Science Mid Year Exam Revision

Chemistry

Rates of reaction

The Periodic Table

Gases in the Atmosphere

Metals

Rates of Reactions

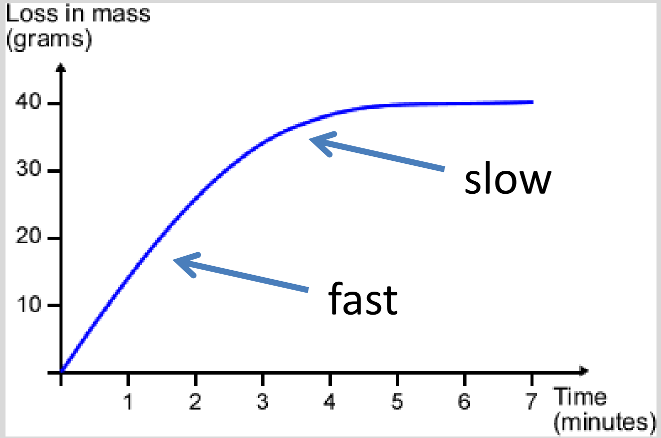
Keywords

- **Rate of reaction** – The speed at which a reaction takes place

Examples

- Fast reactions = Burning, explosions
- Slow reaction = Rusting, apple browning

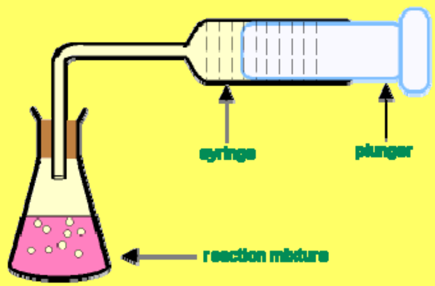
Rate of reaction = **the amount of reactants used or products formed** / **time**



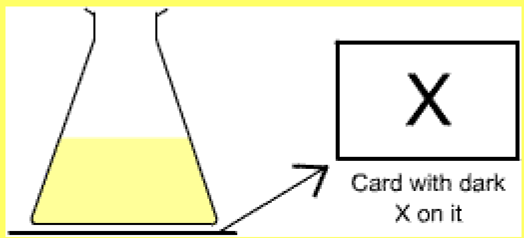
The slope of the line at any given time tells us the rate of a reaction at that time. The steeper the line the faster the reaction.

How to measure the sate of a reaction.

1. Measure the rate at which the mass of a reaction changes if a gas is given off.
2. Measure the volume of gas produced in a reaction at given time intervals.



3. Measure the rate at which a solid appears. Do this by timing how long it takes for a solution to go cloudy.



Collision Theory and changing the rate

Keywords

- **Concentration** – A measure of how much solute is dissolved in a fixed volume of solvent.
- **Surface area**– The total area of all the surfaces of an object or substance

Collision Theory

- For particles to react they need to collide.
- They also need enough energy to react when they collide
- The minimum energy needed is called the activation energy.

Factors affecting Rate

1. Temperature

- Higher temperature = faster reaction

e.g. And egg cooks faster in boiling water than warm water

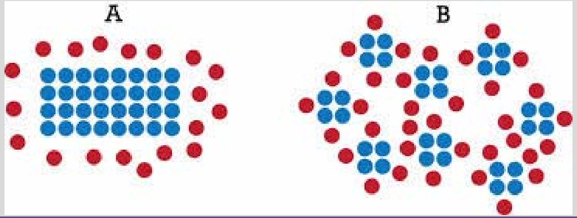
- Particles have more energy = move faster
  - More effective collisions (collide with more energy)
  - Collide more frequently

2. Concentration

- More concentrated = more particles
- More particles = more collisions = faster reaction

3. Surface area (SA)

- Solid broken up into smaller pieces = larger SA
- Greater surface area = faster reaction
- More surface area = more particles on the surface therefore more frequent collisions
- A = Smaller SA (block)
- B = Larger SA (powder)



Catalysts

Keywords

- **Catalyst** – A substance that speeds up the rate of a reaction without being used up in the reaction

FACTS:

- Many chemical processes use catalysts to increase rate of production of products
- Catalysts help to lower the temperature and pressure needed = less energy needed = saves money
- Different chemical reactions require different catalysts.
- Catalysts lower the activation energy of a reaction.
- Catalysts are normally used as powders or pellets to give them as big surface area as possible.

