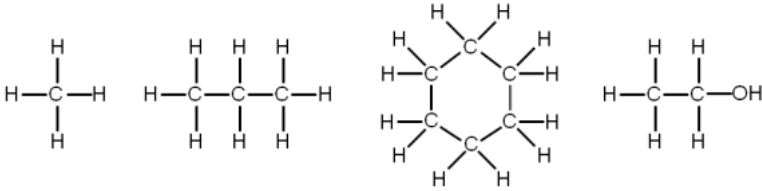


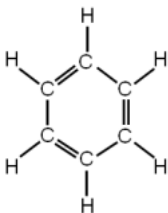
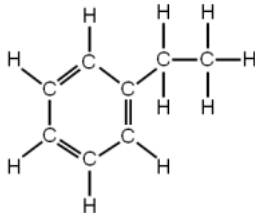
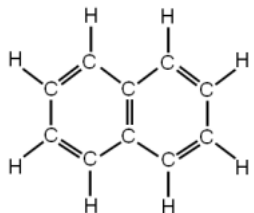
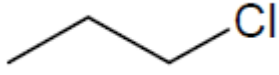
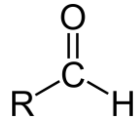
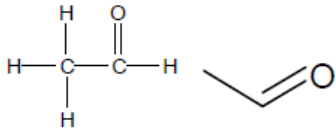
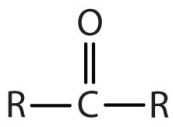
## 4.1 - Basic concepts and hydrocarbons

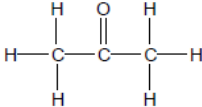
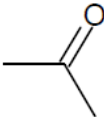
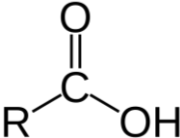
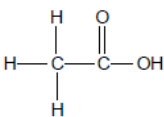
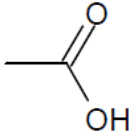
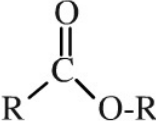
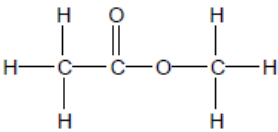
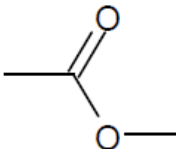
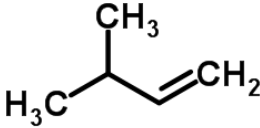
### 4.1.1 - Basic concepts of organic chemistry

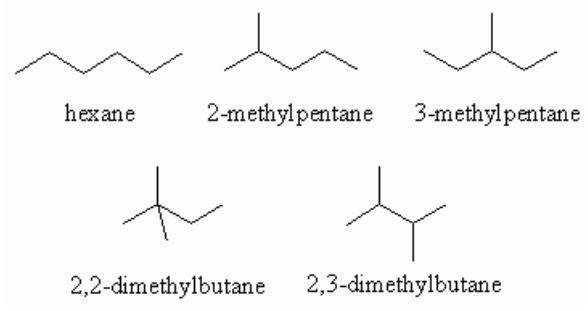
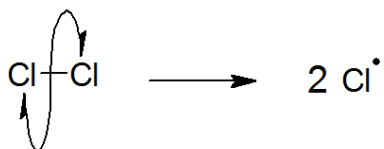
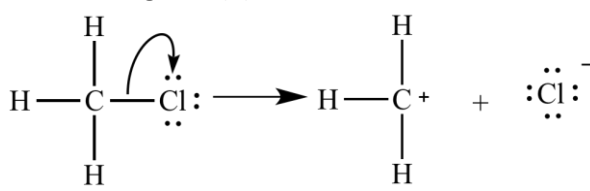
<b>Define hydrocarbon</b>	A compound consisting of <b>ONLY</b> hydrogen and carbon.
<b>Define saturated and unsaturated</b>	<ul style="list-style-type: none"><li>• Saturated means <b>ONLY</b> single carbon-carbon bond.</li><li>• Unsaturated means multiple carbon-carbon bonds (e.g., C=C and C≡C).</li></ul> <p><i>Remember, s in saturated for single.</i></p>
<b>Test for unsaturated compounds</b>	Add bromine water which turns the solution from orange to colourless.
<b>Define molecular formula</b>	The <b>ACTUAL</b> number of atoms of <b>EACH ELEMENT</b> in an element/compound.
<b>Define empirical formula</b>	The <b>SIMPLEST</b> ratio of atoms of <b>EACH ELEMENT</b> in an element/compound.
<b>Define general formula</b>	The algebraic formula for homologous series (e.g., C <sub>n</sub> H <sub>2n</sub> ).

The arrangement of atoms in compound (e.g., CH<sub>3</sub>(CH<sub>2</sub>)<sub>2</sub>CH<sub>3</sub>).

