

# METAL

## THE MATERIAL FOR ALL GENERATIONS

Metals are arguably the most important material that humans have mastered. They have been so influential to society, they have been used to describe key stages in human history, from the Chalcolithic (Copper Age), the Bronze Age (Bronze is an alloy of copper and tin), to the Iron Age.

Some metals, for example iron and steel, have been useful for making tools and weapons, whilst other metals such as silver and gold have been sought as they are precious and considered beautiful. Since the 1940's, some metals have even become a source of fuel because they are radioactive - uranium and plutonium.

## WHERE PURE METALS COME FROM

Most metals are mined from the Earth in the form of ores. Ores are a mixture of rock and metal and these two components must be separated. Different metals require different techniques to separate them from the rock. You will learn more about this process in Chemistry.

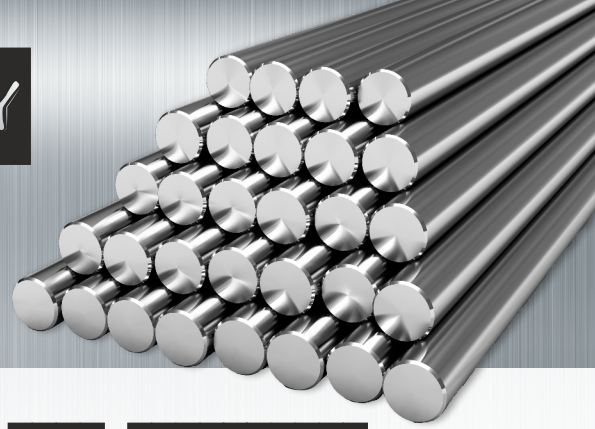
Some metals are mined underground by digging deep pits into the Earth. This technique involves employing lots of miners to manually dig valuable ores from the ground. It is a dangerous and expensive process, but does not significantly damage the surface of the earth.

Surface mining involves stripping away layers of earth to expose the valuable ores beneath. Whilst surface mining is more cost effective than underground mining, it does make huge scars in the landscape.

Extracting metallic ores is only part of the process. Once these ores are recovered, they need to be processed to become useful.



# METALLIC FAMILY



*Ferrous metals and pure iron are prone to rust. Rust is a reaction of the iron to oxygen and water - especially salt-water. Given enough time the iron will completely dissolve.*



*Non-ferrous metals do not rust. However, many will suffer surface corrosion.*

## FERROUS METALS - VERY ATTRACTIVE

The word ferrous is originally from the Latin word for iron, ferrum. A ferrous metal is one that contains a significant proportion of iron. Ferrous metals have some unique characteristics, including being magnetic and prone to rust. Ferrous metals are typically less expensive than non-ferrous.

Iron is one of the most common metallic elements on Earth - the centre of the planet comprises of super heated iron, that is moving, creating Earth's magnetic field.

## NON FERROUS-METALS - ALL WEATHER METAL

Non-ferrous metals contain no iron and are therefore not magnetic and do not rust. However some non-ferrous metals do suffer from corrosion. Corrosion is also caused by contact to air and water, however in many cases, corrosion will only occur on the surface of the metal and forms a protective barrier that keeps the rest of the metal safe.

Aluminium is a very common non-ferrous metal (the third most common metal in the Earth's crust, however it requires a lot of processing to make it usable). Aluminium can be polished to a chrome-like finish, however, it will eventually become chalk-white as it reacts to oxygen. This chalk-white layer is called aluminium-oxide.

Some non-ferrous metals do not suffer any corrosion, including gold and platinum.

## NEED TO KNOW

In unit or the Course Assessment Task you may be required to consider metals.

If the product will be outside or exposed to water, ferrous metals will need some form of protection, such as paint, anodising or plastic dip-coating.

Most non-ferrous metals are lighter, which is an important consideration with some products.

## ALLOYS - MIXING THINGS UP

Alloys are a mixture of two or more metals or metals mixed with other elements to give unique features. Alloys can either be ferrous or non-ferrous depending on whether they contain a large portion of iron.

Very few alloys occur in nature. Most alloys are manufactured by humans - the first alloy created by prehistoric civilisations was bronze, which is a mixture of copper and tin. Bronze was stronger and more durable than either copper or tin so allowed a wider range of tools and weapons to be developed.



