Learning Outcomes Leaving Certificate Chemistry

7 Organic Chemistry			
Each topic has a set of boxes which the pupil can tick to show how well they understanding or how well they know the topic. This is useful for revision. **Bold text** indicates Higher Level.			
7.1 Tetrahedral Carbon (4 class periods) By the end of this section pupils should be able to	**Good**	**Fair**	**Poor**
define tetrahedral carbon explain what is meant by a saturated organic compound construct models to illustrate the structure of saturated organic compounds describe alkanes as a homologous series of aliphatic hydrocarbons discuss the use of alkanes as fuels **explain what is meant by the term alcohol** describe the alcohols as a homologous series of organic compounds **explain what is meant by the term chloroalkane** name the , **chloroalkanes** and alcohols (primary and secondary alcohols only) up to C4 **discuss the use of chloroalkanes as solvents** draw the structural formulas of, **chloroalkanes** and alcohols (primary and secondary alcohols only) up to C4 account for the physical properties [physical state, solubility (qualitative only) in water and in non-polar solvents]of the alkanes and **chloroalkanes** and alcohols up to C4 relate the physical properties of alcohols and water through comparison of their structures account for the solubility of (a) methanol (methyl alcohol) and (b) butan-1-ol in (i) cyclohexane and (ii) water. discuss the use of ethanol (ethyl alcohol) as a solvent outline the use of methanol (methyl alcohol) as a denaturing agent recall that fermentation is a source of ethanol (ethyl alcohol) discuss the use of fermentation in the brewing and distilling industries			

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7.2 Planar Carbon (11 class periods) By the end of this section pupils should be able	**Good**	**Fair**	**Poor**
define planar carbon explain what is meant by an unsaturated organic compound describe alkenes as a homologous series of aliphatic hydrocarbons construct models to illustrate the structure of alkenes name the alkenes to C4 draw the structural formulas of the alkenes up to C4 outline the role of alkenes as raw materials in the industrial manufacture of plastic define carbonyl compound describe the bonding in the carbonyl group describe aldehydes as a homologous series of compounds construct models to illustrate the structure of aldehydes name the aldehydes to C4 draw the structural formulas of the aldehydes up to C4 account for the physical properties [physical state, solubility (qualitative only) in water and in non-polar solvents]of the aldehydes up to C4 account for the solubility of ethanal (acetaldehyde)in (i) cyclohexane and in (ii) water **recall that benzaldehyde is a constituent of almond kernels (structure of benzaldehyde not required)** **describe ketones as a homologous series of compounds** **construct models to illustrate the structure of, ketones** **name the ketones to C4** **draw the structural formulas of the ketones to C4** **account for the physical properties [physical state, solubility (qualitative only) in water and in non-polar solvents]of the ketones up to C4** **account for the solubility of propanone (acetone) in (i) cyclohexane and in (ii) water** **give an example of the use of propanone (acetone) as a solvent e.g. in nail varnish remover**			

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describe carboxylic acids as a homologous series of compounds			
construct models to illustrate the structure of carboxylic acids			
name the carboxylic acids to C4			
draw the structural formulas of the carboxylic acids to C4			
describe the bonding in the carbonyl group of carboxylic acids			
account for the solubility of ethanoic (acetic) acid in (i) cyclohexane and in (ii) water			
account for the physical properties [physical state, solubility (qualitative only) in water and in non-polar solvents] of the carboxylic acids up to C4			
give examples of carboxylic acids in everyday life e.g. methanoic acid (formic acid) in nettles and ants, ethanoic acid (acetic acid) in vinegar			
recall the use of ethanoic acid (acetic acid) **in the manufacture of cellulose acetate (structure of cellulose acetate not required)**			
recall the use of propanoic and benzoic acid and their salts as food preservatives (structure of benzoic acid not required)			
purify a sample of benzoic acid by recrystallisation			
outline the use of melting point to confirm purity			
determine the melting point of benzoic acid			
describe esters as a homologous series of compounds			
construct models to illustrate the structure of esters			
name the esters to C4			
draw the structural formulas of the esters to C			
account for the physical properties of esters [physical state, solubility (qualitative only) in water and in non-polar solvents]			
account for the solubility of ethyl ethanoate (ethyl acetate) in (i) cyclohexane and in (ii) water			
recall that fats are natural esters			
appreciate that esters have a characteristic aroma			
recall the use of ethyl ethanoate (ethyl acetate) as a solvent			
explain what is meant by an aromatic compound			
explain in simple terms the use of the circle to represent the identical bonds in benzene, intermediate between double and single			
describe the bonding in benzene with reference to sigma and pi			