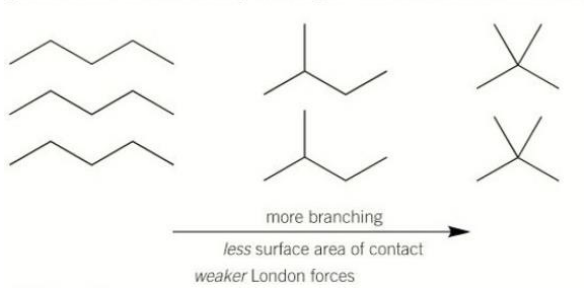
<b>Difference between displayed and skeletal formulae</b>	<ul style="list-style-type: none"><li>• Displayed - every bond is drawn.</li><li>• Skeletal - carbon to hydrogen bonds aren't drawn.</li></ul> <p><i>Every bond means -OH should be drawn as -O-H.</i></p>
<b>Define aliphatic</b>	<p>An organic compound joined in straight or branched chains, or non-aromatic rings.</p> <div style="text-align: center;"><p>The image shows four chemical structures: 1. Methane (CH4) as a central carbon atom bonded to four hydrogen atoms. 2. Propane (C3H8) as a chain of three carbon atoms, each bonded to hydrogen atoms to satisfy four bonds. 3. Cyclohexane (C6H12) as a hexagonal ring of six carbon atoms, each bonded to two hydrogen atoms. 4. Ethanol (C2H5OH) as a two-carbon chain with five hydrogens and one hydroxyl group.</p></div> <p><i>Cyclohexane is more specifically alicyclic yet also aliphatic.</i></p>

<b>Define alicyclic</b>	An organic compound that is both aliphatic and cyclic.
<b>Define aromatic compounds / arenes</b>	<p>Containing benzene ring(s).</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Benzene</p> </div> <div style="text-align: center;">  <p>Ethylbenzene</p> </div> <div style="text-align: center;">  <p>Naphthalene</p> </div> </div>
<b>Define homologous series</b>	A family of compounds with the same functional group yet each successive member differs in the addition of a -CH <sub>2</sub> - group.
<b>Functional group, prefix, and suffix of an alcohol</b>	<ul style="list-style-type: none"> <li>• Functional group: OH.</li> <li>• Prefix: hydroxy-.</li> <li>• Suffix: -ol (more common).</li> </ul>
<b>Functional group and prefixes of haloalkanes</b>	<ul style="list-style-type: none"> <li>• Functional group: C-X.</li> <li>• Prefix: fluoro-, chloro-, bromo-, iodo-.</li> </ul> <div style="text-align: center;">  <p><i>E.g., 1-chloropropane</i></p> </div>
<b>Functional group, prefix, and suffix of aldehydes</b>	<ul style="list-style-type: none"> <li>• Functional group:</li> </ul> <div style="text-align: center;">  </div> <ul style="list-style-type: none"> <li>• Prefix: formyl-.</li> <li>• Suffix: -al.</li> </ul> <div style="text-align: center;">  <p><i>E.g., ethanal.</i></p> </div>
<b>Functional group, prefix, and suffix of ketones</b>	<ul style="list-style-type: none"> <li>• Functional group:</li> </ul> <div style="text-align: center;">  </div>

	<ul style="list-style-type: none"> <li>• Prefix: oxo-.</li> <li>• Suffix: -one (more common).</li> </ul> <div style="text-align: center;">   </div> <p style="text-align: center;"><i>E.g., propone.</i></p>
Functional group and suffix of carboxylic acids	<ul style="list-style-type: none"> <li>• Functional group:</li> </ul> <div style="text-align: center;">  </div> <ul style="list-style-type: none"> <li>• Suffix: -oic acid.</li> </ul> <div style="text-align: center;">   </div> <p style="text-align: center;"><i>E.g., ethanoic acid.</i></p>
Functional group and suffix of esters	<ul style="list-style-type: none"> <li>• Functional group:</li> </ul> <div style="text-align: center;">  </div> <ul style="list-style-type: none"> <li>• Suffix: -yl-oate.</li> </ul> <div style="text-align: center;">   </div> <p style="text-align: center;"><i>E.g., methyl ethanoate.</i></p>
What takes precedence when naming with branched chains?	<ul style="list-style-type: none"> <li>• Functional groups.</li> <li>• E.g., 3-methylbut-1-ene is right, 2-methylbut-3-ene is wrong.</li> </ul> <div style="text-align: center;">  </div> <p style="text-align: center;"><i>Begin counting carbons from the functional group.</i></p>
Define structural isomers	Same molecular formula but <b>different structural formula</b> . E.g.,

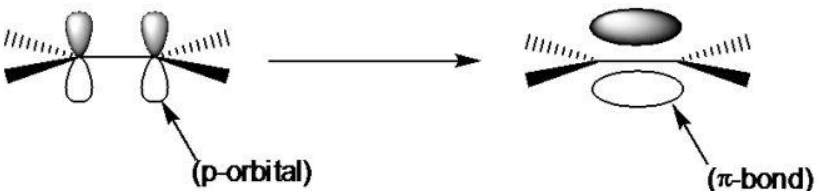
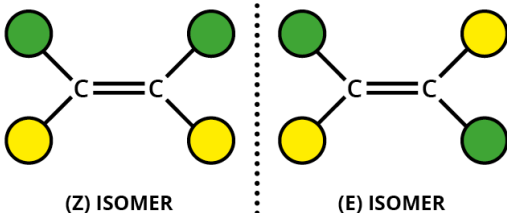
	 <p>hexane      2-methylpentane      3-methylpentane</p> <p>2,2-dimethylbutane      2,3-dimethylbutane</p> <p><i>This has the subsets of chain isomers, positional isomers, and functional group isomers.</i></p>
<b>Define chain isomers</b>	Same molecular formula but <b>different arrangement of carbon atoms</b> .
<b>Define positional isomers</b>	Same molecular formula but <b>different position of functional group</b> (e.g., propan-1-ol and propan-2-ol).
<b>Define functional group isomers</b>	Same molecular formula but <b>different functional group</b> (e.g., but-2-one and butan-1-ol).
<b>What is homolytic fission and what does it form?</b>	<p>A <b>COVALENT BOND BREAKS</b> (1) with each bonded atom getting an electron forming radicals (1).</p> 
<b>Define free radical</b>	A reactive species with an unpaired electron.
<b>What is heterolytic fission?</b>	<p>When a <b>COVALENT BOND BREAKS</b> (1) with one bonded atom getting both electrons forming ions (1).</p> 
<b>Where must curly arrows start?</b>	At a lone pair or the centre of a bond.

