C5 Chemical Changes

Displacement reactions and metal extraction

potassium	most reactive	K
sodium		Na
calcium		Ca
magnesium		Mg
aluminium		Al
carbon		C
zinc		Zn
iron		Fe
tin		Sn
lead		Pb
hydrogen		H
copper		Cu
silver		Ag
gold		Au
platinum	least reactive	Pt

Reactivity depends on tendency to form metal ion

A and C are Cations (Positive Ions)
B and D are Anions (Negative Ions)
Double Displacement Reaction

HT: OILRIG
Oxidation Is Loss of electrons
Reduction Is Gain of electrons

Metal + Oxygen → Metal Oxide

Metal + Water → Metal Hydroxide + hydrogen

Metal + acid → Metal salt + Hydrogen

Reactions of acids

Acid+metal → salt + hydrogen
Acid + alkali → salt + water
Acid + insoluble base → salt + water
Acid + carbonate → salt + water + carbon dioxide

HT: OILRIG
e.g. $2HCl + Mg \rightarrow MgCl_2 + H_2$
Magnesium is oxidised
$Mg \rightarrow Mg^{2+} + 2e^-$

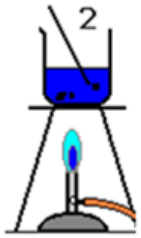
Hydrochloric Acid → Chlorides
HCl
Nitric Acid → Nitrates
HNO_3
Sulphuric Acid → Sulphates
H_2SO_4

RP: Preparation of a dry sample of a soluble salt

Choose correct acid

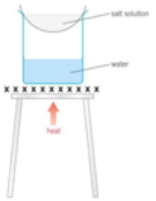
Add base to excess

warm

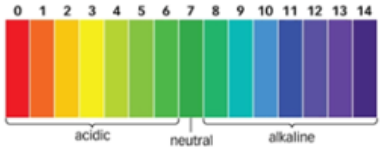


Filter off excess

Evaporate off water



Neutralisation



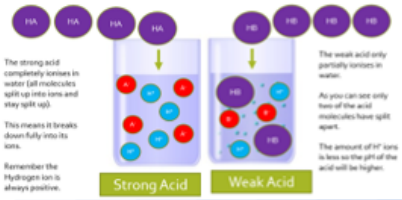
Acids produce H^+ ions
Alkalis produce OH^- ions

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

HT: Strong and Weak acids

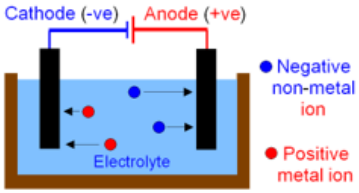
Concentration of hydrogen ions in mol/dm³	pH
0.10	1.0
0.010	2.0
0.0010	3.0
0.00010	4.0

Strong and weak acids



Electrolysis

..of molten:

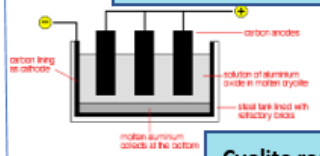


Higher:
At the cathode
$Pb^{2+} + 2e^- \rightarrow Pb$

Higher:
At the anode
$2Br^- \rightarrow Br_2 + 2e^-$
or
$2Br^- - 2e^- \rightarrow Br_2$

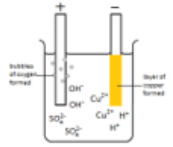
..to extract aluminium:

Oxygen goes to anode → CO_2 (needs replacing)



Cyolite reduces the melting point

..of solutions:



At the anode:
Halide (Gp7)
Oxygen

At the cathode:
Least reactive

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C2 Periodic Table

History

Early periodic tables arranged in order of **atomic weight**

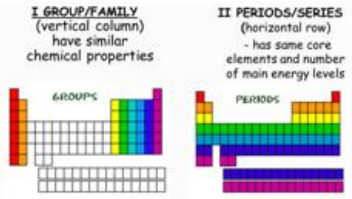
☹ Some elements were in the wrong groups so didn't follow the pattern

Mendeleev **left gaps** for undiscovered elements.

☺ The elements were discovered that filled the gaps and proved him right.

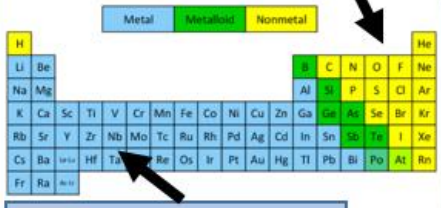
☺ **Isotopes were discovered** which explained why order based on weight didn't work.

Modern periodic table – order of **atomic (proton) number.**
Elements with similar properties in columns (**groups**).
Elements in same group have the same number of electrons in their outer shell and so have similar chemical properties.



Metals vs Non-metals

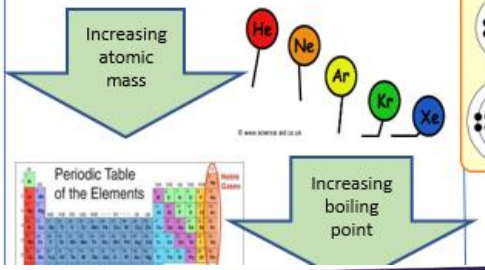
Non-metals: Many electrons in outer shell so form **negative ions.** Low melting and boiling points.