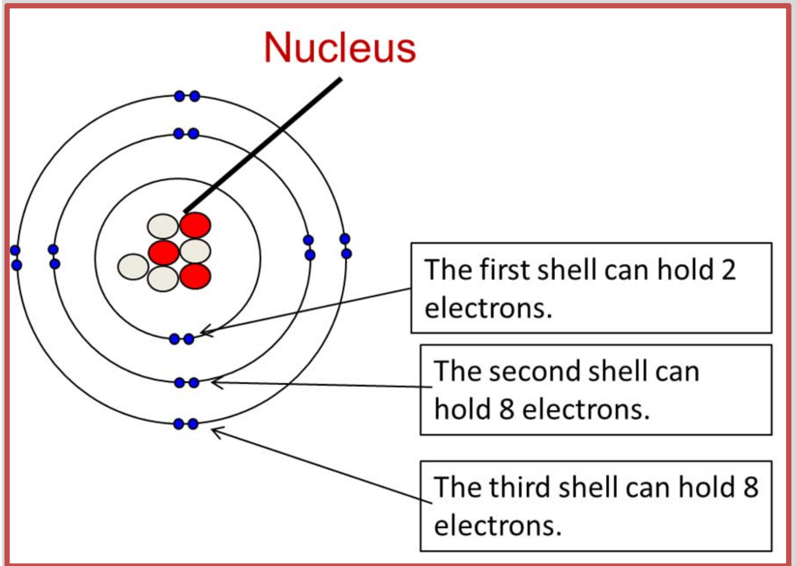
Catalysts – disadvantages

•Catalysts are often transition metals. These can be toxic. If they get into the environment they can build up in living things.

Atoms

STRUCTURE OF THE ATOM:
Protons and Neutrons are found in the **nucleus**. Electrons orbit the nucleus in **shells**.

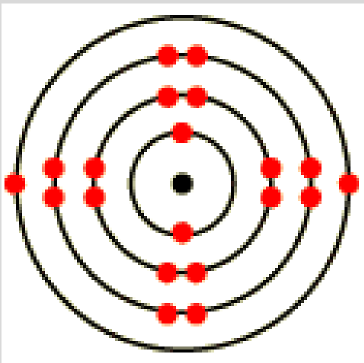
All substances are made of **atoms** this is cannot be chemically broken down it is the smallest part of an **element**. **Elements** are made of only one type of atom. **Compounds** contain more than one type of atom. Compounds are held together by **bonds**. **Mixtures** contain elements and compounds.



An atom contains **equal** numbers of **protons** and **electrons**. All **atoms** of an **element** have the same **number** of **protons**. Atoms of **different** elements have **different numbers** of **protons**.

	Proton	Neutron	Electron
Mass	**1**	**1**	**negligible**
Charge	**+**	**0**	**-**
Location	**nucleus**	**nucleus**	**shells**

Electron configurations can be written 2,8,8



Calcium Ca 2,8,8,2

Atoms of each element are represented by a **chemical symbol** e.g. O for oxygen, Na for sodium.