## METALS GOING FULL CIRCLE

Mining and processing metallic ores into useful products has a huge environmental impact. Refining some metals require more energy and produce more harmful pollution than others.

Some metals themselves have a destructive effect on the environment and can be very toxic. Mercury, the only metal that is a fluid at ambient temperatures, can be absorbed through the skin and can be fatal. While mercury and all other metals have unique properties that make them useful to designers and engineers, the **environmental impact** must be considered.

Whilst metallic elements are to be found within the Earth's crust, some are more common than others. Some metals, such as platinum and palladium, are considered precious as there is little of them on Earth. Platinum and palladium are used in cars as part of a catalytic convertor, converting dangerous gases to less harmful ones. The **sustainability** of metals is an important factor when choosing materials.

Recycling metals has become a very important industry and the value of scrap metal has become increasingly valuable. Recycling metal is considerably better for the environment as in most cases, it requires less energy to achieve that mining, processing and manufacturing new metals.

However, there are greater demands on metals as many countries develop their industries and infrastructure. Huge amounts of metals are in demand and this results in significant damage to the planet.



*Both ferrous and non-ferrous metals can be recycled.*

*Metals are shipped all over the world to be returned into useful products.*



# KNOW YOUR METALS

There are huge range of metals, each with their own unique characteristics, costs and suitability for projects.

As part of your unit and Course Assessment, you may be expected to research suitable metals. However, it is important that you do not waste time or space within your assignments researching metals that are obviously not relevant or suitable to a project - you will receive no marks.

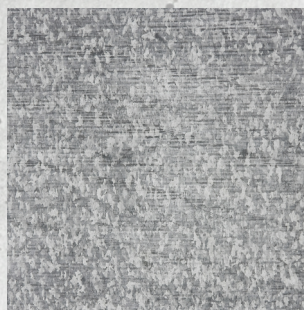
**Below is some information to help you with research.**



**Iron** is the second most common metallic element on earth. While pure iron is very soft, it is the most widely used metallic element as it is alloyed with other metals to achieve particular characteristics. Iron will rust with exposure to oxygen and water.



**Nickel** is a pure metallic element that is often alloyed with other metals, including mild steel to manufacture guitar strings, batteries and coins. Nickel is resistant to corrosion so is often used to simulate decorative silver.

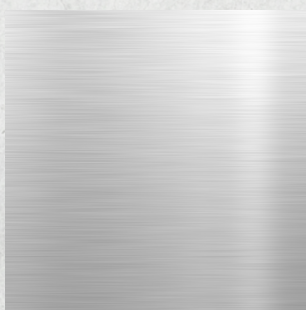


**Tin** is another pure metallic element that is one of the earliest used metals, being alloyed with copper to create bronze.

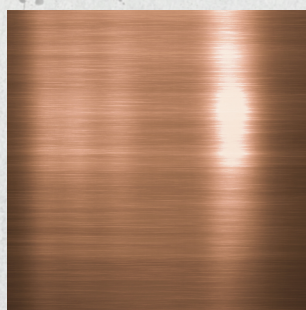
Tin is a non-toxic metal, so it is often used plate steel in the manufacture of food cans.



Whilst **Aluminium** is the most common metallic element in the Earth's crust, is not found naturally and is usually found with the ore of Bauxite. It takes a huge amount of energy to refine aluminium into a useful metal. Aluminium is light weight and has low melting point.



**Steel** is an alloy of carbon and Iron. The amount of carbon added will determine the strength or malleability of steel. Steel is often alloyed with other metals to achieve particular characteristics. For instance, adding chromium to steel will prevent it from rusting.



**Copper** is found in a pure metallic form and is most commonly used in electrical wires and pipes as it is very malleable and ductile.

Copper alloys have been found to kill bacteria and are being increasingly used for manufacturing sterile surfaces.



**Brass** is an alloy of zinc and copper, most commonly used to manufacture a range of objects from cooking pots to door knobs.

Brass is malleable and corrosion resistant.



**Pewter** is an alloy of tin, bismuth, antimony and copper. It has very low melting point and is very malleable.

Pewter has been used for thousands of years to create decorative items and tableware such as tankards and plates.

## NEED TO KNOW

Aluminium is commonly used in school as it is low cost, has a low melting point and is light weight