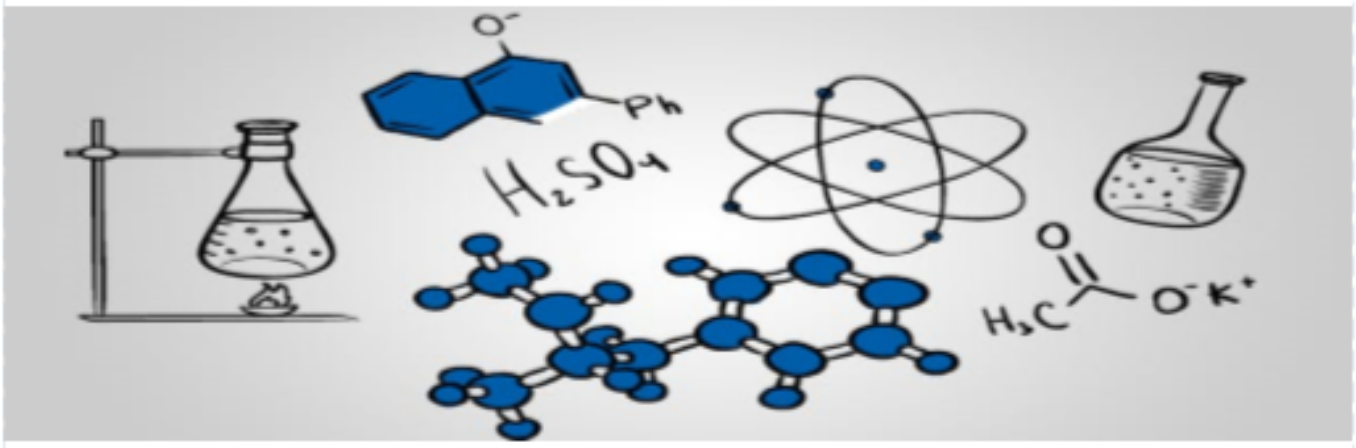
THE DUSTON SCHOOL 4-19

Knowledge Organiser

Year 11

Chemistry Paper 2

C7,C8 Organic & chemical analysis



Knowledge Booklet: **Organic Chemistry and Chemical Analysis**

Big Questions and Vocabulary

- What are hydrocarbons and why are they important in chemistry
- Why is crude oil so valuable and what can be extracted from it?
- What are the trends in alkanes and how does this affect their properties
- What is the difference between alkanes and alkenes
- What is the importance of pure substances and formulations in chemistry
- How does chromatography allow purity to be test and used as means of qualitatively testing a sample
- What are the common tests for gases and how are they carried out.

Crude oil A fossil fuel that is a mixture of compounds, mainly hydrocarbons.	**Hydrocarbon** A compound containing only carbon and Hydrogen atoms	**Alkanes** These are saturated hydrocarbons. They only have single C-C bonds and follow the general formula C_nH_{2n+2}
Alkenes These are unsaturated hydrocarbons. They contain a C=C double bond, and follow the general formula C_nH_{2n}	**Fractional Distillation** A separation technique used to separate crude oil. The oil is vaporised then the hydrocarbons isolated into fractions based on boiling point.	**Intermolecular force** A weak force of attraction between molecules. The larger the molecule the greater the number of intermolecular forces, which affects the properties
Boiling point The temperature required to get a change in state from a liquid to a gas, or if cooling a gas to a liquid.	**Viscosity** Used to describe the fluidity of a liquid. A low viscosity liquid is very runny ie water, a high viscosity liquid is thick and flows slowly ie syrup.	**Flammability** This is how easily the chemical is combusted, small chain hydrocarbons have greater flammability so combust / ignite more easily than long chain.
Combustion A reaction where an element or elements in a compound are oxidised by reacting with oxygen. It is an exothermic reaction	**Cracking** A thermal or chemical decomposition reaction where long chain hydrocarbons are broken down into smaller more useful hydrocarbons.	**Pure** A pure element or compound is not mixed with any other substance, they melt and boil at specific temperatures
Formulation A formulation is a mixture that has been designed as a useful product. They are made useful components in carefully measured quantities	**Chromatography** A separation technique that splits substances based on their relative attraction to either the mobile phase or stationary phase	**Rf value** The ratio of the distance moved by the compound compared to the distance moved by the solvent.

