Trilogy C9 – Crude Oil and Fuels

Crude oil is a finite (non-renewable) resource formed over millions of years. Crude oil is formed from the remains of sea life, mainly plankton, that were buried in mud and layers upon layers of rock, which created high temperatures and pressure.

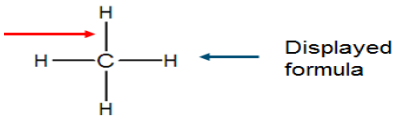
Crude oil is made up of a mixture of **hydrocarbons**.

Hydrocarbons are compounds that contain the elements **hydrogen** and **carbon ONLY**.

Alkanes are a type of hydrocarbon that contain single bonds only. Because of this, we say they are **saturated**.

Methane (the simplest alkane)

Single covalent bonds

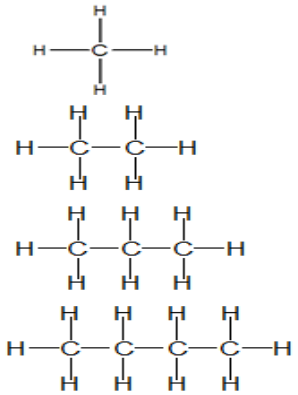


Displayed formula

CH_4 ← Molecular formula

General formula for an alkane = C_nH_{2n+2}

You need to know the names of the 4 simplest alkanes, as well as their displayed and molecular formulas.



Methane, CH_4

Ethane, C_2H_6

Propane, C_3H_8

Butane, C_4H_{10}

An acronym to help remember the names from smallest to largest is:

Monkeys Eat Peanut Butter

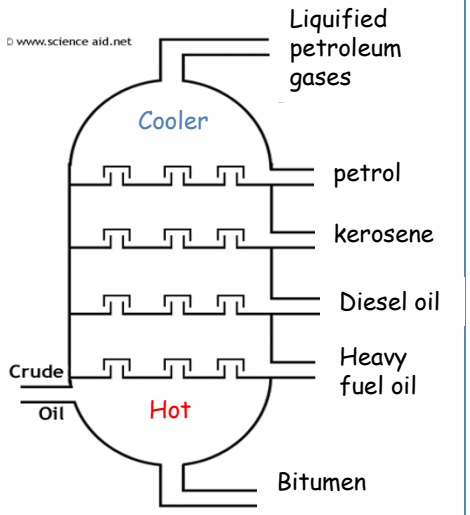
Fractional Distillation

Crude oil is separated into **fractions** in a process called fractional distillation. Fractions are hydrocarbons with similar chain lengths (similar numbers of carbon atoms).

Crude oil is firstly **vaporised** before it goes into a **fractionating column**. The column is very hot at the bottom and gets cooler towards the top, creating a **temperature gradient**.

Short chain hydrocarbons have low boiling points and will condense only at cooler temperatures near the top of the column. Long chains have high boiling points so will condense near the bottom of the column.

The different fractions are collected as liquids at different levels shown on the right.



	Molecular mass	Strength of intermolecular forces	Boiling point	Flammability (how easily it burns)	Viscosity (how thick it is)
Short chains	Low	Low	Low	High	Low
Long chains	High	High	High	Low	High

Burning hydrocarbons: complete combustion

When fuels burn in plenty of oxygen, **complete combustion** occurs. The products are always **carbon dioxide** and **water.**

Propane + oxygen → carbon dioxide + water

$CH_3CH_2CH_3 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Burning hydrocarbons: incomplete combustion

When fuels burn without enough oxygen present, **incomplete combustion** occurs. The products are water with **carbon monoxide and/or carbon**.

$CH_3CH_2CH_3 + 5O_2 \rightarrow 2CO + C + 4H_2O$

$2C_2H_6 + 3O_2 \rightarrow 4C + 6H_2O$

Tests:

Carbon dioxide will turn lime water cloudy.
Water will turn blue cobalt chloride paper pink.
Alkenes will decolourise orange bromine water.
(With alkanes bromine water will stay orange.)

Cracking Hydrocarbons

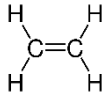
Long chain hydrocarbons are split into shorter, more useful chain lengths in a process called cracking.

When we crack a hydrocarbon we produce an **alkane** and an **alkene.**

$C_{12}H_{26} \rightarrow C_3H_8 + C_9H_{18}$

Note: The number of H s and C s on the left hand side is the **same** as on the right hand side.

There are two types of cracking.
1) **Catalytic** (high temperature + catalyst)
2)**Steam cracking** (Very high temperature + steam)



Alkenes are **unsaturated** hydrocarbons that contain a double carbon bond.

General formula for an alkane = C_nH_{2n}