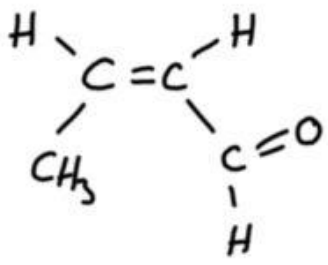
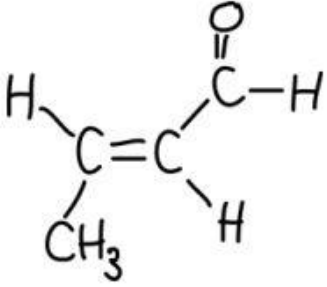
## 4.1.2 - Alkanes

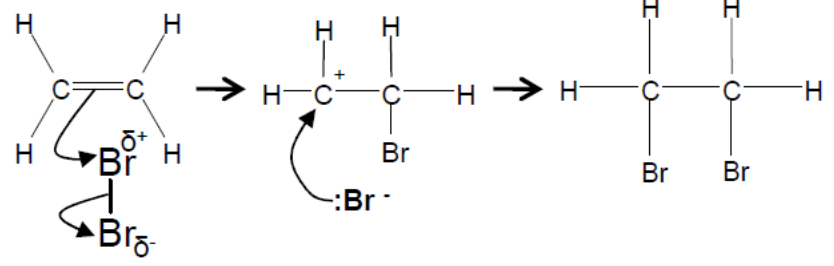
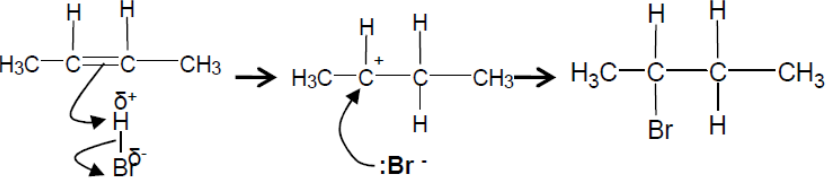
Which important bonds are freely rotating in organic chemistry?	Single C-C and C-H bonds.
What 2 factors affect the boiling points of a homologous series?	<ol style="list-style-type: none"> <li>Length of the main chain: <ul style="list-style-type: none"> <li>Longer <math>\therefore</math> <b>MORE</b> London forces <math>\therefore</math> stronger the attraction <math>\therefore</math> more energy required to overcome.</li> </ul> </li> <li>Surface area of contact: <ul style="list-style-type: none"> <li>Greater <math>\therefore</math> <b>MORE</b> London forces <math>\therefore</math> stronger the attraction <math>\therefore</math> more energy required to overcome.</li> <li>Branching reduces this.</li> </ul> </li> </ol> 
Give 2 reasons why organic compounds are mostly unreactive	<ul style="list-style-type: none"> <li>C-C and C-H have high bond enthalpies.</li> <li>Very low bond polarity (essentially nonpolar).</li> </ul> <p><i>However, they can react with radicals or anything else as reactive as a radical.</i></p>
What is incomplete combustion, what does this form, and what does this mean in terms of energy?	<ul style="list-style-type: none"> <li>Combustion under limited oxygen forming CO and/or C (soot).</li> <li>Produces less energy per mole (as less energy is released from bond making.)</li> </ul>
What is cracking?	<ul style="list-style-type: none"> <li>Converting long chain hydrocarbons to smaller ones.</li> <li>High <math>M_r</math> alkane <math>\rightarrow</math> small <math>M_r</math> alkane + alkene.</li> </ul>
Describe the 3 steps of the synthesis of chloroalkanes (using methane)	<ol style="list-style-type: none"> <li>Initiation - UV light supplies enough energy to break Cl-Cl bonds by homolytic fission.</li> <li>Propagation - chlorine radicals remove H atoms from methane to form methyl radicals. These react with <math>\text{Cl}_2</math> molecules to form a chloromethane and <math>\text{Cl}\cdot</math>. The new radical continues the chain reaction.</li> <li>Termination - when all radicals meet other radicals.</li> </ol>

