

**Y9: Topic 1 knowledge organiser:  
Atmosphere, crude oil & Fuels.**

**Lesson sequence**

1. The early atmosphere
2. The changing atmosphere
3. The atmosphere today
4. Climate change
5. Hydrocarbons
6. Fractional distillation of crude oil
7. The alkanes
8. Complete and incomplete combustion
9. Fuels and pollution
10. Cracking

**1. Hydrocarbons**

<b>*Hydrocarbon</b>	A compound containing only hydrogen and carbon.
<b>*Crude oil</b>	A thick brown liquid made of a mixture of many different hydrocarbons found in deposits underground.
<b>*Molecules in crude oil</b>	Hydrocarbons in many different forms with carbons joined together into both chain- and ring-shaped molecules.
<b>*Properties of hydrocarbons in crude oil</b>	Most of the hydrocarbons in crude oil are liquids, but each of them has a different boiling point.
<b>*Hydrocarbons in crude oil</b>	Mostly alkanes.
<b>*Uses of crude oil</b>	Fuel, feedstock (supply of basic chemicals) for the chemical industry.
<b>*Crude oil as a finite resource</b>	There is a limited amount: at some point it will run out.
<b>*Non-renewable</b>	A resource that will eventually run out.

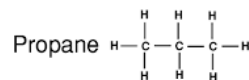
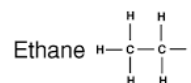
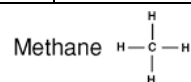
**2. Fractional distillation of crude oil**

<b>*Fractional distillation</b>	A type of distillation used to separate mixtures of two or more liquids.
<b>*Separation in fractional distillation</b>	Fractional distillation separate compounds according to their boiling point.
<b>**Heating crude oil</b>	Crude oil is passed through a heater to heat it to about 400°C so that nearly everything is a gas.
<b>**Separating crude oil in a fractionating column</b>	The hot gases rise up the fractionating column until cool enough to condense.
<b>*Fractions of crude oil</b>	The separated liquids and gases collected at different temperatures. The main ones are gases, petrol, kerosene, diesel oil, fuel oil, and bitumen.
<b>**Fractions in order</b>	Gases, petrol, kerosene, diesel, fuel oil, bitumen: - Smallest to biggest molecules - Lowest to highest boiling point - Lowest to highest viscosity - Easiest to hardest ignition
<b>**Viscosity</b>	How easily a fluid flows – higher viscosity = runnier.
<b>**Ease of ignition</b>	How easily a substance catches fire.
<b>*Gases</b>	Used for domestic heating and cooking.
<b>*Petrol</b>	Used as a fuel for cars.
<b>*Kerosene</b>	Fuel for aircraft
<b>*Diesel oil</b>	Fuel for larger vehicles such as lorries and trains
<b>*Fuel oil</b>	Fuel for ships and power stations
<b>*Bitumen</b>	Surfacing roads and roofs

**3. The alkanes**

<b>**Homologous series</b>	A family of closely related compounds with molecular formulae that differ only in the number of 'CH <sub>2</sub> 's.
<b>**Physical properties in a homologous series</b>	Vary gradually, for example the boiling point gradually increases.

<b>**Chemical properties in a homologous series</b>	Very similar with a gradual variation.
<b>**General formula</b>	Describes the number of each atom in any member of a homologous series.
<b>*Alkanes</b>	Hydrocarbons containing only single bonds. The names end with '-ane'.
<b>*First three alkanes</b>	Methane – CH <sub>4</sub> Ethane – C <sub>2</sub> H <sub>6</sub> Propane – C <sub>3</sub> H <sub>8</sub>
<b>**General formula of alkanes</b>	C <sub>n</sub> H <sub>2n+2</sub>



**4. Complete and incomplete combustion**

<b>*Combustion</b>	When a compound reacts with oxygen producing a flame.
<b>*Complete combustion</b>	Combustion that produces only water and carbon dioxide and releases the most possible energy.
<b>**Complete combustion equation</b>	Fuel + oxygen → carbon dioxide + water  E.g: Ethane + oxygen → carbon dioxide + water $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
<b>*Incomplete combustion</b>	Combustion that produces a mixture of carbon dioxide, carbon monoxide, carbon and water and produces less energy.

<b>**Why incomplete combustion happens</b>	When there is not enough oxygen for all of the reactants to be fully oxidised.
<b>*Carbon monoxide</b>	CO. A colourless odourless a highly toxic gas.
<b>*How carbon monoxide kills</b>	It sticks to haemoglobin in the blood which prevents it from carrying oxygen.
<b>*Soot</b>	The small particles of carbon produced by incomplete combustion.
<b>*Problems with soot</b>	- Causes lung problems when breathed in. - Blackens and dirties buildings
<b>**Preventing incomplete combustion</b>	It is important that boilers at home have a good air supply to prevent incomplete combustion. For this reason a boiler's flue pipe should be checked for blockages every year.

**5. Combustible fuels and pollution**

<b>*Sulfur</b>	An impurity that is naturally present in small amounts in oil and coal.
<b>*Sulfur dioxide</b>	SO <sub>2</sub> . A gas formed from the sulfur in oil and coal when it is burnt.
<b>*Acid rain</b>	Rain with a pH lower than 5.2
<b>*Formation of acid rain</b>	Sulfur dioxide dissolves in water in clouds to form sulfurous acid (H <sub>2</sub> SO <sub>3</sub> ) which oxidises to become sulfuric acid (H <sub>2</sub> SO <sub>4</sub> )
<b>**Effects of acid rain</b>	- Soil becomes too acidic for crops and plants to grow well - Acid in rivers and lakes prevents fish eggs from hatching and kills some insects. - Acid rain increases corrosion of limestone which damages buildings and statues
<b>**Nitrogen oxides</b>	NO <sub>x</sub> . Various gases formed at high temperatures inside internal combustion engines.

