Unit C6

Chemical Synthesis

The topics in this unit are:

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2 – Acids and alkalis 1

3 – Acids and alkalis 2

4 – Neutralisation

5 – Chemical synthesis

6 – Percentage yield

7 – Relative atomic mass

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Uses of Chemicals in Industry

Chemicals are all around us and we depend on them daily.

We can make useful products such as:

Food additives

Pigments

Cosmetics

Fertilisers

Pharmaceuticals

Paints

The chemical industry makes **bulk** chemicals on **large** scale

Fine chemicals, such as medicines, are made on a **smaller** scale

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Acids and Alkalis

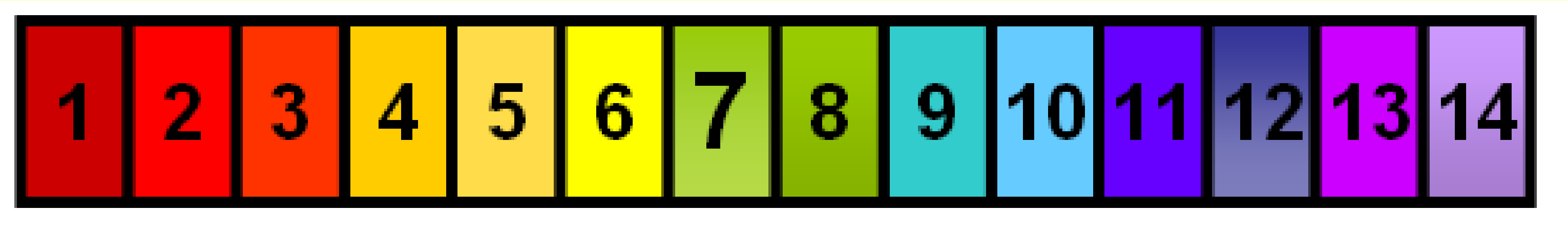
Acids are substances that have a pH **less than 7**

Bases are the opposite of acids and have a pH **greater than 7**

They are the oxides and hydroxides of metals

Those that are **soluble** are called **alkalis**

We can measure the pH of a substance using **universal indicator**



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Acids and Alkalis 2

Acidic compounds make **hydrogen ions (H^+)** when they dissolve in water

Common acids

Citric acid	$C_6H_8O_7$
Nitric acid	HNO_3
Sulphuric acid	H_2SO_4
Hydrochloric acid	HCl

Alkali compounds make **hydroxide ions (OH^-)** when they dissolve in water

Common alkalis

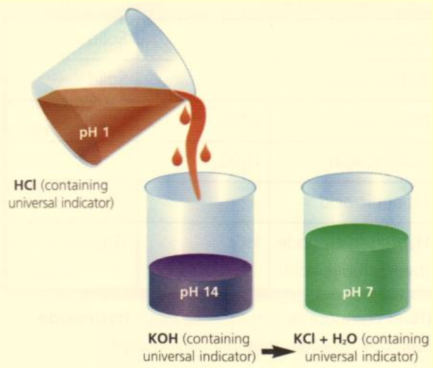
Sodium hydroxide	$NaOH$
Potassium hydroxide	KOH
Calcium hydroxide	$Ca(OH)_2$

Neutralisation

When an **acid** and a **base** are mixed together in the right amounts, they '**cancel**' each other out

The product has a **pH of 7.** It is called a **neutralisation** reaction

During this reaction, the hydrogen ions react with the hydroxide ions to form water.



acid + alkali → salt + water

$H^+ + OH^- \rightarrow$ salt + H_2O

The salt made depends on the acid used

Hydrochloric acid makes a chloride

Sulphuric acid makes a sulphate

Nitric acid makes a nitrate

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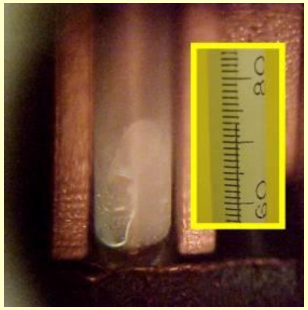
Chemical Synthesis

There are lots of stages in making a compound

1. Work out the reaction needed to make the product
2. Calculate how much of the reactants are needed
3. Carry out the reaction
4. Separate the product from the mixture
5. Purify the product
6. Measure the yield
7. Check the purity



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Percentage Yield

In a reaction, the starting materials (**reactants**) react to produce new substances (**products**).

