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The rate of a reaction is a measure of how quickly a *reactant* is used up, or a *product* is formed.

Collision theory

For a chemical reaction to happen:

- *reactant particles* must collide with each other
- the particles must have enough energy for them to react

A collision that produces a reaction is called a *successful collision*. The *activation energy* is the minimum amount of *energy* needed for a collision to be successful. It is different for different reactions.

There are different ways to determine the rate of a reaction. The method chosen usually depends on the reactants and products involved, and how easy it is to measure changes in them.

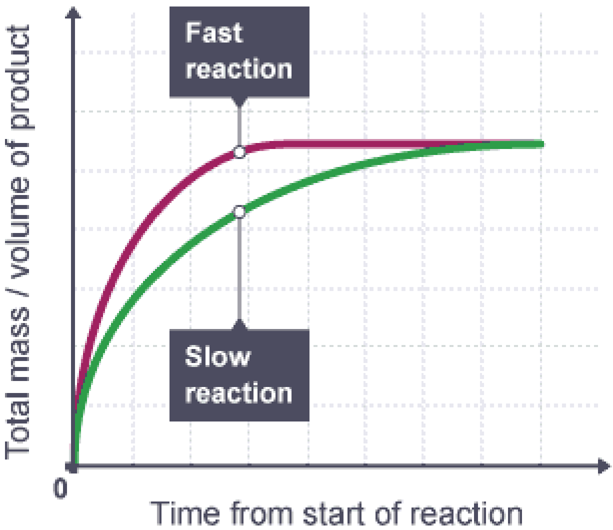
The mean rate of reaction can be calculated using either of these two equations:

$$mean\ rate\ of\ reaction = \frac{quantity\ of\ reactant\ used}{time\ taken}$$

$$mean\ rate\ of\ reaction = \frac{quantity\ of\ product\ formed}{time\ taken}$$

The *gradient* of the line is equal to the rate of reaction:

- the steeper the line, the greater the rate of reaction
- fast reactions - seen when the line becomes horizontal - finish sooner than slow reaction.



The *alkanes* form a *homologous series*. Like all homologous series, the alkanes:

- have the same *general formula*
- differ by CH_2 in *molecular formulae* from neighbouring *compounds*
- show a gradual variation in physical *properties*, such as their *boiling points*
- have similar chemical properties

General formula

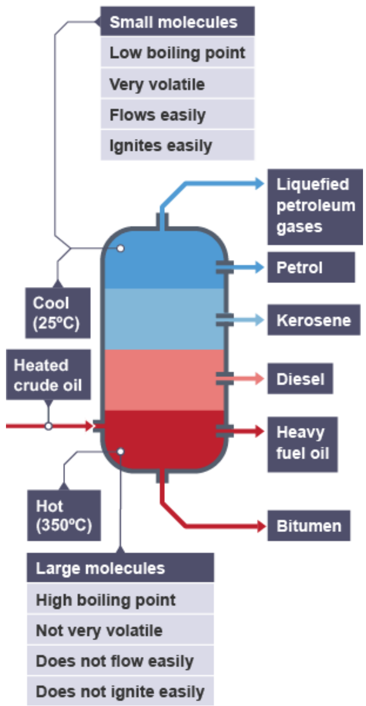
The general formula for the alkanes is C_nH_{2n+2}, where n is the number of carbon atoms in the molecule.

Fractional distillation is used to separate *crude oil* into simpler, more useful *mixtures*. This method can be used because different *hydrocarbons* have different *boiling points*.