Give 2 problems with synthesising haloalkanes by free radical substitution	<ul style="list-style-type: none"> <li>Lots of termination steps lead to impurities (e.g., <math>2 \cdot \text{CH}_3</math> meeting).</li> <li>Further substitution of termination products.</li> </ul>
Describe the process of fractional distillation	<ol style="list-style-type: none"> <li>Heat the crude oil to the highest boiling point.</li> <li>Funnel the vapours into a fractionating column which is cooler further up.</li> <li>Let the hydrocarbons will rise up and condense and their respective b.p.'s.</li> </ol>

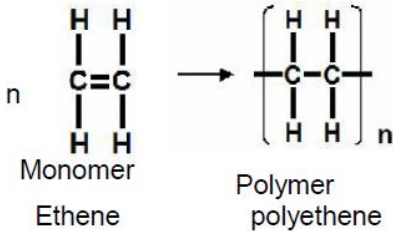
### 4.1.3 - Alkenes

Define electrophile	<p>A species that accepts a lone pair of electrons.</p> <p><i>Think of 'phile' as meaning loving. It loves electrons.</i></p>
What is a $\pi$ bond? (with diagram)	<p>The sideways overlapping of p-orbitals.</p>  <p><i>Draw the full reaction with the arrows.</i></p>
Give 2 differences between $\sigma$ and $\pi$ bonds	<ol style="list-style-type: none"> <li><math>\pi</math> bonds have a lower bond enthalpy than <math>\sigma</math> bonds.</li> <li><math>\sigma</math> bonds have electron density between bonding atoms <b>WHEREAS</b> <math>\pi</math> bond have electron density above and below bonding atoms (so are more exposed/prone to attack).</li> </ol>
What are stereoisomers?	Same structural formulae but different spatial arrangement of atoms.
What is required for E-Z stereoisomerism to arise?	<ol style="list-style-type: none"> <li>A double <math>\text{C}=\text{C}</math> bond (which provides limited rotation).</li> <li>Two different groups on each carbon atom around the double bond.</li> </ol> 

<p><b>Describe the Cahn-Ingold-Prelog (CIP) priority rule</b></p>	<ul style="list-style-type: none"> <li>• Identify the priority groups on either side (the atom with the larger atomic mass).</li> <li>• If the priorities are on the same (<b>zame</b>) side, it is a Z-isomer. If the priorities are on opposite sides (<b>epposite</b>), it is a E-isomer.</li> <li>• If the directly attached atoms are the same, move onto the next atom.</li> </ul>
<p><b>What is E/Z isomerism?</b></p>	<p>An example of stereoisomerism where...</p> <ul style="list-style-type: none"> <li>• There is restricted rotation about the C=C.</li> <li>• Two different groups attached to each <math>^{12}\text{C}</math> of the C=C group.</li> </ul>
<p><b>What is cis-trans isomerism?</b></p>	<p>A special case of E/Z isomerism (and thus stereoisomerism) where a substituent group on one <math>^{12}\text{C}</math> of the C=C group is the same as the other <math>^{12}\text{C}</math>.</p> <p>Eg,</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p>The left is cis <u>whereas</u> the right is trans.</p> <p><i>Note that above, they only need 2 of the same groups, both groups on each carbon <u>don't</u> have to be the same. This also counts as E/Z isomerism as it can be named using the CIP convention too. It's just the cis-trans is a most specific form.</i></p> <p><i>Cis for same and trans for opposite.</i></p>
<p><b>What is the hydration of alkenes and its conditions?</b></p>	<ul style="list-style-type: none"> <li>• Forming alcohols from alkenes.</li> <li>• Conditions: <ul style="list-style-type: none"> <li>○ Steam.</li> <li>○ Phosphoric acid catalyst.</li> <li>○ Around 300°C</li> </ul> </li> <li>• Example: <ul style="list-style-type: none"> <li>○ <math>\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH}</math></li> </ul> </li> </ul>

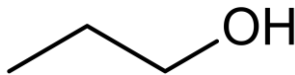
<p><b>What is hydrogenation of alkenes and its conditions?</b></p>	<ul style="list-style-type: none"> <li>• <math>C_2H_4 + H_2 \rightarrow C_2H_6</math>.</li> <li>• With <b>hydrogen</b> in the presence of a <b>nickel catalyst</b> at around <b>150°C</b>.</li> </ul>
<p><b>Describe and draw the electrophilic addition between bromine and ethene</b></p>	 <ol style="list-style-type: none"> <li>1. <math>Br_2</math> molecule approaches alkene.</li> <li>2. Electrons in the <math>\pi</math> bond induce a temporary dipole the <math>Br_2</math> thus causing the <math>Br^{\delta+}</math> to attack the electron dense <math>\pi</math> bond whilst the <math>Br-Br</math> bond breaks by heterolytic fission.</li> <li>3. The positive carbon on the carbocation intermediate attracts the <math>Br^-</math> ion</li> </ol>
<p><b>Describe the electrophilic addition of hydrogen bromide and butene</b></p>	 <ol style="list-style-type: none"> <li>1. As the <math>HBr</math> (polar molecule) approaches the double bond, the <math>H^{\delta+}</math> attacks the electron dense <math>\pi</math> bond whilst the hydrogen-halogen bond breaks by heterolytic fission.</li> <li>2. This forms a carbocation intermediate which attracts the <math>Br^-</math> atom.</li> </ol>
<p><b>What is Markovnikov's rule and what is used to do? (both with and without <math>^1H</math>)</b></p>	<ul style="list-style-type: none"> <li>• That the <math>H^{\delta+}</math> in the hydrogen halide will attach to the carbon with more hydrogens attached.</li> <li>• It's used to determine the major and minor products of electrophilic addition between hydrogen halides and asymmetric alkenes.</li> <li>• For <math>ICl</math>, the <math>I^{\delta+}</math> will bond with the carbon with more hydrogens attached to it since it is less electronegative (just like <math>H^{\delta+}</math>).</li> </ul>
<p><b>What conditions are required for polymerisation?</b></p>	<ul style="list-style-type: none"> <li>• High temperature.</li> <li>• High pressure.</li> <li>• A catalyst.</li> </ul> <p><i>The specifics depend on the product you want to form.</i></p>