Mass number = Number of **protons** and **neutrons**

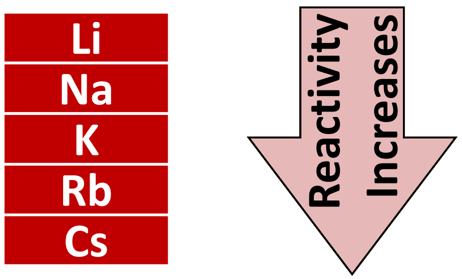
Atomic number = Number of protons

7
Li
3

Number of neutrons Mass Number – Atomic Number

The periodic table

Elements in the **same group** in the periodic table have the **same number** of **electrons** in their **outer shell** so they have **similar chemical properties**.
E.g. Group 1 Alkali metals



Reactions of group 1 elements with water

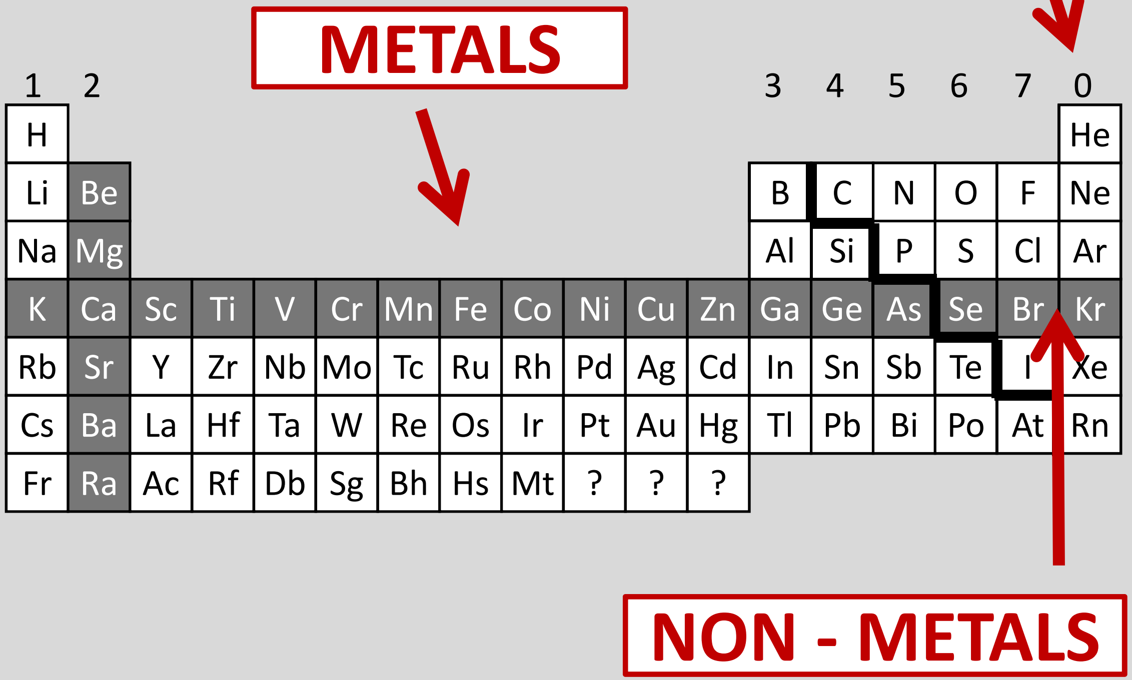
Lithium, sodium and potassium all react vigorously with water.

metal + water → metal hydroxide + hydrogen

The **metal hydroxides** are strong alkalis. The **group 1 elements** need to be stored under **oil** to prevent them reacting with **oxygen** and **water** vapour in the **air**.

Each **element** has its own **symbol**. **Columns** are called **groups** **Elements** in a group have **similar** properties. **Rows** are called **periods**. The staircase line splits **metals** (LEFT) from **non-metals** (RIGHT)

Elements in **Group 0** of the periodic table are called the **noble gases**. They are unreactive because their atoms have **stable** arrangements of **electrons**. A full outer shell.



