

Scheme of work – Cambridge IGCSE[®] Chemistry (0620)

Unit 8: Organic 1

Recommended prior knowledge

Students should have completed the units on air and water, and covalent bonding prior to teaching this unit.

Context

This unit builds on Unit 2 and 7. The concepts in this unit will be revisited in Unit 9.

Outline

This unit starts by introducing the different types of organic molecules (alkanes, alkenes, alcohols and carboxylic acids) and how their functional group is related to their properties. The process of fractional distillation of crude oil is discussed with its importance as the main source of organic molecules. Opportunity for students to research and explore the vast variety of everyday products that originate from crude oil. In addition, students have the chance to debate non-renewable versus renewable fuel. This unit is cross-referenced to assessment objectives A1–5, B1–5, C1–3 and Units 2 and 7.

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

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
14.1	Name and draw the structures of methane, ethane, ethene, ethanol, ethanoic acid and the products of the reactions stated in syllabus references 14.4–14.6	<p>Students need to be able to draw full structural formulae (showing all atoms and all bonds). Stress the importance of correct bond attachments.</p> <p>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 Unit 7 has been covered).</p> <p>Students, in pairs or groups, could be given molecules to build using model kits or name/draw using mini white boards.</p>	<p>Excellent model kits can be purchased: www.molymod.com</p> <p>Drawing packages and other software are listed at: www.acdlabs.com/resources/freeware/</p>

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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	<p>Extend the practical above by increasing the number of carbon, hydrogen and oxygen atoms available for modelling.</p> <p>Students could use mini white boards for drawing structures.</p> <p>Students could be introduced to the term 'functional group' to aid the identification of these organic compounds, for example alkene C=C, alcohol -OH, carboxylic acids – COOH.</p>	
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	Cards with names or structures could be used as an activity.	

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
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>Students could make models from 14.1 to determine the structural formula of successive members. The molecular, empirical formula and general formula can be worked out. Emphasise the difference of CH₂ between successive members of the homologous series.</p> <p>Stress that the functional group determines chemical reactions, but M_r and length of molecule affects physical properties e.g. state, boiling point.</p> <p>Opportunity for ICT: students could develop (or be provided with) a spreadsheet 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>	Database of chemical compound data: www.webbook.nist.gov/chemistry/
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 ICT activity, above).</p> <p>Link to fractional distillation (section 14.2 below).</p>	
14.3(S)	Describe and identify structural isomerism	<p>Emphasise drawing of structural formulae to represent isomers. Use butane as the initial example and extend to other examples.</p> <p>Students could use mini-white boards or design posters showing all the isomers of a particular alkane with names.</p>	

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
6.2	Describe hydrogen as a fuel	<p>Possible demonstrations include burning hydrogen balloons and fuel cells [link to Unit 11].</p> <p>Possible group work for students to present the pros and cons of using hydrogen as a fuel source.</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. 	<p>www.alternative-energy-news.info/technology/hydrogen-fuel/</p> <p>www.auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm</p>
14.2	Name the fuels coal, natural gas and petroleum	<p>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.</p> <p>Awareness of the competing demand for hydrocarbons as fuels and as raw materials for the petrochemical industry.</p>	
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	<p>Define a hydrocarbon as a molecule containing carbon and hydrogen atoms only.</p> <p>Awareness that the use of the fractions as fuels is rapidly depleting crude oil, the essential raw material for plastics and other petrochemicals.</p> <p>Discuss the supply and demand problem for some fractions- link to cracking in this unit. Also why the composition of crude oil differs from the location.</p>	<p>Video clip on the fractional distillation: www.rsc.org/Education/Teachers/Resources/Alchemy/</p> <p>www.science.howstuffworks.com/environmental/energy/oil-refining1.htm</p>

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
14.2	Name the uses of the fractions as: <ul style="list-style-type: none"> refinery gas for bottled gas for heating and cooking gasoline fraction for fuel (petrol) in cars naphtha fraction for making chemicals kerosene/paraffin fraction for jet fuel diesel oil/gas oil for fuel in diesel engines fuel oil fraction for fuel for ships and home heating systems lubricating fraction for lubricants, waxes and polishes bitumen for making roads 	Opportunity for display work. Students can 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.	
14.4	Describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning	Lack of reactivity is partly due to the presence of strong C-C and C-H bonds only [link to Unit 5].	
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.	www.chemguide.co.uk/organicprops/alkanes/halogenation.html
14.4	Describe the bonding in alkanes	Single covalent bonds only and links to Unit 7.	

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
14.5	Describe the manufacture of alkenes and of hydrogen by cracking	<p>Paraffin 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.</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>	<p>www.practicalchemistry.org/experiments/cracking-hydrocarbons%2C139%2Cex.html</p> <p><i>R. Norris & R. Stanbridge. Chemistry for IGCSE, Nelson Thornes, 2009, ISBN 9781408500187, p220 Fig 18.2.2.</i></p> <p>Extension to cracking of ethanol: <i>Chemistry Experiments, J. A. Hunt, A. Geoffrey Sykes, J. P. Mason, Longman 1996, Experiments 15.</i></p>
14.5(S)	Describe the properties of alkenes in terms of addition reactions with bromine, hydrogen and steam This should all be bold as it is supplementary	<p>The addition of bromine water to the product of the above reaction demonstrates this addition reaction.</p> <p>Emphasise the difference between an addition and a substitution 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	Distinguish between saturated and unsaturated hydrocarbons <ul style="list-style-type: none"> • from molecular structures • by reaction with aqueous bromine 	<p>Relate this to the modelling at the start of the unit and the reactions of alkanes and alkenes mentioned above.</p> <p>Emphasise that a saturated molecule contains only single covalent bonds and an unsaturated molecule contains one or more C=C double bonds.</p>	

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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.	Video clip on polyethene: www.rsc.org/Education/Teachers/Resources/Alchemy/ <i>Chemistry Experiments</i> , J. A. Hunt, A. Geoffrey Sykes, J. P. Mason, Longman 1996, Experiments 17–18.
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. Students can tabulate the pros and cons of each process. This links closely with Unit 10.	<i>R. Norris & R. Stanbridge. Chemistry for IGCSE</i> , Nelson Thornes, 2009, ISBN 9781408500187, p244 Fig 20.4.1.
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, Italy). Ethanol may become a 'fuel for the future' as fossil fuel supplies run out.	