The **percentage yield** can be calculated by comparing the actual amount of product made (**actual yield**) with the amount you expected (**theoretical yield**)

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Example

When making MgSO4, we expected to make 10g. We actually made 8g. What is the % yield?

$$\% \text{ yield} = \frac{8}{10} \times 100 = 80\%$$

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Relative Atomic Mass

To **compare** the mass of one atom to the mass of other atoms, we use the **relative atomic mass** (RAM)

We look at the periodic table and the **top number**

Examples

RAM of Mg = 24

RAM of C = 12

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Relative Formula Mass

The **relative formula mass** (RFM) is the relative atomic masses of the elements **added** together

Example

What is the relative formula mass of H_2O?

H = RAM 1 x 2 = 2

O = RAM 16 x 1 = 16

Added together = 2 + 16 = 18

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Titrations

We can use this to work out **how much** acid is needed to **neutralise** an alkali

1. Use a pipette to measure 25cm^3 of alkali
2. Add a few drops of phenolphthalein
3. Fill a burette with acid
4. Add acid drop by drop and swirl the flask
5. Keep swirling the flask until it stays colourless
6. Record the volume
7. Repeat until you get 2 results that are the same

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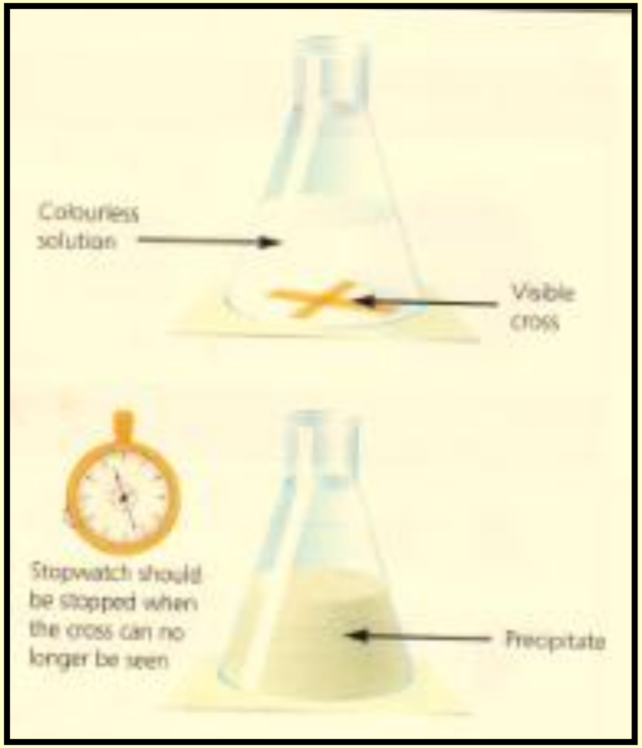
Rates and Measuring Rates

There are lots of ways to **measure** the rate of a reaction



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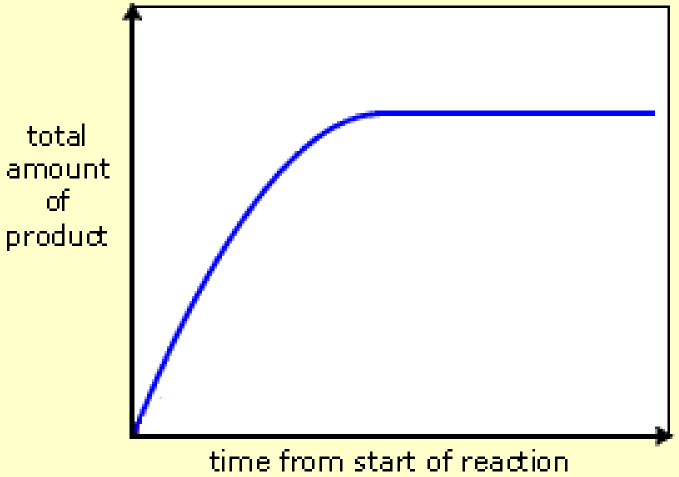
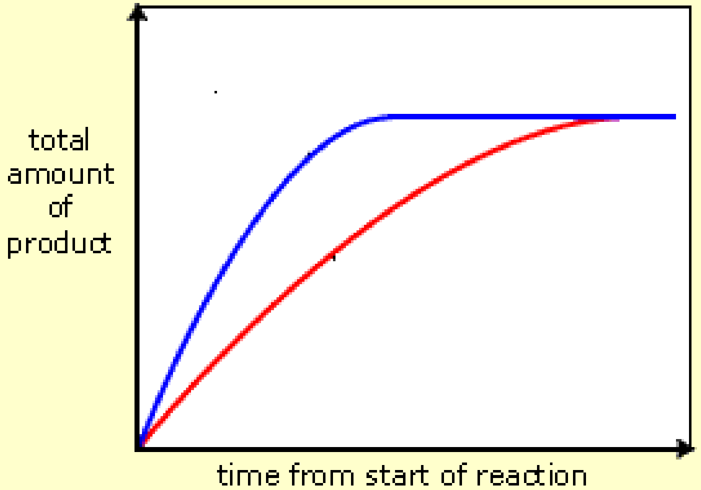
Rates and Graphs