Metals: Few electrons in outer shell so form **positive ions.** Hard, high melting and boiling points.

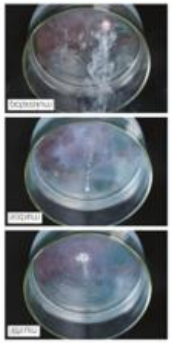
Group 0

Noble gases.
Unreactive (due to full outer shell)



Group 1

Alkali Metals
Very reactive (due to single electron in outer shell)

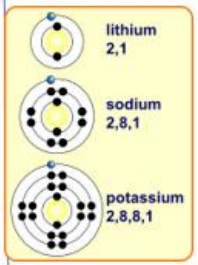


- Metals
- React with oxygen to form **oxides**
- React with water to form the **hydroxide and hydrogen**
- React with chlorine to form **chlorides**

sodium + oxygen → sodium oxide
$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$

sodium + water → sodium hydroxide + hydrogen
$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

sodium + chlorine → sodium chloride
$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

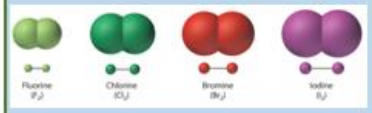


Alkali metals get MORE reactive

Group 7

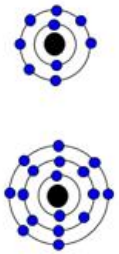
Halogens
Very reactive (due to having 7 electrons in outer shell)

- Non- metals
- Exist in pairs as molecules (diatomic molecules)



- React with metals to form white solid crystals
- React with non-metals to form small molecules

Halogens get MORE reactive



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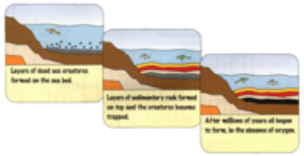
Crude Oil / Fuels
K O

Hydrocarbons

Crude Oil is made from the remains of living **sea creatures** decayed in mud millions of years ago

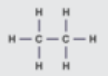
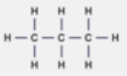
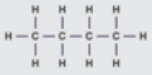


It is a **FINITE** resource

It is made of a mixture of Hydrocarbons.

Hydrocarbons are made of **Hydrogen and Carbon only.**

The main hydrocarbons in Crude Oil are **alkanes**

Alkane	Molecular formula	Structural formula
Methane	CH_4	
Ethane	C_2H_6	
Propane	C_3H_8	
Butane	C_4H_{10}	

The general formula for an alkane is -

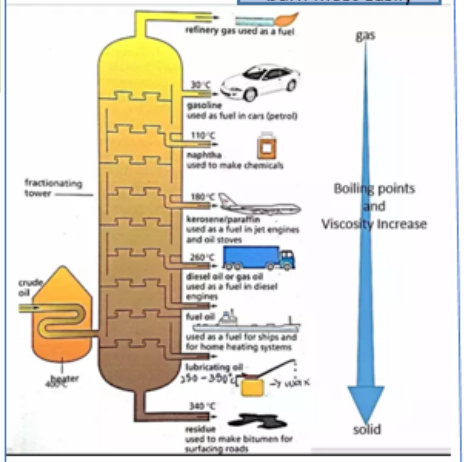
C_nH_{2n+2}

Fractional Distillation

How do we separate the mixture of hydrocarbons to use them?

Works by **evaporation** and then **condensation.**

Smaller molecules burn most easily



1. **Heat** the crude oil to **evaporate** it.
2. The gases **rise** up the column.
3. The different fractions **condense** at **different temperatures.**

Combustion

Combustion (burning) is a reaction with **oxygen**

A reaction with oxygen is called **'oxidation'**

When hydrocarbons burn a lot of **energy** is released.

Complete combustion of hydrocarbons the only products are **carbon dioxide and water**

Complete combustion only happens if there is plenty of oxygen

General equation

hydrocarbon + oxygen → carbon dioxide + water

Complete combustion of propane

propane + oxygen → carbon dioxide + water

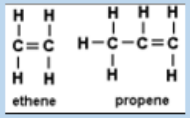
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Cracking

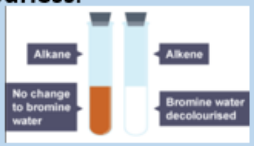
The larger molecules from fractional distillation are less useful. We can break them down into smaller, more useful molecules.

Cracking produces a mixture of **alkanes and alkenes.**

Alkenes have **some double bonds.**

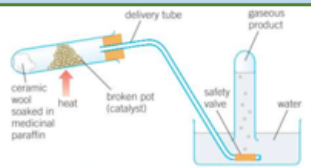


They turn **bromine water colourless.**



They are used to make **polymers.**

The apparatus for cracking



Catalytic cracking – catalyst and 500°C

Steam cracking – steam and 850°C

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