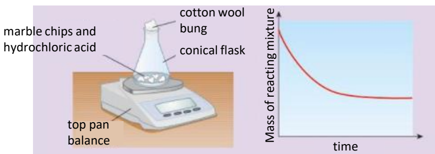
Year 11 – Chemistry / C8 Rates & Equilibrium – HT3

Measuring Rate

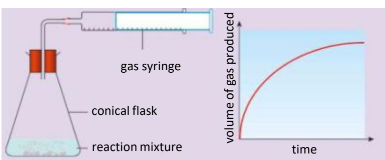
To measure the rate of a reaction you can:

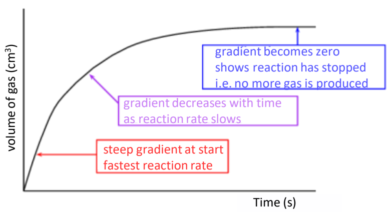
- Measure how fast the reactants are used up
- Measure how fast the products are made

e.g. measure mass lost due to gas formed



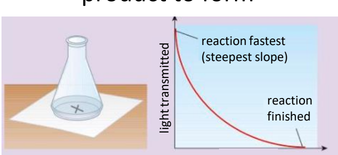
e.g. measure volume of gas made





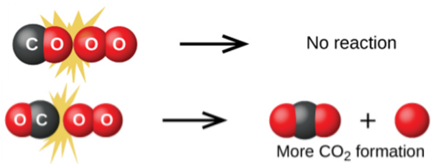
Rate = volume of gas ÷ time
cm^3/s

e.g. measure time for insoluble product to form



Collision Theory

For a reaction to happen reactants must: **collide** with **enough energy** (activation energy)



A successful collision is one that leads to a reaction

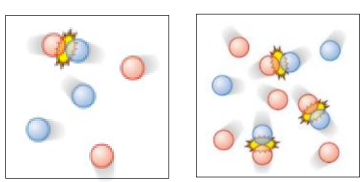
So to increase the rate of a reaction you must either

- **Increase the frequency of collisions**
- **Increase the energy of the collisions**
- **Decrease the energy needed for a collision to be successful**

FACTORS AFFECTING RATE

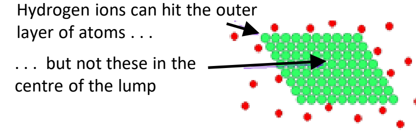
Concentration and Pressure

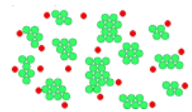
More particles in the same space.
More frequent collisions



Surface Area

More particles available to react.
More frequent collisions

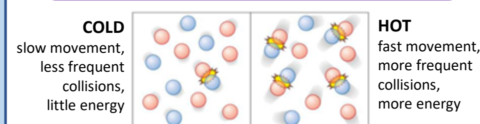


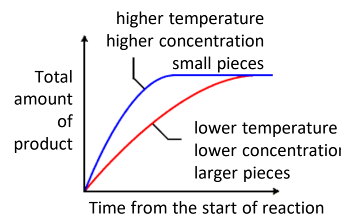


With the same number of atoms now split into lots of smaller bits, that are hardly any magnesium atoms which the hydrogen ions can't get at

TEMPERATURE

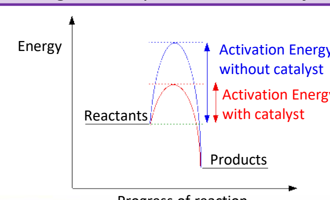
Particles **move faster**.
So they **collide more frequently**.
Particles collide **with more energy**.
So more of the collisions are **successful**.





CATALYSTS

Lower the energy needed for successful collisions (Activation Energy) **Not used up**
Biological catalysts are called **enzymes**



Reversible Reactions

Can go in both directions

$$A + B \rightleftharpoons C + D$$

If a reaction is exothermic in one direction it is endothermic in the other direction

endothermic (in forward reaction)

hydrated copper (II) sulphate (blue) ⇌ anhydrous copper (II) sulphate (white) + water

$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$

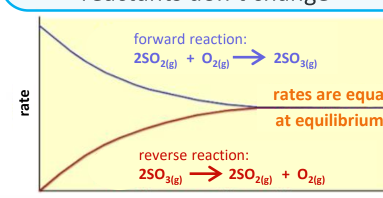
exothermic (in reverse reaction)

In a **closed system** (where nothing can get in or out) an **equilibrium** is reached where the **rate of reaction is the same in both directions**

1) A+B →	Reactants only at start of reaction
2) A+B ⇌ C+D	Rate of → much greater than ← at first
3) A+B ⇌ C+D	Rate of ← increases as C+D build up. Rate of → slows down as reactants get used up
4) A+B ⇌ C+D	Eventually the rates of → and ← are the same

At equilibrium:

- Rate of forward reaction = rate of reverse reaction
- Mount of products and reactants don't change



