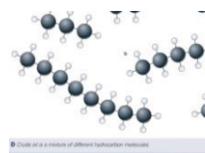


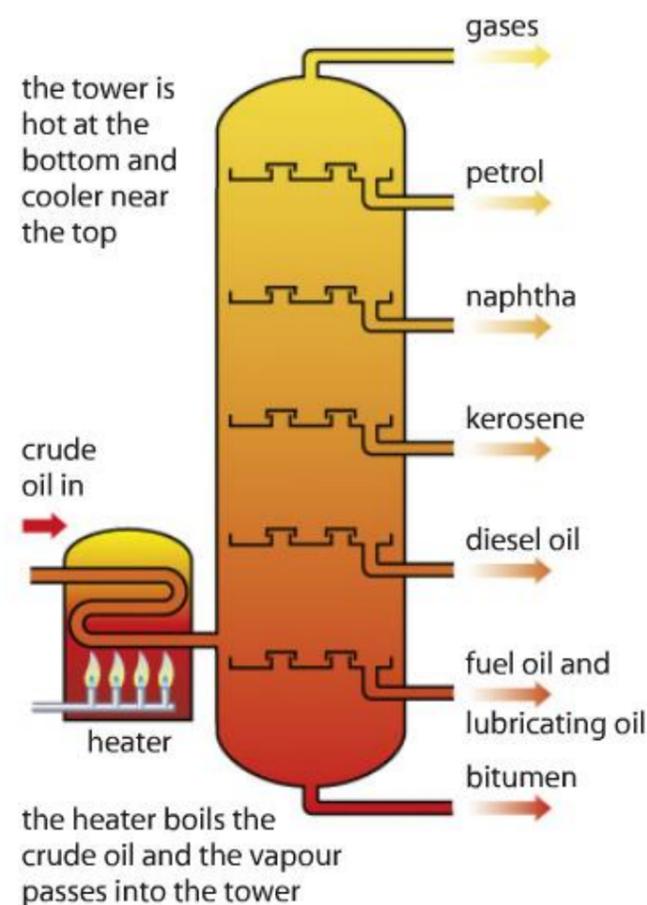
## Chemistry knowledge organiser – Unit 7 Hydrocarbons

### Crude Oil

- Crude oil is a **fossil fuel** that comes directly from the Earth's crust and is one of the most important substances in the world.
- Crude oil is a mixture.** The compounds in a mixture are not chemically combined together



- Crude oil is a **mixture of hydrocarbons** (it contains only hydrogen and carbon atoms). Crude oil itself has no uses – it must first be processed or refined. This is done in an oil refinery using **fractional distillation**.
- During refining, compounds in the oil are separated into simpler groups called **fractions**. Each fraction contains a mix of compounds with a similar number of carbon atoms.



### How the fractionating column works

- Oil is heated to about 370 °C and pumped into the bottom of a tall tower called a fractionating column, where it vaporizes.
- The column is very hot at the bottom but much cooler at the top. As the vaporised oil rises, it cools and condenses.
- Heavy fractions (containing large molecules) have high boiling points and condense near the bottom of the column.**
- Lighter fractions (containing small molecules) have lower boiling points and condense further up the column.**

### Why can the fractions be separated? (HT ONLY)

- The hydrocarbons are different lengths and are held together by **weak forces of attraction** between the molecules. These weak forces of attraction can be broken during boiling – turning the liquid into a gas.
- Large molecules have lots of weak forces of attraction – so require lots of energy to pull the molecules apart – leading to a high boiling point.

### Properties

As the molecules get larger:

- They become more viscous;
- Harder to ignite;
- Darker in colour;
- Release more energy when ignited;
- Release more carbon and carbon dioxide when combusted.

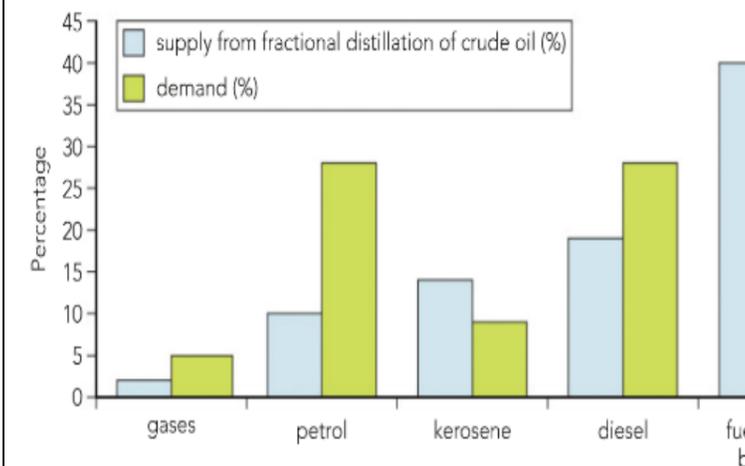
### Organic molecules

Generally speaking:

- Carbon must make four bonds
- Oxygen must make two bonds
- Hydrogen must make one bond
- A double bond counts as two bonds eg C=C or C=O. A triple bond counts as three bonds.

A **homologous series** is a group of chemicals which have similar chemical properties and can be represented by the same general formula.

