METALS

Alloys

Alloys Metals in their pure form can be useful for many purposes, but sometimes we need to adjust their mechanical and physical properties in order to produce a alloy more suitable material for a particular use and function.
Alloys are made by combining different metals to produce another that is more useful for a specific task. Stainless steel is an alloy of iron and chromium (from 10.5 per cent to 27 per cent). The chromium produces an oxide layer on the outer surface of the steel and prevents corrosion. Stainless steel is often used for kitchen utensils as it will not rust and can be wiped and cleaned with ease

Ferrous

Ferrous metals contain iron. Most are magnetic, which is a useful property when it comes to sorting out metals for recycling. Their carbon content means that they are prone to corrosion in the form of rust when exposed to moisture and oxygen.
Their properties, such as hardness and malleability, relate to their carbon content. For example, the more carbon that is found in the metal, the harder and less malleable it is. A good way of remembering that ferrous metals contain iron is to remember the periodic table symbol for iron.

Non - Ferrous

Non-ferrous metals do not contain iron. The absence of iron makes non-ferrous metals **malleable** and resistance to corrosion. The majority of them are also **not magnetic**, which means that they can be used in electronic devices and wiring.

Smart Metals - A shape-memory alloy is an alloy that can be deformed when cold but returns to its pre-deformed shape when heated.
For example muscle wire.

Aluminium like steel is the **most widely used metal**.
To create **aluminium**, the ore **bauxite** is mined as it contains aluminium hydroxide minerals. The bauxite is **purified** so that **aluminium oxide** is produced, and the aluminium is **extracted** from this through **electrolysis**. Huge amounts of energy are used to extract aluminium and convert it into a usable material. Recycling it requires some energy to make it usable again, but nowhere near as much.

Raw form

Metal is a naturally occurring material and is mined from the ground in the form of **ore**. The raw metal is then extracted from the ore through a combination of crushing, smelting or heating with the addition of chemicals and electrical energy. A huge amount of heat energy is needed to extract the metal from the ore - this energy often comes from **fossil fuels**.
Metal ores are **non-renewable**, meaning they are a **finite resource** and therefore **recycling** metal is important.

Metal	Characteristics and uses
Brass: A non ferrous alloy 	**Composition**: an alloy of copper65% and zinc 35%. String and ductile. Casts well. Resistant to corrosion. Conducts heat and electricity **Used for:** Musical instruments, plumbing fittings, taps and wood screws.
Stainless Steel: A ferrous alloy	**Composition:** an alloy of steel including chromium 18% and nickel 8%. Hard and tough. Very corrosion resistant. **Used for** : Sinks, cutlery and surgical equipment.
Duralumin 	**Composition:** an alloy of aluminium 90%, copper 4%, magnesium 1% and manganese 0.5 - 1%. Strong, soft and malleable, resistant to corrosion and lightweight. **Used for:** Aircraft, fixings and fuel tanks.
High speed steel: A ferrous alloy	**Composition:** an alloy of iron, carbon (>0.6%) and other metals including chromium, tungsten and vanadium. Able to withstand high temperatures created when machining at high speed, keeps its cutting edge well. **Used for:** cutting tools such as drill bits, mill cutters and taps and dies.

Metal	Characteristics and uses
Cast iron 	**Composition:** iron and 3.5% carbon. Hard surface but has a brittle soft core, strong compressive strength, inexpensive. **Used for:** vice, car brake discs,
Low carbon steel mild steel	**Composition:** iron and 0.15-0.35% carbon. Good tensile strength, tough, malleable, poor resistance to corrosion. **Use for:** car bodies, nuts, bolts and screws, RSJs and girders.
High carbon steel tool steel	**Composition**: iron and 0.70-1.4% carbon. Hard but also brittle, less tough, malleable or ductile than medium carbon steel. **Used for:** screwdrivers, chisels,
High speed steel A ferrous alloy 	**Composition:** an alloy of iron, carbon (>0.6%) and other metals including chromium, tungsten and vanadium. Able to withstand high temperatures created when machining at high speed, keeps its cutting edge well. **Used for:** cutting tools such as drill bits, mill cutters and taps and dies.

Metal	Characteristics and uses
Aluminium 	**Composition:** pure metal Lightweight, soft, malleable, good conductor of heat and electricity, corrosion resistant. **Used for:** aircraft bodies, cans, sauce pans, bike frames.
Copper 	**Composition:** pure metal. Extremely ductile + malleable, excellent conductor, easily soldered and corrosion resistant. **Used for:** plumbing fittings, water tanks, electrical wire.
Pewter 	**Composition:** 85–99% tin, mixed with approximately 5–10% antimony, 2% copper, bismuth. A malleable metal alloy. **Used for:** decorative items .
Tin 	**Composition:** pure metal. Soft, ductile + malleable, low melting point, excellent corrosion resistance. **Used for:** coatings on food and drinks cans

Words

-Non Ferrous
-Ferrous
-Alloy
-Non renewable
-Finite
-Ore
-Bauxite
-Brittle
-Conductor
-Ductile
-Malleable
-Corrosion resistant
-Durable
-Tensile strength

-Do not mix up your ferrous and non ferrous.