Displacement Reactions & 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

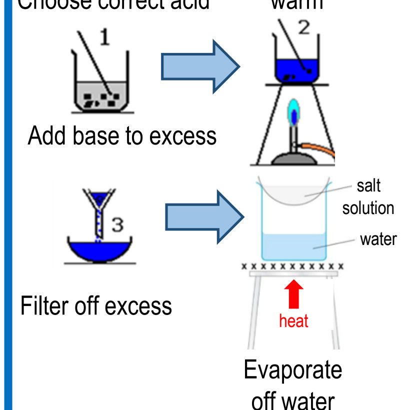
Reactions of Acids

Acid + Metal → Salt + Hydrogen
Acid + Alkali → Salt + Water
Acid + Insoluble Base → Salt + Water
Acid + Carbonate → Salt + Water + Carbon Dioxide

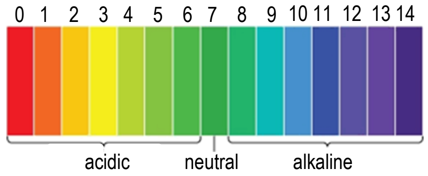
HT: OILRIG
e.g. $2HCl + Mg \rightarrow MgCl_2 + H_2$
Magnesium is oxidised
$Mg \rightarrow Mg^{2+} + 2e^-$

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



Neutralisation



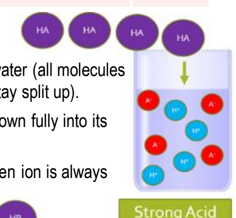
Acids produce	**H^+ ions**
Alkalis produce	**OH^- ions**

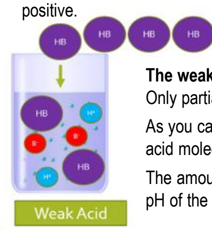
$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

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

The strong acid
completely ionises in water (all molecules split up into ions and stay split up).
This means it breaks down fully into its ions.
Remember the Hydrogen ion is always positive.

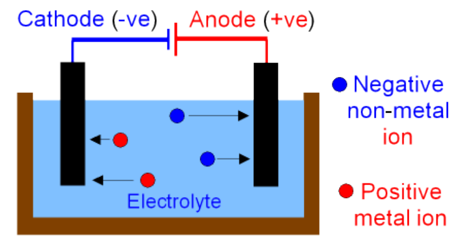




The weak acid
Only partially ionises in water.
As you can see only two of the acid molecules have split apart.
The amount H^+ ions is less so the pH of the acid will be higher

Electrolysis

… of molten

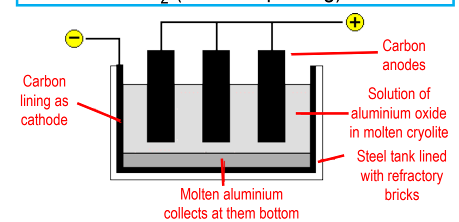


Higher:
At the cathode
$Pb^{2+} + 2e^- \rightarrow Pb$

Higher:
At the cathode
$2Br^- \rightarrow Br_2 + 2e^-$
Or $2Br^- - 2e^-$ Br_2

… to extract aluminium

Oxygen goes to anode → CO_2 (needs replacing)

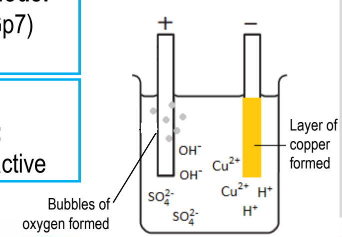


Cyolite reduces the melting point

… of solutions

At the anode:
Halide (Gp7)
Oxygen

At the cathode:
Least reactive



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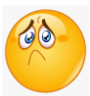
Year 11 – Chemistry / Periodic Table – HT3

History

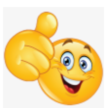
Early periodic tables were arranged in order of **atomic weight**

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 that proved him right

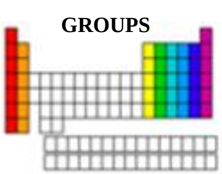


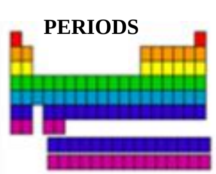
Isotopes were discovered which explained why order based on weight didn't work

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

I GROUP/FAMILY (vertical column) have similar chemical properties

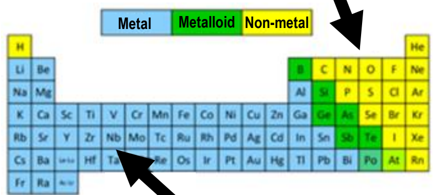
II PERIODS/SERIES (horizontal row) has some core elements and number of main energy levels





Metals vs Non-Metals

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

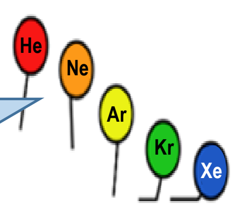


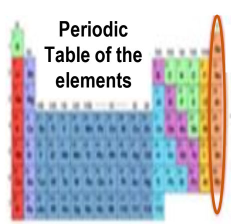
Metals: Few electrons in outer shell so form **positive ions**. Hard, high melting and boiling points.