Graphs can be plotted to show the **progress** of a reaction





The **steeper** the graph, the **faster** the reaction

When the line is **flat**, the reaction has **stopped**

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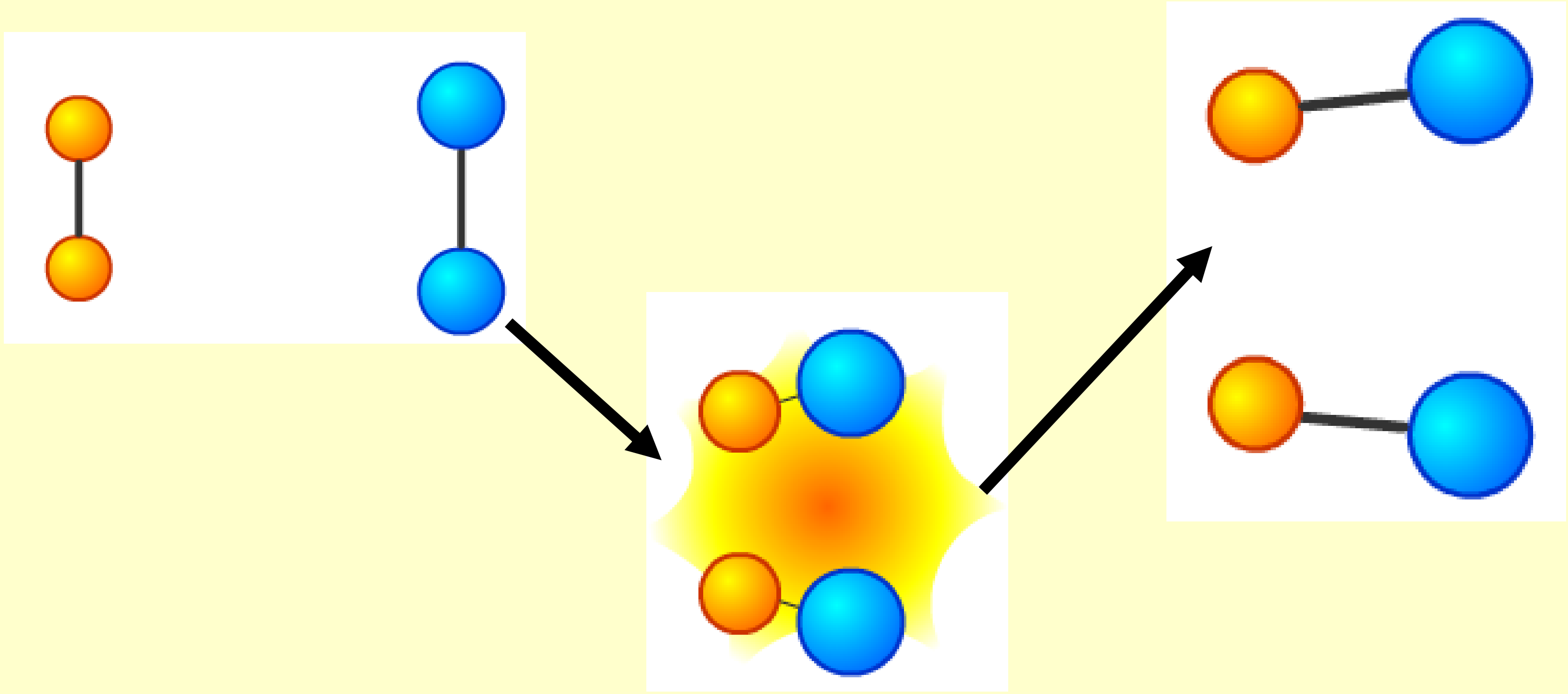
Rates and Collision Theory

Chemical reactions only happen when particles **collide** with each other with enough **energy**.