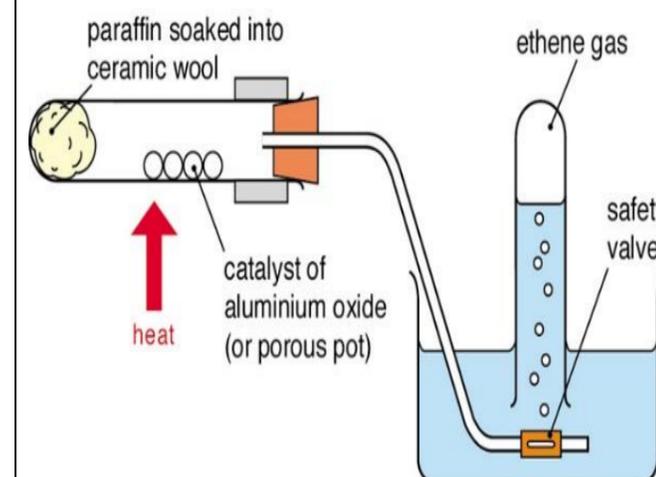
### Cracking



- The graph above shows that more of the smaller more useful petrol and diesel molecules are needed than the supply we have.
- Cracking** helps to meet this demand. Long chain alkanes are thermally decomposed over a hot **zeolite catalyst** to produce short alkanes and an alkene.



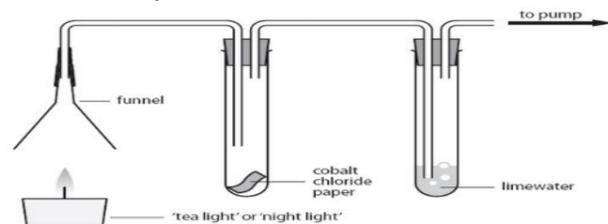
How it's done in the lab:



## Combustion

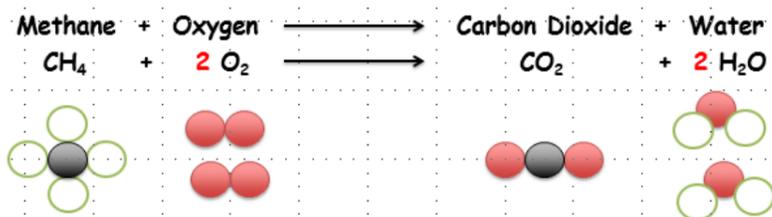
### Complete combustion

- Complete combustion occurs when the fuel has a good supply of oxygen (from the air).
- The fuel burns efficiently with a blue flame releasing lots of energy.
- To test the products:



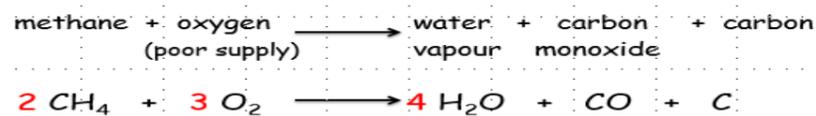
Cobalt chloride paper goes blue → pink showing water  
Limewater goes clear → cloudy showing carbon dioxide.

- Complete combustion of methane is shown by the equation:



### Incomplete combustion

- Incomplete combustion occurs when the fuel has a limited supply of oxygen (from the air).
- The fuel burns inefficiently with a yellow flame releasing limited energy.
- Incomplete combustion of methane is shown by the equations:



### The dangers of the products of combustion

- Carbon dioxide (complete):** Increases the greenhouse gases which trap infra-red radiation causing the earth's atmosphere to warm up.
- Carbon monoxide (incomplete):** Poisonous gas. Eventually leads to death.
- Carbon/soot (incomplete)** - Blackens buildings and trees. Causes breathing problems. Can lead to lung damage due to heavy coughing.

## Alkanes and Alkenes

**Alkanes (saturated hydrocarbons)** are in the same homologous series: General formula  $\text{C}_n\text{H}_{2n+2}$ . They all burn well and have all single Carbon-Carbon bonds.

Alkane	Molecular formula	Structural formula	Ball-and-stick model
Methane	$\text{CH}_4$		
Ethane	$\text{C}_2\text{H}_6$		
Propane	$\text{C}_3\text{H}_8$		
Butane	$\text{C}_4\text{H}_{10}$		
Pentane	$\text{C}_5\text{H}_{12}$		

**Alkenes (unsaturated hydrocarbons)** are in another homologous series. Their general formula is  $\text{C}_n\text{H}_{2n}$ . They don't burn as well as alkanes and have a double Carbon-Carbon bond.

Alkene	Molecular formula	Structural formula	Ball-and-stick model
Ethene	$\text{C}_2\text{H}_4$		
Propene	$\text{C}_3\text{H}_6$		
But-1-ene	$\text{C}_4\text{H}_8$		
But-2-ene	$\text{C}_4\text{H}_8$		

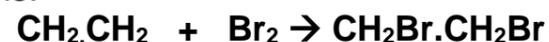
### Testing the difference between an alkane and an alkene

Add **orange** bromine water, it will turn colourless if an unsaturated hydrocarbon (alkene) is present.



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The reaction is:



- What is crude oil?
- What is a hydrocarbon made of?
- Compare the boiling points of long and short hydrocarbons.
- What does fractional distillation do?
- Name the bonds that need to be broken between the hydrocarbons.
- What does volatility mean?
- What does flammability mean?
- What does high viscosity mean?
- Why are long hydrocarbons more viscous than short ones?
- Why are short Hydrocarbons more volatile than long ones?
- What are the 2 names for hydrocarbons that only have single bonds?
- What are the 2 names for hydrocarbons than contain a double bond?
- What are the names of the first 4 hydrocarbons with single bonds?
- What is the general formula for hydrocarbons containing only single bonds?
- What is the general formula for the hydrocarbons that contain a double bond?
- What causes complete combustion?
- What is the word equation for complete combustion?
- What causes incomplete combustion?
- What is the word equation for incomplete combustion?
- What danger is posed by incomplete combustion?
- What is cracking?
- Cracking is an example of what type of reaction?
- What sort of catalyst is used?
- What is the general equation for cracking?
- How do you test the saturation of hydrocarbons?

