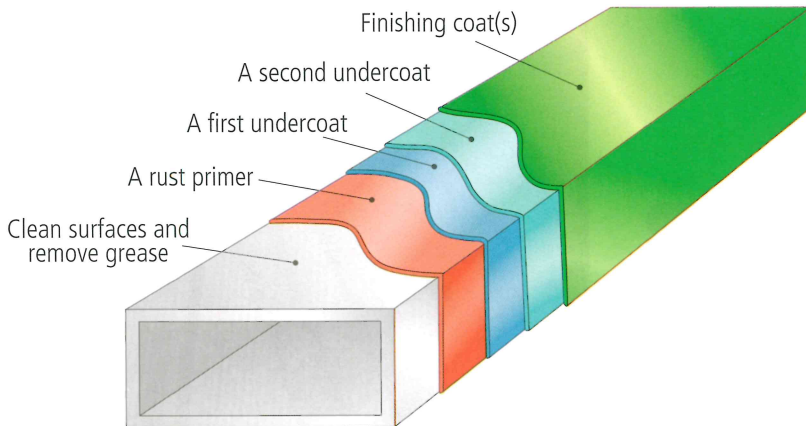
- Polishing – for quality metals in decorative situations
- Painting – general finishing of steel, etc.
- Coating – protective coating of non-corroding metal (galvanising or plastic coating)



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.

Although paint will give protection, rust will eventually develop if the paint is not maintained. Paint has the advantage that colours can be varied and they can be changed each time you have to paint.



Stages in painting metal

Plastic coating

Metals can be covered with a coating of plastic. This allows the use of bright colours. The metal uses a thermoplastic powder, such as polystyrene. The metal is heated in an oven to a temperature of about 180°C. Using tongs, the metal is dipped into a container of the powder which melts on to the surface. The piece is briefly re-heated to ensure that the powder is 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.

1 Dipping

Dipping is used as a means of weatherproofing a metal that corrodes easily. The piece of metal is dipped into a bath of molten metal such as zinc.

Galvanising is the process of dipping steel into zinc to protect it. It is used on nails, gutters, dustbins and corrugated roofing.

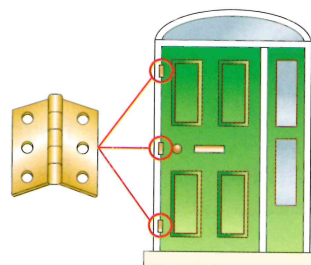
2 Electroplating

Electroplating gives a protective or decorative coat to a base metal. It is used to coat cheap metals with thin layers of more expensive metals (gold). The process uses a direct electric 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.



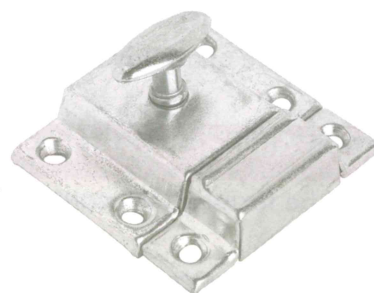
Exercises

- 1 What is a ferrous metal?
- 2 List three properties common to most metals.
- 3 Name the type of metal used in the manufacture of the blades of chisels.
- 4 Describe the steps necessary for the preparation and finishing of a metal gate with a paint finish.
- 5 Shown in the diagram is a front door that is hung using hinges. What metal is used for these hinges and why is it suitable?



Exam Questions

- 1 Brass is an alloy of two metals. Name the two metals.
(JC, HL, 2008)
 - 2 (a) What is the main difference between ferrous and non-ferrous metals?
(b) For each of the following metals, state whether it is ferrous or non-ferrous.
 - Copper
 - Steel
 - Aluminium
- (JC, HL, 2005)



Web Links

www.technologystudent.com/equip1/heat1.htm

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<http://fun.familyeducation.com/page/39508.html>

<http://videos.howstuffworks.com/discovery/28128-how-its-made-bronze-bells-video.htm>