The **more collisions** there are, the **faster** the reaction is



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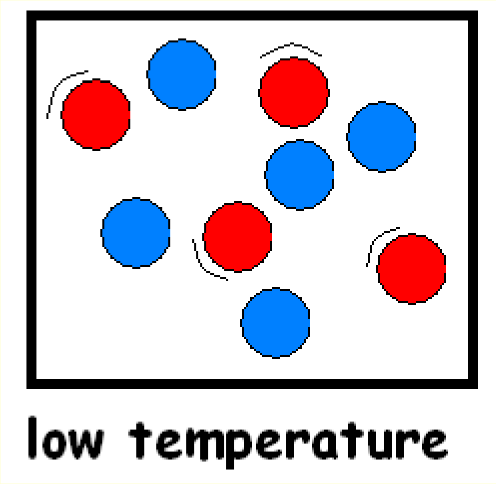
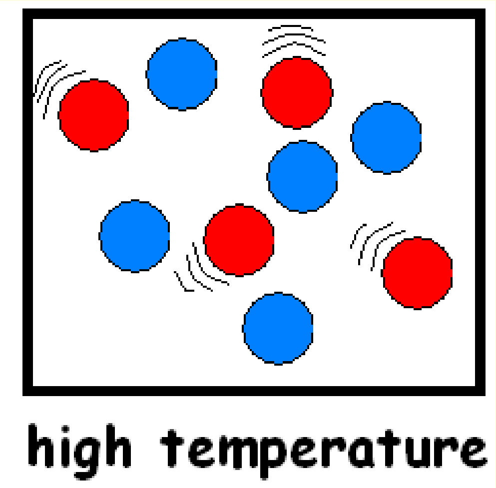
Rates and Temperature





In a cold reaction, the particles move **slowly**

In a **hotter** reaction, the particles move **quicker**. This means they will **collide** more often, with more **energy**. More collisions will be successful so the reaction will be faster

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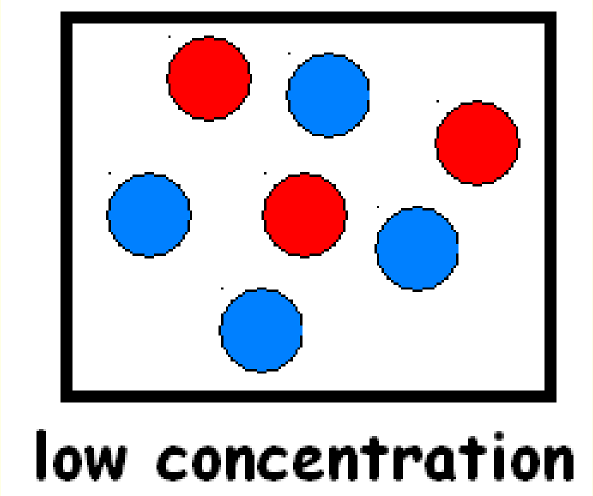
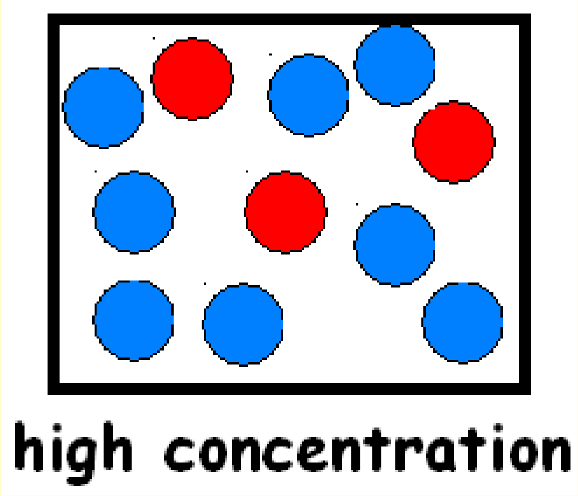
Rates and Concentration





In a low concentration, the particles are **spread out**.

In a high concentration, the particles are crowded **close** together. The particles **collide** with each other more often. This means more successful collisions and a faster reaction