C3.1.3

Trends within the periodic table:
Group 1 - the alkali metals

- Physical properties:
  - **Low density** (the first three elements in the group are less dense than water)
  - The further **down the group** an element is:
    - the **more reactive** the element
    - the **lower** its **melting point** and **boiling point**
- Chemical properties:
  - All react **with non-metals** to **form ionic compounds** in which the **metal ion** carries a charge of **+1**
  - The **compounds** are **white solids** that dissolve in water to form colourless solutions
  - All **react with water**, releasing **hydrogen**
  - All form **hydroxides** that dissolve in water to give **alkaline solutions**

C3.1.3

Trends within the periodic table:

The transition elements

- Compared with the elements in Group 1, transition elements:
  - have **higher melting points** (except for mercury) and **higher densities**
  - are **stronger** and **harder**
  - are much **less reactive** and so do not react as vigorously with water or oxygen
- Many transition elements have **ions with different charges**, form **coloured compounds** and are useful as **catalysts**

C3.1.3

Trends within the periodic table:
Group 7- the halogens

- The elements in Group 7 of the periodic table **react with metals** to form **ionic compounds** in which the **halide ion** carries a **charge of –1**
- In Group 7, the **further down** the group an element is:
  - the **less reactive** the element
  - the **higher** its **melting point** and **boiling point**
- A **more reactive** halogen can **displace** a **less reactive** halogen from an aqueous solution of its salt.

C3.1.3

Higher tier only

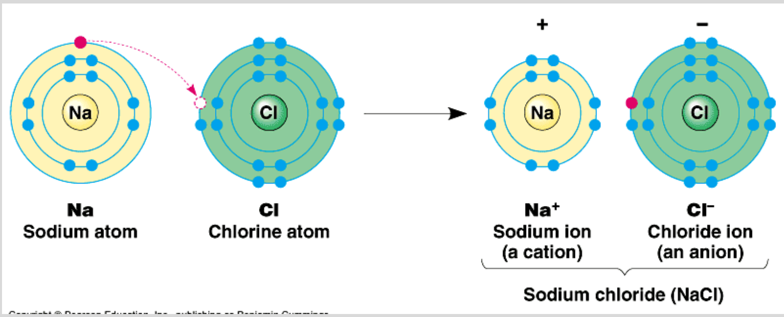
Trends within the periodic table:
Explaining the trends

Higher tier only

- The trends in reactivity within groups in the periodic table can be explained because the higher the energy level of the outer electrons:
  - the more easily electrons are lost
  - the less easily electrons are gained
- Group 1 elements react by losing an electron
  - Therefore Li is less reactive than K, because it its outer electron is nearer to the attractive nucleus
- Group 7 elements react by gaining an electron
  - So F_2 is more reactive than I_2, because its outer electrons are nearer the positive nucleus

Chemical reactions

Ionic Bonding: Metal and **non-metal** react. **Metals** form **positive ions**, **Non-metals** form **negative ions. Opposite** charges **attract.** Metals **LOSE** electrons Non Metals **GAIN** electrons.



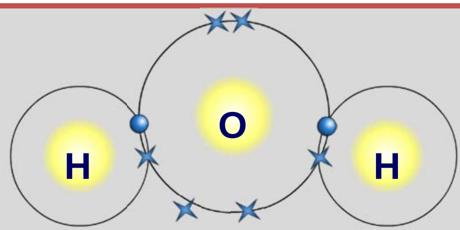
Na $[2,8]^+$ and Cl $[2,8,8]^-$

IONS ARE FORMED WHEN ELEMENTS LOSE OR GAIN ELECTRONS THEY ARE CHARGED PARTICLES.

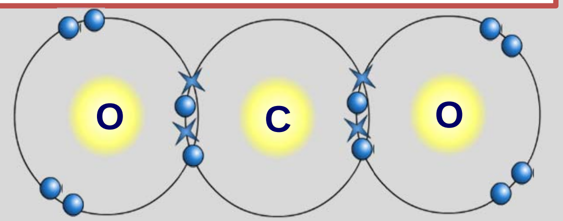
Group 1 elements **lose 1** electron make **ions** $^+$, **group 2** lose **2 electrons** make **ions** 2^+, **group 6** gains **2 electrons** make **ions** 2^-, **group 7** gains **1 electron** make **ions** 1^-.

