

IGCSE Chemistry: Organic Chemistry 1

Whole Unit Overview

(Please note: (S) denotes material in the Supplement (Extended syllabus) only)

Learning Outcomes		Suggested Teaching Activities	Resources
14.1	Name and draw the structures of methane, ethane, ethanol, ethanoic acid and the products of the reactions of alkanes, alkenes and alcohols. NOTE: the relevant products therefore include halogenoalkanes	Students need to be able to draw full structural formulae (showing all atoms and all bonds), Establish rules of number of bonds formed for carbon, hydrogen and oxygen (links to valency, Group number and electronic configuration are possible, but not essential, if Bonding and Structure unit has been covered). Allow students to use ball and spoke models to build the molecules.	Drawing packages and other software are listed at: http://www.mdli.com/ http://scistore.cambridge.com/ http://www.acdlabs.com/ http://www.softshell.com/
14.1 (S)	Name and draw the structures of the unbranched alkanes, alkenes (not <i>cis-trans</i>), alcohols and acids containing up to four carbon atoms per molecule.	Extend the practical above by increasing the number of carbon, hydrogen and oxygen atoms available for modelling.	For structural formulae table see in : http://www.rjclarkson.demon.co.uk/junior/
14.1	State the type of compound present given a chemical name, ending in <i>-ane</i> , <i>-ene</i> , <i>-ol</i> or <i>-oic acid</i> or a molecular structure.		

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14.3	Describe the concept of homologous series as a 'family' of similar compounds with similar properties due to the presence of the same functional group.	<p>Use full structural formulae / ball and spoke models from 14.1 to emphasise difference of CH₂ between members.</p> <p>Emphasise that the functional group determines chemical reactions, but mass and length of molecule affects physical properties e.g. state, boiling point.</p> <p>Opportunity for spreadsheet work: students could develop (or be provided with) a spread sheet showing number of carbon atoms. They could devise formulae for calculating number of hydrogen atoms for alkanes / alkenes / alcohols and/or carboxylic acids. Formulae could also be derived to calculate molecular masses. If boiling point and/or enthalpy change of combustion data are included, there are opportunities for students to produce line graphs to show trends of mass, boiling points and enthalpies of combustion against number of carbon atoms down the series.</p>	<p>For notes and graph for homologous series properties see in: http://www.rjclarkson.demon.co.uk/junior/ http://webbook.nist.gov/chemistry/</p>
14.3 (S)	Describe the general characteristics of a homologous series.	<p>Discuss effect of increased molecular mass down the series on boiling point (see suggested spreadsheet activity, above).</p> <p>Link to fractional distillation (section 14.2 below).</p>	
14.3 (S)	Describe and identify structural isomerism.	Emphasise drawing of structural formulae to represent isomers. Use butane as the initial example and extend to other examples.	

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6.2	Describe the production of heat energy by burning fuels.	<p>Relevant examples should include Bunsen burner, fuels for heating the home and fossil fuel burning power stations.</p> <p>Link to spreadsheet data, suggested above.</p> <p>Opportunities for experiments to compare energy evolved on heating fuels using spirit burner and metal can.</p> <p>Awareness of the importance of energy output of hydrocarbon fossil fuels to transport and manufacturing industry.</p>	<p>http://www.warmair.com/</p> <p>(mainly advertising of products and general heating apparatus)</p>
6.2	Describe hydrogen as a fuel.	<p>Possible demonstrations include burning hydrogen balloons and hydrogen/oxygen electrolysis mixtures.</p> <p>Possible issues to discuss</p> <ul style="list-style-type: none"> • the high cost of hydrogen due to the energy demand of electrolysis of water / brine. • that obtaining hydrogen involves input of fossil fuel energy for electrolysis • that hydrogen is difficult to store for fuel use, particularly for cars, due to explosion risk and need for heavy pressurised cylinders • that hydrogen is non polluting when burnt, the only product being water. 	

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14.2	Name the fuels coal, natural gas and petroleum.	Awareness of the finite nature of fossil fuel supply and the role of chemistry in the 'search for solutions' for alternative fuels and alternative industrial feedstock. Awareness of the competing demand for hydrocarbons as fuels and as raw materials for the petrochemical industry.	
14.2	Name methane as the main constituent of natural gas.	Relate to use in the home and in Bunsen burners.	
14.2	Describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation. Name the uses of the fractions as: petrol fraction as fuel in cars; paraffin fraction for oil stoves and aircraft fuel; diesel fraction for fuel in diesel engines; lubricating fraction for lubricants and making waxes and polishes; bitumen for making roads.	Opportunity for display work. Students find magazine pictures and advertisements to illustrate the uses of the fractions. The pictures can be mounted on a large outline of the fractionating column, showing where fractions emerge, with boiling points and chemical detail, such as number of carbon atom range in each fraction. Awareness that the use of the fractions as fuels is rapidly depleting crude oil, the essential raw material for plastics and other petrochemicals.	
14.4	Describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning.		
14.4 (S)	Describe substitution reactions of alkanes with chlorine.	Demonstration of the reactions of bromine with liquid alkanes/cycloalkanes in strong sunlight shows the general substitution reaction for alkanes	

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14.4	Describe the bonding in alkanes.	Single covalent bonds only and links to the Bonding and Structure unit	
14.5	Describe the manufacture of alkenes and of hydrogen by cracking.	<p>Petroleum jelly on mineral wool can be cracked using hot broken pot or granules of aluminium oxide as a catalyst. The resultant gas can be collected over water (this experiment demonstrates that large molecules, such as those in the near-solid jelly, form small gaseous molecules, a clear demonstration of the effects of cracking on molecular size)</p> <p>Awareness of the importance of cracking to the petrochemical industry to meet demand for smaller molecules e.g. petrol components, from larger molecules in crude oil for which there is less demand.</p>	See UCLES O'level chemistry Paper 2 Theory 1999 Q B9 for a diagram of the laboratory cracking of petroleum jelly.
14.5	Describe the properties of alkenes in terms of addition reactions with bromine, hydrogen and steam.	<p>The addition of bromine water to the product of the above reaction demonstrates this addition reaction.</p> <p>(For more advanced students the list could be extended to include potassium manganate(VII) to show addition / oxidation}</p> <p>Examples of hydrogen addition include the hydrogenation of polyunsaturated vegetable oils to make solid margarines.</p>	
14.5	<p>Distinguish between saturated and unsaturated hydrocarbons</p> <p>from molecular structures</p> <p>by simple chemical tests</p>	Relate this to the modelling at the start of the unit and the reactions of alkanes and alkenes mentioned above.	

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14.5	Describe the formation of poly(ethene) as an example of addition polymerisation of monomer units.	Demonstration of the polymerisation of styrene or acrylates shows the general addition polymerisation reaction.	
14.6	Describe the formation of ethanol by fermentation and by the catalytic addition of steam to ethene.	Demonstration of fermentation of sugar is possible here. This links closely with Unit 9, Organic Chemistry 2.	
14.6	Describe the properties of ethanol in terms of burning.	Discuss the importance of ethanol as a renewable fuel, already used in many countries where sugar cane grows easily (e.g. Brazil). Ethanol may become a 'fuel for the future' as fossil fuel supplies run out.	
14.6	Name the uses of ethanol; as a solvent; as a fuel.	Mention use of ethanol as a solvent for perfumes and cosmetics (link to diffusion, section 1, Unit 10 Bonding and Structure). The non toxic nature and low boiling point (fast evaporation) of ethanol increase its usefulness as a fast drying solvent.	