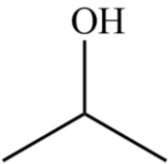
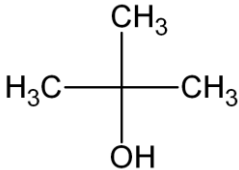
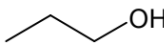
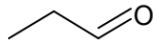


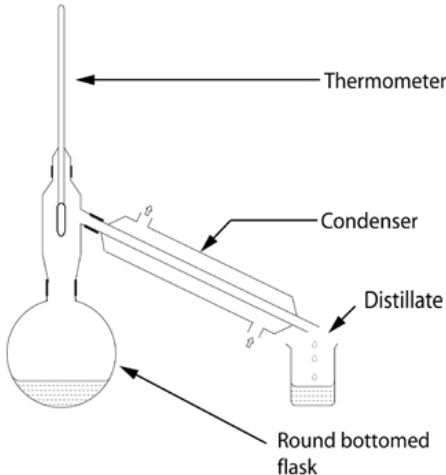
Draw the polymerisation of monomers into a polymer	 <p style="text-align: center;"><i>The bracket with the ethane inside is a repeat unit.</i></p>
What limits biodegradable plastics?	Not having the right conditions to decompose (i.e., moisture and oxygen).
Give 3 ways of dealing with waste polymers	<ol style="list-style-type: none"> <li>1. Separating and recycling.</li> <li>2. Used as feedstock for cracking.</li> <li>3. Combusting for energy production.</li> </ol>
What are the problems of combusting polymers?	Can lead to toxic fumes (e.g., HCl).
Give examples of homogeneous catalysis	<ul style="list-style-type: none"> <li>• Acid catalyst in esterification.</li> <li>• Depletion of atmospheric ozone by chlorine radicals.</li> </ul>

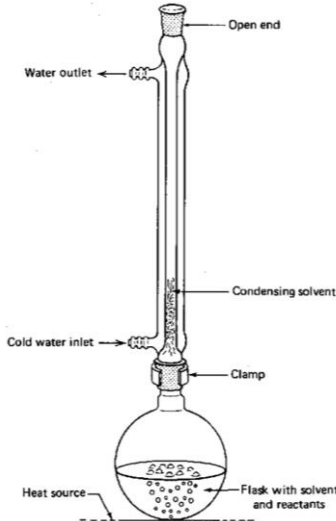
## 4.2 Alcohols, haloalkanes and analysis