When **elements react,** their **atoms join with other atoms** to form **compounds.** There are **two** types of **bonds** formed in a **chemical reaction**

Covalent Bonding: When **two non-metals** bond. Outermost **electrons** are **shared** . A pair of **shared electrons forms a bond**



WATER (H_2O)



Carbon dioxide (C O_2)

Group 4 elements share **4 electrons**. **Group** 5 elements share **3 electrons**. **Group 6** elements share **2 electrons**. **Group 7** elements and **hydrogen** share **1 electron**.

Chemical equations: They show the **reactants** (what we start with) and the **products** (what we end with). No **atoms** are **lost** or **made**. The **mass** of the **products** equals the **mass** of the **reactants**.

Word Equation:	**calcium carbonate**	→	**calcium oxide + carbon dioxide**			
Symbol Equation:	$CaCO_3$	→	CaO	+	CO_2	

Chemical reactions Higher Tier – Balancing equations.

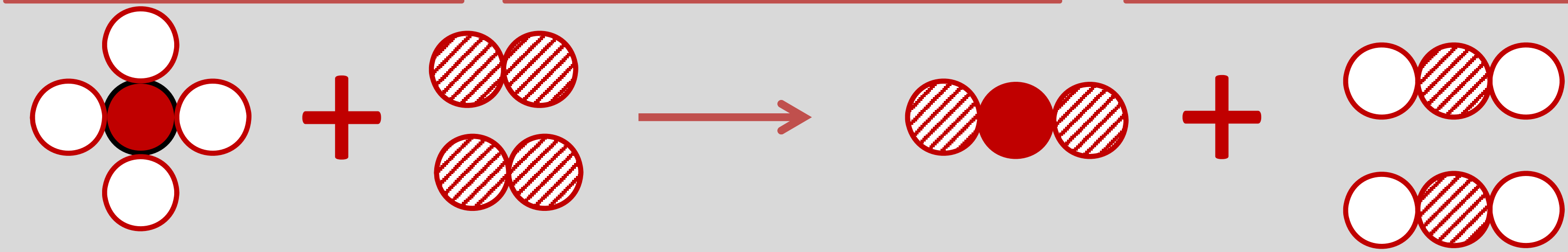
Methane + Oxygen → Carbon dioxide and Water

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

There are 4 hydrogens here, bonded together.

There are 2 molecules of oxygen not bonded together.

There are 4 hydrogens here. You multiply the big number by the little number.



Equations **MUST** balance

We can **ONLY** add **BIG** numbers to the front of a substance

We can tell elements within a compound by **BIG** letters

We can check an equation is balanced by counting the number of each type of atom on either side

C3.4.1

Analysing substances:

Tests for positive ions – flame tests

- Many metal ions will produce distinctive colours when a crystal or a solution of a metal compound is held in a flame:
  - **lithium** compounds result in a **crimson flame**
  - **sodium** compounds result in a **yellow flame**
  - **potassium** compounds result in a **lilac flame**
  - **calcium** compounds result in a **red flame**
  - **barium** compounds result in a **green flame**

C3.4.1

Analysing substances:

Tests for positive ions - NaOH

- Some metal ions will form a precipitate (solid) when added to solution of sodium hydroxide ($NaOH_{(aq)}$)
  - **Aluminium, calcium** and **magnesium ions** form **white precipitates** with **sodium hydroxide** solution
    - ***only*** the **aluminium** hydroxide precipitate **dissolves in excess** sodium hydroxide solution
  - **Copper(II)** (Cu^{2+}) forms a **blue precipitate**
  - **Iron(II)** (Fe^{2+}) forms a **green precipitate** (which quickly turns **brown** due to oxidation with oxygen in the air)
  - **Iron(III)** (Fe^{3+}) forms a **brown precipitate**