Sample Extended Questions / Practical based questions

How does fractional distillation work?

What are the trends in properties as the carbon chain length increases?

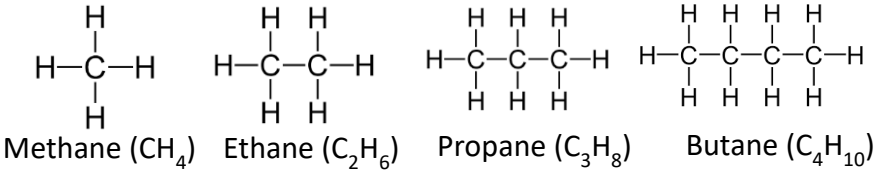
What can be done to meet the demand for smaller chain hydrocarbons?

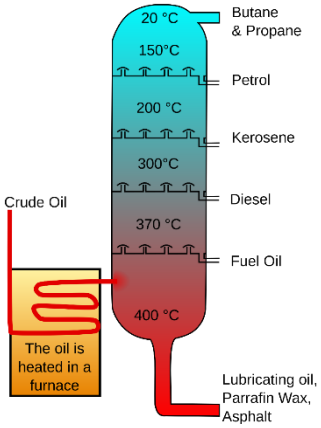
How can chromatography be used to determine if a substance is pure or not?

What is the difference in tests for Oxygen, Hydrogen, Chlorine and Carbon dioxide?

Crude oil is a finite resource, that contains a variety of compounds, including hydrocarbons, which are valuable chemical feedstocks.

Alkanes are saturated hydrocarbons, they all have the general formula C_nH_{2n+2} When drawing, each Carbon has 4 bonds coming from it.





Hydrocarbon chains	***In oil***	Hydrocarbon chains in crude oil come in lots of different lengths, they are held together by lots of intermolecular forces, which is why crude oil is a very viscous liquid
	Boiling points	The boiling point of the chain depends on its length. The longer the chain, the greater the number of intermolecular forces between chains, which require more energy (a therefore higher temperature) to separate. During fractional distillation, the crude oil is vaporised and the different length hydrocarbons condense and therefore separate at different temperatures.

Fractions	***The hydrocarbons in crude oil can be split into fractions, this is where chains with similar numbers of carbon atoms condense at similar temperature***	*Fractions can be processed and purified to produce fuels and feedstock for the petrochemical industry. The smallest carbon chains are at the top as they have the fewest number of intermolecular forces between molecules so have lower boiling points as less energy is needed to break the forces between molecules.*

Boiling point (temperature at which liquid boils)	***As the hydrocarbon chain length increases, boiling point increases. This is because more energy in needed to break the intermolecular forces***
Viscosity (how easily it flows)	***As the hydrocarbon chain length increases, viscosity increases, this is because there are more intermolecular forces holding the chains / molecules together***
Flammability (how easily it combusts / oxidises)	***As the hydrocarbon chain length increases, flammability decreases, this is because the small chains have lower molecular masses, which makes it easier for oxygen to react with them at lower temperatures.***

Smaller chain hydrocarbons tend to be more in demand that the available supply, so cracking is used to meet demand. Long chain molecules are broken down into smaller chain molecules. When an alkane is cracked, both an alkane and an alkene is are produced

Cracking	***The breaking down of long chain hydrocarbons into smaller chains***	The smaller chains are more useful. Cracking can be done by various methods including catalytic cracking and steam cracking.
Catalytic cracking	***The heavy fraction is heated until vaporised***	After vaporisation, the vapour is passed over a hot catalyst forming smaller, more useful hydrocarbons.
Steam cracking	***The heavy fraction is heated until vaporised***	After vaporisation, the vapour is mixed with steam and heated to a very high temperature forming smaller, more useful hydrocarbons.