Fractional distillation

During the fractional distillation of crude oil:

- heated crude oil enters a tall *fractionating column*, which is hot at the bottom and gets cooler towards the top
- *vapours* from the oil rise through the column
- vapours *condense* when they become cool enough
- liquids are led out of the column at different heights



Small hydrocarbon molecules have weak *intermolecular forces*, so they have low boiling points. They do not condense, but leave the column as gases. Long hydrocarbon molecules have stronger intermolecular forces, so they have high boiling points

Cracking is a reaction in which larger saturated *hydrocarbon molecules* are broken down into smaller, more useful hydrocarbon molecules, some of which are unsaturated:

- the original starting hydrocarbons are *alkanes*

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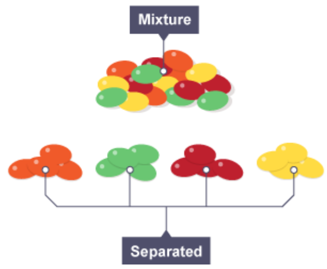
- the products of cracking include alkanes and *alkenes*, members of a different *homologous series*

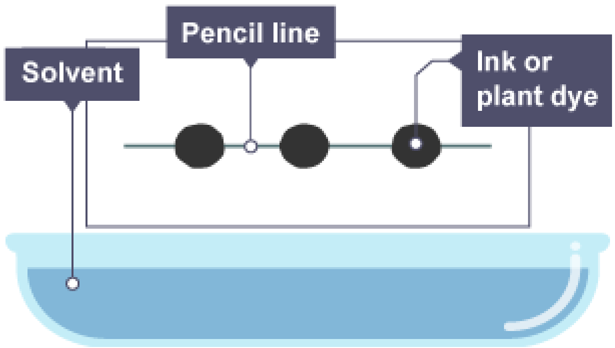
a pure substance consists only of one *element* or one *compound a mixture* consists of two or more different substances, not chemically joined together



Paper *chromatography* is used to separate mixtures of *soluble* substances and to provide information on the possible identity of the substances present in the mixture. These are often coloured substances such as food colourings, inks, dyes or plant pigments.

Chromatography Required Practical Method

1. draw a pencil line across the chromatography paper, 1- 2 cm from the bottom
2. use a pipette or capillary tube to add small spots of each ink to the line on the paper
3. place the paper into a container with a suitable solvent in the bottom
4. allow the solvent to move through the paper, but remove the *chromatogram* before it reaches the top
5. allow the chromatogram to dry, then measure the distance travelled by each spot and by the solvent



Test	Observation	Inference
Glowing splint held in a test tube	Splint relights	Oxygen is present
Lighted splint held in a test tube	Pop sound heard	Hydrogen is present
Gas bubbled through limewater	Limewater turns milky or cloudy white	Carbon dioxide is present
Damp litmus paper held in a test tube	Paper turns white	Chlorine is present

Without *greenhouse gases* in its *atmosphere*, the mean temperature on Earth would be about -18°C. That would make it too cold to support life as we know it. Greenhouse gases present in the atmosphere include:

- water *vapour*
- *carbon dioxide*
- *methane*

Human activities are increasing the amount of some greenhouse gases in the atmosphere. For example:

- farming cattle releases *methane*
- farming rice in *paddy fields* releases methane
- burning *fossil fuels* in vehicles and *power stations* releases carbon dioxide
- *deforestation* releases carbon dioxide and reduces the absorption of carbon dioxide through *photosynthesis*
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Pollutant	Source
Carbon dioxide, CO_2	Complete combustion of any fuel containing carbon atoms
Carbon monoxide, CO	Incomplete combustion of any fuel containing carbon atoms
Particulate carbon, C (soot)	Incomplete combustion of any fuel containing carbon atoms
Unburned hydrocarbons	Hydrocarbon fuel molecules which have not been oxidised at all
Sulfur dioxide, SO_2	Combustion of a fossil fuel which contains sulfur impurities
Nitrogen oxides, NO_x	Oxidation of atmospheric nitrogen inside the engine of a car, lorry, etc

Most potable water in the UK is produced from naturally occurring fresh water by:

1. passing the water through filter beds to remove *insolubleparticles*
2. *sterilising* the water to kill microbes

The methods used for sterilisation include chlorine, ozone and ultraviolet light.