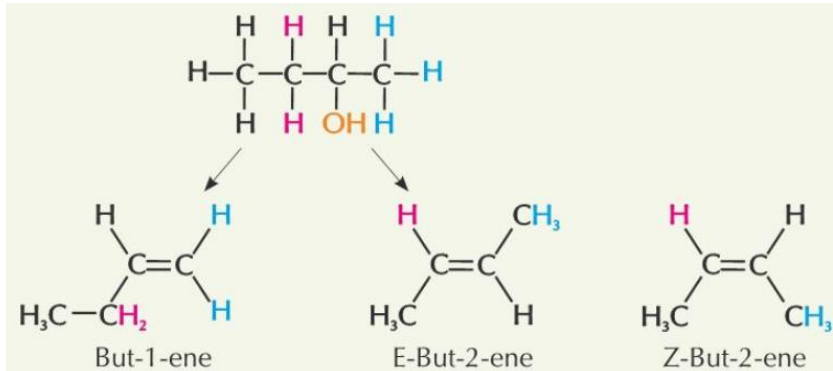
### 4.2.1 - Alcohols

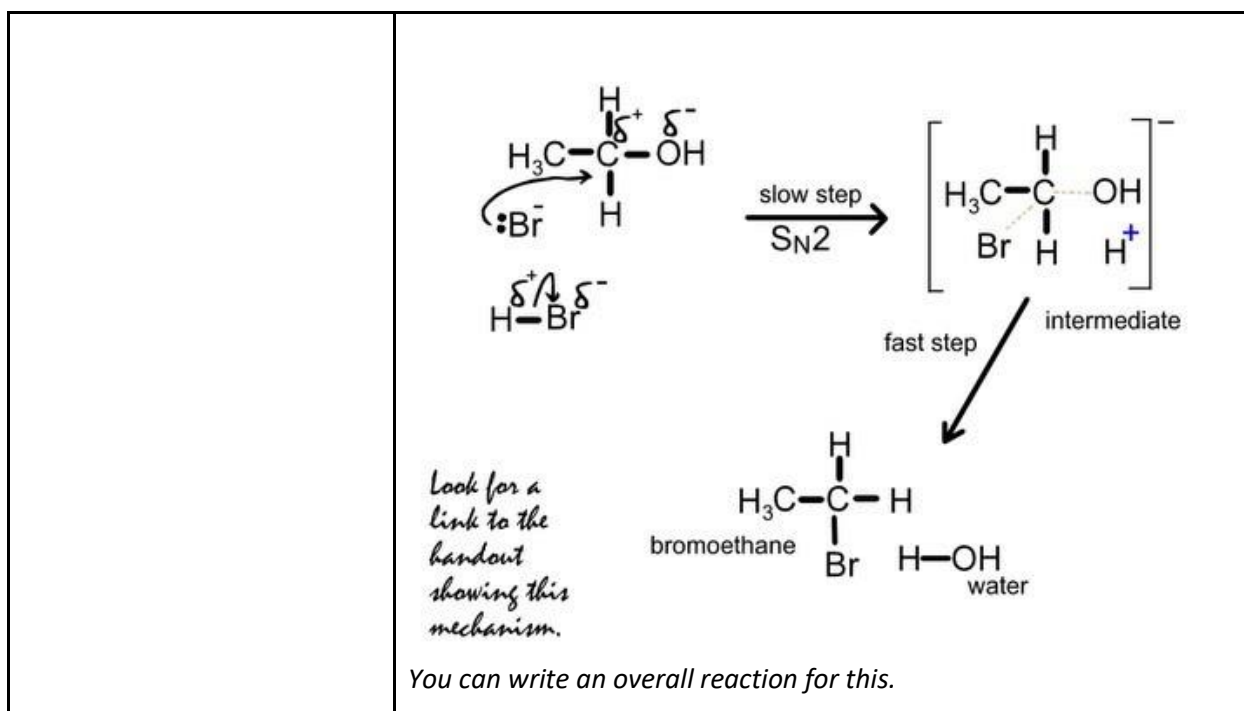
What dangers are there with some alcohols?	Methanol, ethanol, and propanol are very flammable.
Why do alcohols have a low volatility and high b.p.?	As they can form hydrogen bonds which require more energy to overcome.
Why are shorter chain alcohols more soluble in water?	The functional group, which forms hydrogen bonds with water molecules making it soluble, forms a greater proportion of the molecule.
What are the 3 degrees of alcohols?	<ul style="list-style-type: none"> <li>• Primary (1°):</li> </ul>  <p style="text-align: center;"><i>The carbon which the functional group is attached to is only attached to one other carbon.</i></p>

	<ul style="list-style-type: none"> <li>Secondary (2°):  </li> <li>Tertiary (3°):  </li> </ul>
What are the reagents for the oxidation of primary and secondary alcohols and where are they from?	<ul style="list-style-type: none"> <li>An excess of... <ul style="list-style-type: none"> <li><math>\text{Cr}_2\text{O}_7^{2-}</math>.</li> <li><math>\text{H}^+</math>.</li> </ul> </li> <li>From solution of potassium dichromate (VI) and dilute sulfuric acid.</li> </ul> <p><i>Something such as hydrochloric acid cannot be used as the dichromate ions would rather oxidise this.</i></p>
What is the equation for the partial oxidation of primary alcohols?	<p>A primary alcohol reacts with [O] (the oxidising agent) to form an aldehyde and water.</p> <p>  <math>+ [\text{O}] \longrightarrow</math>  <math>+ \text{H}_2\text{O}</math> </p> <p> <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + [\text{O}] \longrightarrow \text{CH}_3\text{CH}_2\text{CHO} + \text{H}_2\text{O}</math> </p> <p><i>E.g., propan-1-ol to propanal.</i></p>
What are the reaction conditions for the partial oxidation of primary alcohols and why?	Distilling the aldehyde as it forms otherwise it will continue onto form a carboxylic acid.
What is observed (colour-wise) under the oxidation of alcohols?	Orange to green colour change.

<p><b>Describe the setup for distillation with an explanation for the key points</b></p>	 <p><i>Some setups may have a receiver at the end of the condenser.</i></p> <ul style="list-style-type: none"> <li>• Bulb of thermometer at T-junction - to display the correct b.p.</li> <li>• Water entering via bottom of condenser - entire condenser will fill up before water exits.</li> <li>• Electric heater - prevents highly flammable organic compounds setting alight under a live flame.</li> </ul> <p><i>If water enters via the top of the condenser, it would trickle down and leave without filling the whole condenser.</i></p>
<p><b>What is the equation for the full oxidation of a primary alcohol? Explain it</b></p>	<p>Primary alcohol + 2[O] → carboxylic acid + water</p> $  \begin{array}{c}  \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + 2[\text{O}] \longrightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{H}_2\text{O}  \end{array}  $ <ol style="list-style-type: none"> <li>1. Two lots of oxidising agent is required; one for each stage</li> <li>2. The water was produced at the first stage (when forming aldehyde)</li> </ol> <p><i>You can distill afterwards to remove any unreacted alcohol molecules.</i></p>
<p><b>What are the reaction conditions for the full oxidation of primary alcohols and oxidation of secondary alcohols? Why?</b></p>	<p>Heating under reflux to prevent evaporation.</p>