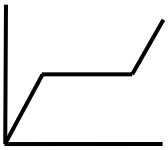
Decane → pentane + propene + ethane $C_{10}H_{22} \rightarrow C_5H_{12} + C_3H_6 + C_2H_4$

Alkenes and uses as polymers	***Used to produce polymers, only alkenes are used for this as alkanes don't have a double bond. They are also used as the starting materials of many other chemicals, such as alcohol, plastics and detergents.***
Why do we crack long chains?	***Without cracking, many of the long hydrocarbons would be wasted as there is not much demand for these as for the shorter chains.***

Alkenes	***Alkenes are hydrocarbons with a double bond (some are formed during the cracking process).***
Properties of alkenes	***Alkenes are more reactive that alkanes and react with bromine water. Bromine water changes from orange to colourless in the presence of alkenes.***

Complete combustion	***When there is plenty / excess on oxygen, and the carbon and hydrogen are completed oxidised to form Carbon dioxide and water.***
Incomplete combustion	***When there is limited oxygen, and the carbon is only partially oxidised. Water is always produced. Either carbon monoxide or Carbon particulates are produced.***

Pure substances	***A pure substances is a single element or compound, not mixed with any other substance.***	Pure substances melt and boil at specific temperatures. Heating graphs can be used to distinguish pure substances from impure.

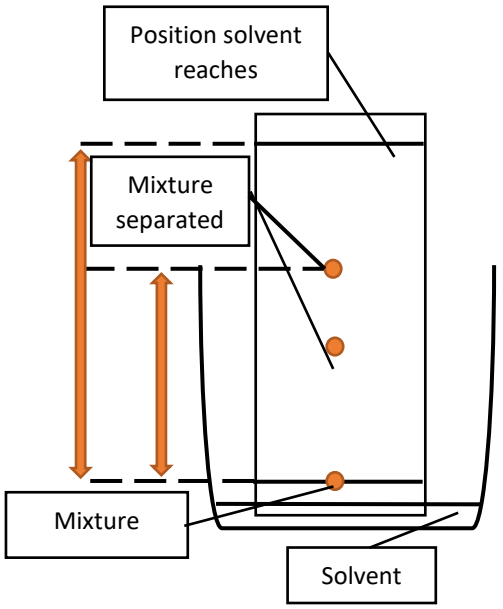


Melting point of a pure substance

Melting point of an impure substance

Formulation	***A formulation is a mixture that has been designed as a useful product.***
How are formulations made?	***By mixing chemicals that have a particular purpose in careful quantities.***
Examples of formulations.	***Fuels, cleaning agents, paints, medicines and fertilisers.***

Chromatography	***Can be used to separate mixtures and help identify substances.***	Involves a mobile phase (e.g. water or ethanol) and a stationary phase (e.g. chromatography paper). The mobile phase move across (up) the stationary phase
R_f Values	***The ratio of the distance moved by a compound to the distance moved by solvent. Always less than 1***	R_f = distance moved by substance / distance moved by solvent
Identification	***The compounds in a mixture separate into different spots.***	This depends on the solvent used. A pure substance will produce a single spot in all solvents whereas an impure substance will produce multiple spots.



Gas	Test	Positive result
Hydrogen	***Burning splint***	'Pop' sound.
Oxygen	***Glowing splint***	Re-lights the splint.
Chlorine	***(Blue) Litmus paper (damp)***	(Turns red) then bleaches the paper white.
Carbon dioxide	***Limewater***	Goes cloudy (as a solid calcium carbonate forms) If keep bubbling through carbon dioxide, the milky white colour disappear as Calcium hydrogen carbonate forms

Q1. Crude oil is a mixture of many different chemical compounds.