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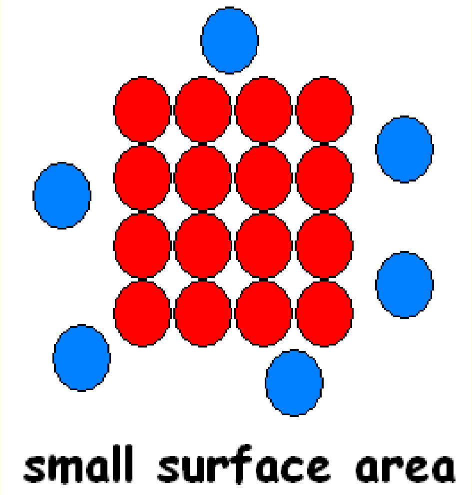
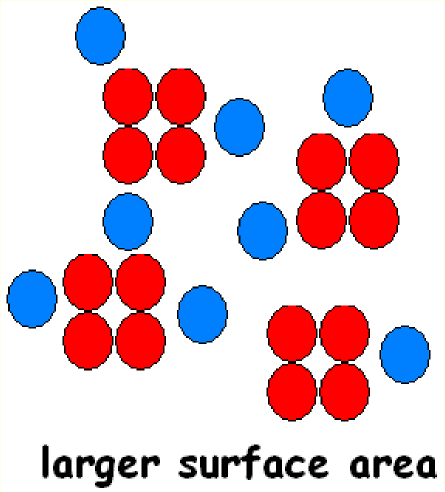
Rates and Surface Area





Large particles have a **small surface area**

The same amount in **smaller** particles have a **large** surface area. More particles are exposed and available for **collisions**. This means **more** collisions and a faster reaction.

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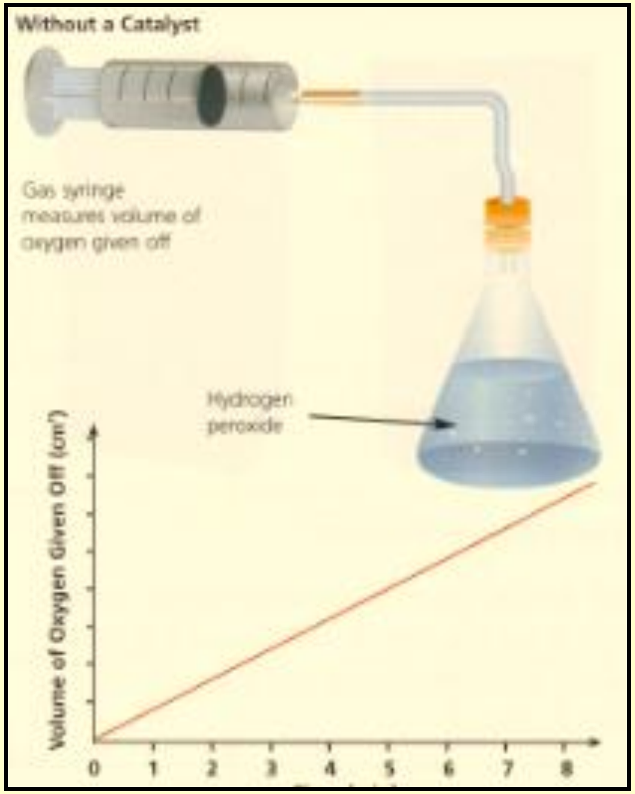
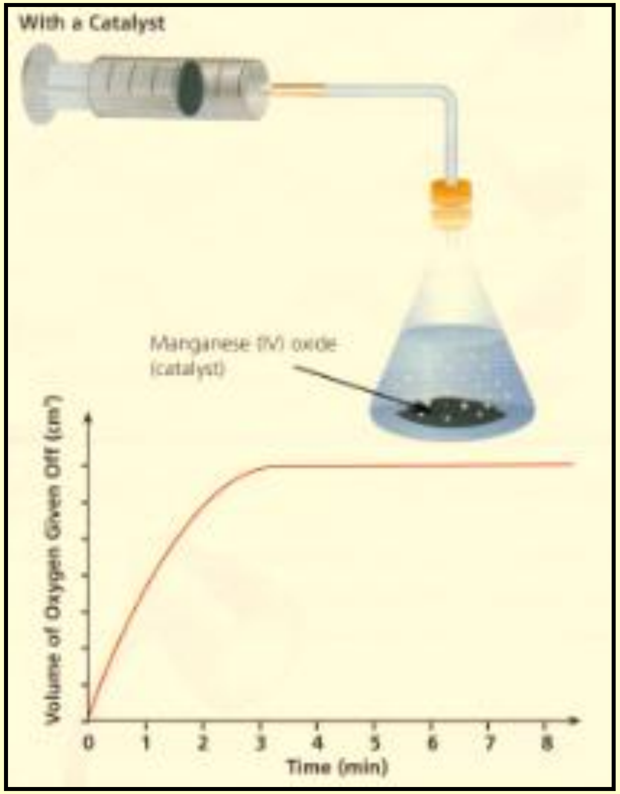
Rates and Catalysts

A substance that **increase** the rate of a chemical reaction **without** being changed in the process





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