Think about the elements on the periodic table this may help you work out if a metal is an alloy, ferrous or non ferrous metal

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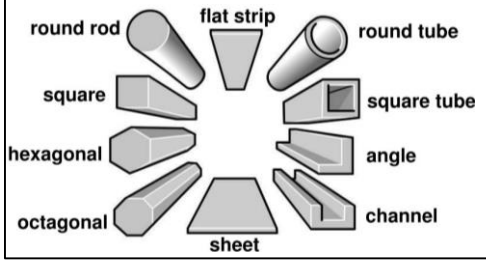
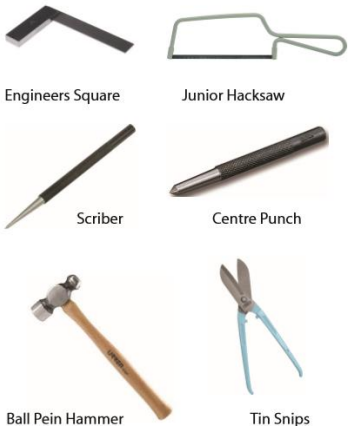
Materials core: Metals

Stock forms

Metals are available in several forms. Each form is suitable for different manufacturing processes depending on the type of equipment used, the cost of the metal, the scale of production and the properties of the finished product.



Tools for metal



Marking out on metal

Scriber - a sharp point to put a fine scratch on the surface of the metal , used for marking out
Steel rule - more accurate than a plastic ruler and often has half mm as well as mm
Ball pein hammer - used for tapping a centre punch before drilling a hole
Centre punch - used to create a drill point before a hole is drilled into metal so that the drill bit does not slip
Engineer's square - used for marking out at 90 degrees to an edge or
Marking blue or **layout fluid** - dye used to coat the surface to be marked with the scriber (making it easier to see the mark).

Words

-Brazing
-Oxyacetylene Welding
-Arc Welding
-Rivets
-Turning
-Milling
-Casting

Permanent joining methods

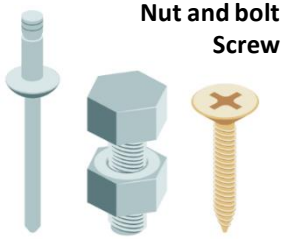
Adhesive	Some metals can be permanently bonded with adhesives such as epoxy resin.
Soft soldering	Used to solder printed circuit boards (PCBs) and electronic components. Plumbing where copper pipes are joined.
Brazing	Used for joining steel by melting a brass rod on the hot steel. As the brass melts, it forms a joint.
Gas welding/ Oxyacetylene welding	Oxygen and acetylene are used to produce a flame with a temperature of over 3,000°C. A filler rod is melted so that pieces of metal can be joined. Gas welding/ Oxyacetylene welding is faster than brazing.
Arc welding	Heat is produced by a high current that is passed down the filler rod. When the filler rod melts, it fuses the pieces of metal together. Arc welding is fast and portable.

Forming and Deforming

Cold forming – Thin sheet materials and a narrow gauge rod and wire can be deformed using a range of cold forming processes.
Simple bends can be made using a vice and a ball pein hammer.

Fixing and fastening methods

Rivet
Nut and bolt
Screw



Riveting provides a quick and clean method to join metals together instead of welding but needs the metals to be over lapping.
Nuts and bolts and **self-tapping screws** are temporary

Wasting metals by cutting and shaping.

Sawing - hack saw, jigsaw	**Drilling** – hand drill and pillar drill with high-speed bits.
Shearing – Thin sheet metal can be cut with metal sheers or tin snips	**Filing** – Edge shaping and finishing can be achieved by hand with a range of files
Using a flat-ended slot drill, milling machine cuts laterally, giving a high degree of control	**Turning** – CAM (computer controlled) or manual lathes can waste metal rod accurately by both boring and turning.

Wasting Metals Using CAD/CAM – Computer controlled milling machines and lathes are used in schools and industry to waste and shape metals.

Shaping metals - Milling and turning

There are 3 main methods of shaping metal by a machine in a commercial setting.
· **Turning** · **Milling** · **Casting**

Metal can be **turned** in a **lathe**, which can be hand operated or controlled via a computer. A lathe spins the work at high speed as a cutting tool is used to create round and cylindrical shapes.	Metal can be **cast** by smelting metal and then pouring it into a mould. **Pewter** has low melting point and is quite easy to cast. Moulds can be made from laser-cut or hand-shaped **medium-density fibreboard (MDF)**.
Metal can be shaped using a **milling machine** - a very versatile tool for smoothing a surface or edge and for cutting grooves and profiles.	**Sandcasting** can be used to cast larger and more complex shapes as it uses a two-part mould.

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Materials core: Metals – techniques and processes

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