<p><b>Describe reflux setup</b></p>	 <ul style="list-style-type: none"> <li>• Open end - prevents build up of gas that can cause explosion</li> <li>• Anti-bumping granules - prevents vigorous and uneven boiling by forming smaller bubbles</li> </ul>
<p><b>When is the reflux setup most often used?</b></p>	<p>When heating organic reaction mixtures for long periods.</p>
<p><b>What is the equation for oxidation of secondary alcohols?</b></p>	<p>Secondary alcohol + [O] → ketone + water</p> $  \begin{array}{c} \text{H} & \text{H} & \text{H} \\   &   &   \\ \text{H}-\text{C} & -\text{C}- & \text{C}-\text{H} \\   &   &   \\ \text{H} & \text{O} & \text{H} \end{array} + [\text{O}] \longrightarrow \begin{array}{c} \text{H} & & \text{O} & & \text{H} \\   & &    & &   \\ \text{H}-\text{C} & - & \text{C} & - & \text{C}-\text{H} \\   & & & &   \\ \text{H} & & & & \text{H} \end{array} + \text{H}_2\text{O}  $
<p><b>Why won't tertiary alcohols oxidise?</b></p>	<p>As you need to remove a <math>^1\text{H}</math> atom from the carbon the -OH is bonded to (alongside the <math>^1\text{H}</math> from the -OH substituent group). Yet, no <math>^1\text{H}</math> is bonded to said carbon.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math display="block">  \begin{array}{c} \text{OH} \\   \\ \text{H}-\text{C}-\text{H} \\   \\ \text{R} \end{array}  </math> <p>primary alcohol</p> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{c} \text{OH} \\   \\ \text{R}-\text{C}-\text{H} \\   \\ \text{R}' \end{array}  </math> <p>secondary alcohol</p> </div> <div style="text-align: center;"> <math display="block">  \begin{array}{c} \text{OH} \\   \\ \text{R}-\text{C}-\text{R}'' \\   \\ \text{R}' \end{array}  </math> <p>tertiary alcohol</p> </div> </div>
<p><b>What are the products and conditions for the dehydration of alcohols and why?</b></p>	<ul style="list-style-type: none"> <li>• Forms an alkene and water.</li> <li>• <b>HEAT</b> under reflux.</li> <li>• Concentrated sulphuric or phosphoric acid.</li> <li>• As we don't want any water to form alcohols again.</li> </ul>

	<i>In short, the same catalyst, however, without water.</i>
<b>What is an elimination reaction?</b>	A reaction involving the elimination of leaving group to form an unsaturated compound.
<b>What type of reaction is the dehydration of alcohols? And why?</b>	<ul style="list-style-type: none"> <li>• Acid-catalysed <b>elimination</b>.</li> <li>• The -OH group (and a <sup>1</sup>H on an adjacent carbon) is eliminated forming an unsaturated molecule.</li> </ul>
<b>When and why are isomers formed from the dehydration of alcohols?</b>	<ul style="list-style-type: none"> <li>• From secondary or tertiary alcohols.</li> <li>• As an H is removed from either one of the two/three adjacent carbons to the carbon the -OH is bonded to.</li> </ul> 
<b>How are haloalkanes formed from alcohols safely, and why? (conditions) (using hydrogen bromide and ethanol as an example)</b>	<ol style="list-style-type: none"> <li>1. Form the hydrogen halide in a substitution reaction between NaBr and H<sub>2</sub>SO<sub>4</sub>.  <math display="block">\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}</math> </li> <li>2. React the alcohol with the hydrogen halide.  <math display="block">\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}</math> </li> </ol> <ul style="list-style-type: none"> <li>• This is by nucleophilic substitution <b>UNDER REFLUX</b>.</li> <li>• The HBr is highly toxic so has to be produced within the reaction mixture and reacted instantly.</li> </ul>



## 4.2.2 - Haloalkanes

What is a nucleophile (with examples)?	<ul style="list-style-type: none"> <li>A species that donates lone pair of electrons.</li> <li><math>\text{HO}^-</math>, <math>\text{H}_2\text{O}</math>, and <math>\text{NH}_3</math>.</li> </ul>
What makes $\text{HO}^-$ a better nucleophile than $\text{H}_2\text{O}$ ?	Its full charge.
Describe and draw the general nucleophilic substitution of a haloalkane	<p>Substitution here is swapping the halogen for another atom.</p> <ol style="list-style-type: none"> <li>The nucleophile attacks the delta positive carbon in the carbon-halogen polar bond to form a covalent bond.</li> <li>At the same time, the carbon-halogen bond breaks by heterolytic fission forming a halide ion.</li> <li>The geometry of the product switches.</li> </ol> <ul style="list-style-type: none"> <li>The nucleophile approaches from behind as its repelled by the delta negative halogen.</li> </ul>