C3.4.1

Analysing substances:
Tests for negative ions

- **Carbonates** react with **dilute acids** to form **carbon dioxide**:
  - Carbon dioxide produces a **white precipitate** with **limewater**, which turns the limewater **cloudy**
- **Halide ions** in solution produce precipitates with **silver nitrate solution** in the presence of **dilute nitric acid**:
  - Silver **chloride** is **white**
  - Silver **bromide** is **cream**
  - Silver **iodide** is **yellow**
- **Sulfate ions** in solution produce a **white precipitate** with **barium chloride** solution in the presence of **dilute hydrochloric acid**

Gases in the atmosphere

Our atmosphere today…

Gas	Formula	% in dry air
Nitrogen	N_2	78
Oxygen	O_2	21
Argon	Ar	0.9
Carbon Dioxide	CO_2	0.04
other		trace

How do scientists use rocks to work out the composition of the Earth's early atmosphere?

Analyse the minerals in them and look for oxides. As more oxygen was present, more oxide mineralswere formed.

Changes in the atmosphere occur through;

Natural activities:

- Volcanic activity can lead to a rise in sulphur dioxide; lightening can lead to a rise in nitrogen oxides.

Human activity:

- burning fossil fuels can lead to an increase of carbon dioxide, carbon monoxide and sulphur dioxide.
- **Deforestation** lead to an increase in carbon dioxide; burning trees releases carbon dioxide (combustion), fewer trees to photosynthesise and absorb carbon dioxide; engines and furnaces release **nitrogen oxides.**
- **Farming:** increasing numbers of cattle and rice fields can lead to an increase of methane.

Extracting metals

A **metal compound** within a **rock** is an **ore.** The metal is **often combined** with **oxygen**. Ores are **mined** and then **purified**.

The Reactivity Series

Increasing reactivity

Potassium
Sodium
Calcium
Magnesium
Aluminium

CARBON

Zinc
Iron
Lead
Copper
Silver
Gold

Copper-rich Ores: Large amounts of copper.
1. Smelting: 80% of copper is produced this way. **Heat copper ore in a furnace with air.**
Then use electrolysis to purify the copper. **Expensive** as needs lots of heat and power.
2. Copper Sulphate: Add **sulphuric acid** to a copper ore. Produces copper sulphate. Extract copper using electrolysis or displacement.

Low Grade Copper Ores: Small amount of copper.
1. Phytomining:
Plants absorb **copper** ions from low-grade ore. **Plants** are **burned**. Copper ions dissolved by adding **acid**. Use **displacement** or **electrolysis** to extract pure Copper.
2. Bioleaching:
Bacteria feed on low-grade ore
Produce a **waste product** that contains **copper** ions
Use **displacement** or **electrolysis** to extract pure copper.

The reactivity of a metal determines the method of extraction. Metals **above** carbon must be **extracted** using **electrolysis.** Metals **below** carbon can be extracted by **reduction** using **carbon**, coke, or charcoal. **Gold** and **silver** do not need to be extracted. They occur **native** (naturally).

During electrolysis: In a solution or molten compound when electricity is passed through it **positive metal** ions move towards the **negative electrode**. **Negative non metal** ions move towards the **positive electrode**.