(a) Fuels, such as petrol (gasoline), can be produced from crude oil.

(i) Fuels react with oxygen to release energy.

Name the type of reaction that releases energy from a fuel.

_____

(1)

Reactions that release energy are exothermic, the surroundings get warmer

(ii) Fuels react with oxygen to produce carbon dioxide.
The reaction of a fuel with oxygen can produce a different oxide of carbon.

Name this different oxide of carbon and explain why it is produced.

_____

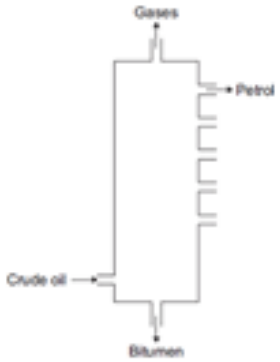
_____

_____

(2)

Complete vs incomplete combustion, how does this gas interact in the body

(b) Most of the compounds in crude oil are hydrocarbons.
Hydrocarbons with the smallest molecules are very volatile.



Describe and explain how **petrol** is separated from the mixture of hydrocarbons in crude oil.

Use the diagram and your knowledge to answer this question.

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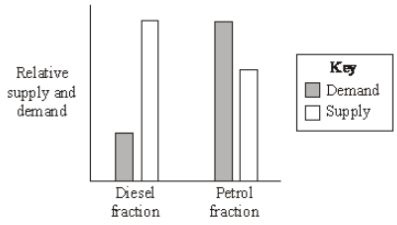
What state is the crude oil in and what state does it need to be in?

Why do the gases rise to the top.

How does chain length affect the properties of the hydrocarbons.

(b) The bar chart shows the relative supply and demand for the petrol and diesel fractions.



(i) How does the relative supply and demand for petrol and diesel fractions cause problems for an oil company?

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_____

_____

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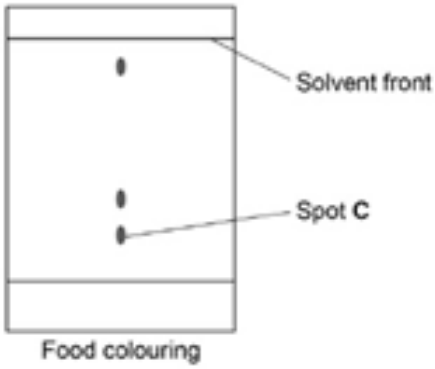
(2)

Diesel is a longer chain hydrocarbon than petrol, what process can be done to break this into a smaller chain hydrocarbon?

Q1. The diagram shows a chromatogram for a food colouring.



How many spots are there, what does each represent

(a) How does the chromatogram show that the food colouring is a mixture?

_____

(1)

(b) A student makes measurements for spot C. The table shows the results.

	Distance in mm
Distance moved by spot C	7
Distance moved by solvent	39

Calculate the R_f value for spot C.

Give your answer to 2 significant figures.

Use the results in the table.

Rf = Distance moved by chemical / Distance moved by solvent

_____

_____ R_f value =

(3)

(c) Plan a chromatography experiment to investigate the colours in an ink.

_____

_____

_____

_____

_____

Where must the solvent be below?

What must the line be drawn in?

Where does the sample go?

How long do you leave it in solvent for?

Useful Websites

https://www.youtube.com/watch?v=2U6806fLx6c (stop at 14 minutes unless doing triple)

https://www.youtube.com/watch?v=YyUQiUddBA4 (stop at 2.50 unless doing triple)

https://www.youtube.com/watch?v=-XCPPB-sBFU

https://www.bbc.com/bitesize/examspecs/z8xtmnb

Wider Reading

Revision guide chapter C7 and c8

BBC bitesize

Homework Tasks

1. **Complete C7 and C8 in workbook**