<b>**Problems of nitrogen oxides</b>	- Can dissolve in clouds to form acid rain - NO <sub>2</sub> causes lung damage - NO <sub>x</sub> can cause smog to form
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### 6. Cracking

<b>*Cracking</b>	Breaking down longer less useful hydrocarbons into shorter more useful ones.
<b>*How to crack hydrocarbons</b>	Heat the hydrocarbons and pass the vapours over an aluminium oxide catalyst heated to 650°C.
<b>**Products of cracking an alkane</b>	An alkane and an alkene.  E.g: Hexane → butane + ethene C <sub>6</sub> H <sub>14</sub> → C <sub>4</sub> H <sub>10</sub> + C <sub>2</sub> H <sub>4</sub>
<b>**Alkene</b>	A hydrocarbon containing a C=C double bond.
<b>**Usefulness of cracking</b>	There is more demand for shorter hydrocarbons – such as petrol and gas – than longer ones such as bitumen. Cracking turns the less useful ones into more useful ones.
<b>*Hydrogen gas as a fuel</b>	H <sub>2</sub> . Hydrogen has the potential to be used as a fuel for cars.
<b>**Advantages of hydrogen as a fuel</b>	- It only produces H <sub>2</sub> O when burnt so does not directly contribute to global warming - It can be produced using renewable energy
<b>**Disadvantages of hydrogen as a fuel</b>	- Most of it is currently produced in ways that also produce CO <sub>2</sub> which contributes to global warming - It is difficult to store

### 7. The early atmosphere

<b>*The early Earth</b>	4.5-3.5 billion years ago the Earth was extremely hot and there were many volcanoes.
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<b>*The early atmosphere</b>	Little or no oxygen, a lot of carbon dioxide, water vapour, small amounts of other gases such as nitrogen.
<b>*Origin of the early atmosphere</b>	Gases from volcanoes.
<b>**Evidence for a lack of oxygen</b>	The oldest rocks on Earth contain compounds such as iron pyrite that cannot form in the presence of oxygen.
<b>**Formation of the oceans</b>	As the Earth cooled, water vapour in the air condensed to liquid water, forming the oceans.

### 8. The changing atmosphere

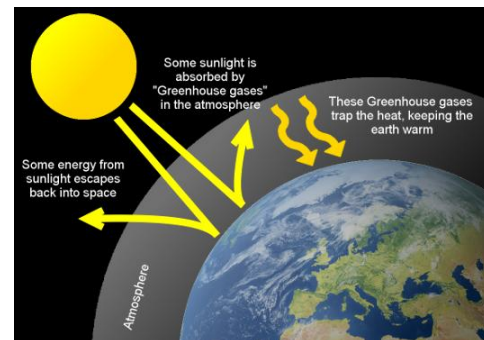
<b>*Changes to the atmosphere</b>	The amount of carbon dioxide decreased, water vapour decreased, oxygen increased.
<b>*Photosynthesis and the atmosphere</b>	Photosynthesis – by cyanobacteria and plants – consumes carbon dioxide (decreasing it) and produces oxygen (increasing it).
<b>**Oceans and carbon dioxide</b>	Carbon dioxide dissolves in the ocean and is used by sea creatures to make their shells, enabling even more CO <sub>2</sub> to dissolve.
<b>*Test for oxygen</b>	A glowing splint (stick) placed in oxygen will relight.

### 9. Global warming

<b>**Greenhouse effect</b>	Infrared radiation (heat) from the sun travels through the atmosphere and warms the ground. The ground re-emits slightly different infrared radiation that is not able to pass back through the atmosphere and is trapped by gases called greenhouse gases.
<b>*Greenhouse gases</b>	Gases that trap re-emitted infrared radiation – including carbon dioxide, methane and water vapour.

<b>**Importance of the greenhouse effect</b>	The greenhouse effect is extremely important; without it the average global temperature would be 32 °C lower and most life could not exist.
<b>**Increased greenhouse effect</b>	Human activities are increasing the concentration of greenhouse gases such as carbon dioxide and methane, meaning the greenhouse effect is strong and traps more heat.
<b>*Global warming</b>	An increase in global temperatures caused by the increased greenhouse effect.
<b>*Climate change</b>	Change in global weather patterns caused by global warming.
<b>**Correlation between carbon dioxide and temperature</b>	In Earth's history, every time CO <sub>2</sub> concentrations have been high, the temperature has also been high. This makes scientists think that the current increase in CO <sub>2</sub> is what is increasing the temperature.
<b>**Uncertainty in the data</b>	Scientists measurements of past temperature and CO <sub>2</sub> are not perfect which makes some people doubt them. However, many different sets of data say very similar things, so most scientists believe them.

<b>**Two main causes of climate change</b>	- Carbon dioxide produced by burning fossil fuels - Methane produced by farming (especially cows)
<b>**Effects of climate change</b>	- Rising average global temperature - Increased sea level from melting ice - Increased drought in some areas and flooding in others - Increase in dangerous weather
<b>**Effect of climate change on life</b>	Living organisms are adapted to the conditions where they live. If these conditions change they may struggle to survive. Climate change is causing many species to struggle and some to go extinct.
<b>**Ocean acidification</b>	The carbon dioxide we produce dissolves in the oceans, lowering the pH making it harder for many sea-creatures to build their shells.
<b>**Limiting climate change</b>	- Reduce emissions of greenhouse gases by using renewable energy and eating less meat. - Geoengineering – perhaps placing giant mirrors in space to reflect some of the sun's heat.



### 10. Impact of climate change