Extracting metals

	Aluminium	Titanium
Property	Light, Low density, **Oxide** layer on the surface prevents **corrosion**, Improve hardness by forming **alloys**. These alloys are **stronger** and **rigid** than pure Al.	**Strong**, **Oxide** layer on the surface prevents **corrosion**, **High** melting point – so can be used at high temperatures, **Less dense than most metals**
Use	**Uses:** Drinks cans, cooking oil, saucepans, overhead cables, aeroplanes.	**Uses:** Hip replacements, racing bikes, jet engines, parts of nuclear reactors.
Extraction	**Aluminium ore** is mined and **extracted**. Aluminium oxide (the ore) is melted. **Electric current passed through a high temperature** ***Expensive process – need lots of heat and electricity***	Use **sodium** or **potassium** to **displace** titanium from its ore ***Expensive – lots of steps involved to process and needs lots of heat and electricity.***

It is good to recycle metals:

Reduces the **energy** needed to **extract** them and process them as much **less energy** is needed to **recycle metals** than extract from their ore. **Less pollution** due to less processing and **not as many vehicles** needed to transport. Stops the **landscape** being destroyed and disruption to **wildlife** and people living near.

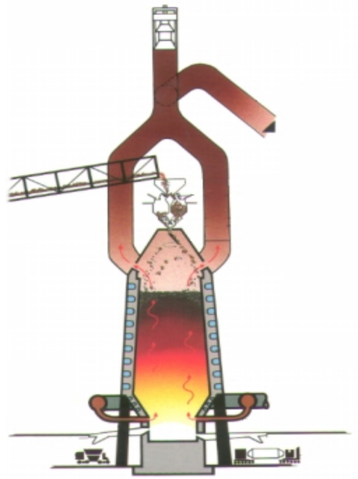
Alloys

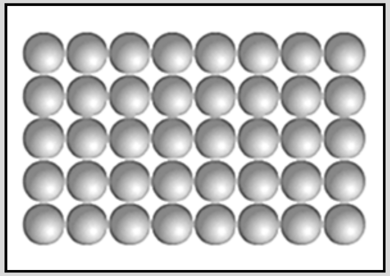
A **metal mixed** with other **elements** is called an **ALLOY.** Alloys are **harder** than pure metals.

Extracting Iron

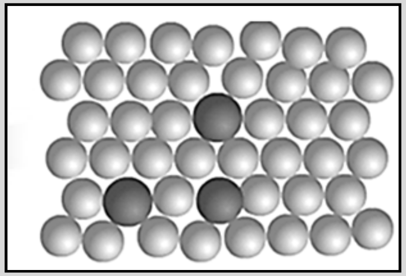
Iron ore goes into the **blast furnace** and the **iron is** removed from **iron oxide by carbon.** Reactions in which oxygen is removed are called **reduction reactions**.

Iron from the **blast furnace** contains about **96%** iron. The **impurities** make it **brittle** and so it has **limited** uses.





Pure metal – regular pattern layers slide easily over each other.



Alloy – other element disrupts regular pattern layers DO NOT slide easily over each other.

IRON ALLOYS

Steel → Iron with carbon and/or other elements. Impurities make it brittle. **There are a number of types of steel alloys:** Low carbon steel – easily shaped, High carbon steels – very hard, Stainless steels – resistant to corrosion

ALUMINIUM ALLOYS

Aluminium naturally soft
Mixed with **wide range** of other **elements**
All have very **different properties**
E.g. in aircraft or armour plating!

COPPER ALLOYS

Copper naturally soft
Bronze (Copper + Tin) Tough, Resistant to corrosion, **Brass** (Copper + Zinc), Harder but workable

GOLD ALLOYS

Copper naturally soft
Usually add **Copper** to make jewellery **stronger** and last longer.

Properties and uses of metals

Transition Metals have the following properties: **Shiny** when polished, **Malleable** – can be hammered into a shape, **Strong**, don't break easily when a force is applied, **High melting point , Sonorous** – makes a ringing sound when hit, **Ductile** – can be stretched into wires, Conducts **electricity** and **heat.**

Used as **structural** metals to make, buildings, bridges, cars.

Transition Metals

1	2											3	4	5	6	7	8
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt									

Copper has **properties** that make it useful for **electrical wiring** and **plumbing**. Not very reactive, **excellent conductor of electricity**, easily **bent** into shape for **water pipes** in plumbing.