Group 0

Noble Gases:
Unreactive (due to full outer shell)

Increasing atomic mass

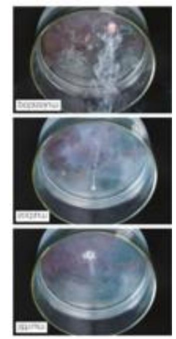




Increasing boiling point

Group 1

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

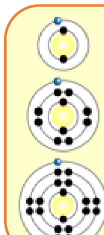


- Metals
- React with oxygen to form oxides
- React with water to form the hydroxide and hydrogen
- React with chlorine to form chlorides

Sodium + oxygen ⟶ sodium oxide
$4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$

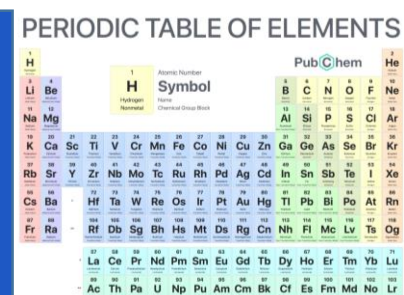
Sodium + water ⟶ sodium hydroxide + hydrogen
$2Na(s) + 2H_2O(l) \longrightarrow 2Na_2OH(aq) + H_2(g)$

Sodium + chlorine ⟶ sodium chloride
$2Na(s) + Cl_2(g) \longrightarrow 2Na_2Cl(s)$



lithium 2,1
sodium 2,8,1
potassium 2,8,8,1

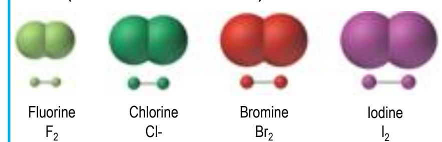
Alkali metals get MORE reactive



Group 7

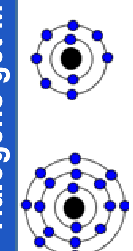
Halogens
Very reactive (due to having 7 electrons in outer shell)

- Non-metals
- Exist in 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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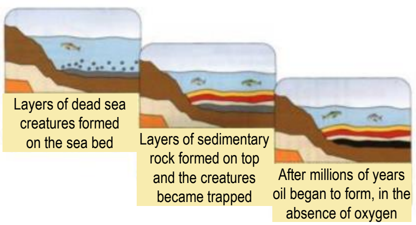
Year 11 – Chemistry / Crude Oil/Fuels – HT3

Hydrocarbons

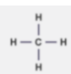
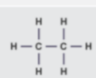
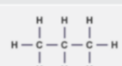
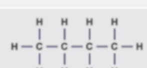
Crude Oil is made from the remains of living **sea creatures** decayed in mud millions of years ago



It is a **FINITE** resource

It is made from a mixture of Hydrocarbons. Hydrocarbons are made from **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}	

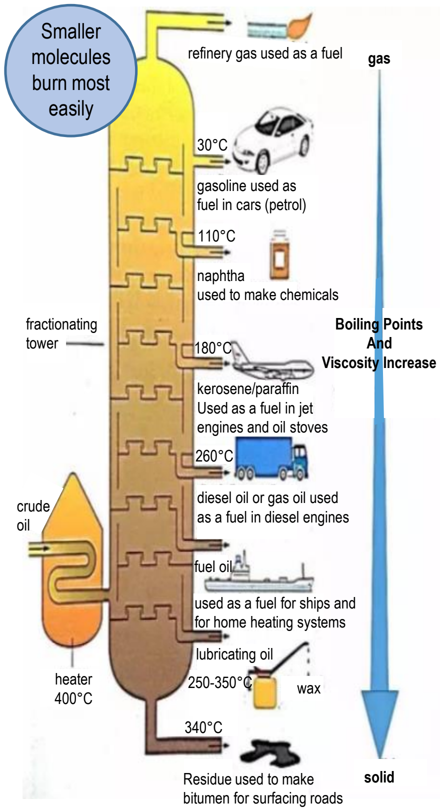
The general formula for an alkane is:

$$C_nH_{2n+2}$$

Fractional Distillation

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

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



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

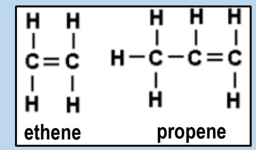
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Cracking

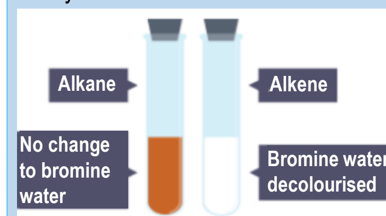
The larger molecules from fractional distillation are less useful. We can break them down into smaller, more useful molecules

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

Alkenes have some **double bonds**

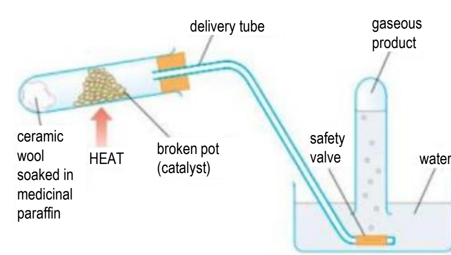


They turn **bromine water colourless**



They are used to make **polymers**

The apparatus for cracking



Catalytic cracking – catalyst and 500°C

Steam cracking – steam and 850°C