	<p><i>For a tertiary haloalkane, this is a 2-step process because the carbocation intermediate is stable on its own.</i></p>
What is hydrolysis?	<p>A <b>type of reaction</b> involving the splitting of a molecule by water.</p>
What are the conditions and products for the hydrolysis of halogenoalkanes?	<ul style="list-style-type: none"> <li>● Heating under reflux with NaOH (aq) or KOH (aq).</li> <li>● The product is an alcohol and a compound of the halogen (e.g., NaBr or KBr for the hydrolysis of bromoalkanes).</li> </ul> <p><i>The NaOH and KOH is needed so it dissociates into HO<sup>-</sup> nucleophiles. You can't just have a pure solution of OH ions.</i></p>
What 2 things does the rate of the hydrolysis of haloalkanes depend on and how?	<ul style="list-style-type: none"> <li>● The bond enthalpy (i.e., strength) of the carbon-halogen bond; the weaker, the faster.</li> <li>● The degree of the haloalkane; tertiary is faster than secondary which is faster than primary.</li> </ul>
Why does the degree of haloalkane affect the rate of hydrolysis?	<p>The higher the degree, the more stable the carbocation intermediate formed.</p>
How does the strength of the carbon-halogen bond vary between different haloalkanes and why?	<ul style="list-style-type: none"> <li>● Bond enthalpy (i.e., strength) decreases for halogens further down the group ∴ <b>broken more easily</b>.</li> <li>● Due to decreased attraction between the bonding pair of electrons and the nuclei of bonding pairs due to increased shielding and atomic radius.</li> </ul> <p><i>This factor overrides the polarity of the bonds.</i></p>
How can the rate of the hydrolysis of haloalkanes be measured and why?	<ul style="list-style-type: none"> <li>● By adding AgNO<sub>3</sub> (aq) and timing how long it takes for a precipitate to form. The quicker it does, the faster the rate of reaction.</li> <li>● As soon as the halide ion is formed from nucleophilic substitution, it can react with the silver ion: Ag<sup>+</sup> (aq) + X<sup>-</sup> (aq) → AgX (s).</li> </ul>
What are CFCs, what are they used as and why?	<ul style="list-style-type: none"> <li>● Chlorofluorocarbons (thus containing only carbon, chlorine, and fluorine).</li> <li>● Used as propellants, aerosols, and refrigerants because of their stability/low-reactivity, non-toxicity, and volatility.</li> </ul>

<b>What is in equilibrium in the upper atmosphere and how?</b>	<ul style="list-style-type: none"> <li>• The formation and destruction of ozone.</li> <li>• <math>O_2 \rightarrow 2O</math> (broken by UV light to form diradicals).</li> <li>• <math>O_3 \rightleftharpoons O_2 + O</math>.</li> </ul>
<b>Describe how CFCs lead to the destruction of ozone and explain why this is so effective</b>	<ul style="list-style-type: none"> <li>• The weaker C-Cl bond is broken by homolytic fission under UV light forming <math>Cl\bullet</math> which catalyses the breakdown of ozone: <ul style="list-style-type: none"> <li>◦ <math>Cl\bullet + O_3 \rightarrow ClO\bullet + O_2</math></li> <li>◦ <math>ClO\bullet + O\bullet \rightarrow O_2 + Cl\bullet</math></li> </ul> </li> <li>• The overall equation is <math>O_3 + O\bullet \rightarrow 2O_2</math></li> <li>• The chlorine radical is reproduced so they have a long residence time.</li> </ul> <p><i>Nitrogen oxides work in a similar way.</i></p>
<b>What does the destruction of the ozone mean?</b>	Exposed to UV light which can cause skin cancer.

### 4.2.3 - Organic synthesis

<i>Most of the techniques are covered earlier on.</i>	
<b>What is redistillation?</b>	Changing the beaker as soon as the b.p. on the thermometer changes as another substance is about to exit the condenser.
<b>How is a separating funnel used?</b>	<ol style="list-style-type: none"> <li>1. Shake the reaction mixture then allow to settle into a dense aqueous layer (containing the impurities) and a less dense organic layer.</li> <li>2. Open the tap to run off the aqueous layer.</li> </ol>

### 4.2.4 - Analytical techniques

<b>Give an everyday use of IR spectroscopy</b>	Breathalyzers.
<b>How does mass spectroscopy work?</b>	By ionising atoms/molecules, accelerating them via an electric field, deflecting them by varying degrees using a magnetic field, and detecting.



What are the lines on a mass spectrum?	<ul style="list-style-type: none"> <li>• If analysing elements, they're isotopes.</li> <li>• If analysing compounds, they're fragment ions.</li> </ul>
What is fragmentation under mass spectroscopy?	<p>When a bond breaks in a molecular ion (due to instability) forming fragment ions.</p> <p><i>The electron can go onto either side of the double bond. E.g., for <math>\text{CH}_3\text{CH}_2\text{OH}</math>, it may form <math>[\text{CH}_3\text{CH}_2]^+</math> (with the positive charge on the second carbon) or <math>\text{HO}^+</math>.</i></p>
What absorbs IR in the atmosphere, what happens, and what can this lead to?	<ul style="list-style-type: none"> <li>• The bonds of gaseous molecules such as <math>\text{CO}_2</math> and <math>\text{H}_2\text{O}</math>.</li> <li>• They vibrate <b>MORE</b>.</li> <li>• Global warming.</li> </ul>
Give 3 things the Greenhouse Effect of a gas depends on	<ul style="list-style-type: none"> <li>• Its atmospheric concentration.</li> <li>• Its ability to absorb IR.</li> <li>• Its residence time (how long it's in the atmosphere).</li> </ul>