bonds account for the solubility of methylbenzene in (i) cyclohexane and in (ii) water discuss the use of methylbenzene as an industrial solvent give an indication of the range and scope of aromatic chemistry (Structures not required) identify the benzene ring in the structural formulas of a range of consumer products give one example in each case of: • aromatic compounds as the basis of dyestuffs, detergents, herbicides and many pharmaceutical compounds (structures not required) • aromatic acid-base indicators: phenolphthalein, methyl orange (structures not required) recognise the carcinogenic nature of some aromatic compounds e.g. benzene recognise that not all aromatic compounds are carcinogenic, e.g. aspirin (structure of aspirin not required)			
7.3 Organic Chemical Reaction Types (21 class periods) By the end of this section pupils should be able	**Good**	**Fair**	**Poor**
Students are not, in general, required to know the conditions (temperature, pressure, catalyst, solvent) for these reactions except where specified elsewhere in this syllabus. They are required to write balanced equations using structural formulas, unless otherwise stated. **<u>Addition Reactions</u>** explain what is meant by an addition reaction write balanced equations using structural formula for the reactions of the alkenes with hydrogen, chlorine, bromine, water and hydrogen chloride outline the production of alkenes in the petrochemical industry c.f section 5.5 outline the industrial importance of: • products of the addition reactions of ethene (ethylene) with chlorine, bromine, water and hydrogen chloride • hydrogenation of vegetable oils **describe the mechanisms of ionic addition (addition of HCl, Br_2, Cl_2, only to ethene (ethylene))** **describe the evidence for this mechanism as: the reaction of ethene (ethylene) with bromine water containing sodium chloride results in the formation of 2-bromoethanol (ethyl alcohol) 1-bromo-2-chloroethane and 1,2-dibromoethane** explain what is meant by addition polymerisation			

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outline the polymerisation reaction of ethene(ethylene) and propene (reaction mechanism not required). account for the unreactivity of benzene with regard to addition reactions relative to ethene (ethylene) account for the use of alkenes as raw materials in the industrial manufacture of plastics outline the range and scope of the petrochemical industry list two synthetic products of the petrochemical industry (structures not required unless specified elsewhere on the syllabus) **<u>Substitution Reaction</u>** define substitution reaction recognise halogenation of alkanes as a substitution reaction write balanced equations using structural formula for the halogenations of alkanes **describe the mechanism of free radical substitution (monochlorination of methane and ethane only)** **discuss the evidence for the mechanism of free radical substitution** • **use of ultraviolet light even for a very short period causes a chain reaction** • **formation of trace quantities of ethane and butane in the monochlorination of methane and ethane, respectively** • **these reactions are speeded up by the addition of a known source of free radicals, such as tetraethyllead** **explain what is meant by esterification** **explain what is meant by base hydrolysis of esters** **write balanced equations using structural formulas to illustrate base hydrolysis of esters** prepare a sample of soap **(structures of reactants and products required)** discuss the manufacture of soap **(structures of reactants and products required)** **<u>Elimination Reactions</u>** explain what is meant by an elimination reaction explain what is meant by a dehydration reaction write balanced equations using structural formula for the dehydration of alcohols prepare a sample of ethene(ethylene)			

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demonstrate the properties of ethene(ethylene) combustion, tests for unsaturation using acidified potassium manganate(VII) solution and bromine water.(*equations and structures of products not required unless specified elsewhere on the syllabus)*			
<u>Redox Reactions</u> write balanced half equations using structural formula for the oxidation (using $KMnO_4$ or $Na_2Cr_2O_7$) of: • alcohols to(i) aldehydes and (ii) acids • aldehydes to acids			
prepare a sample of ethanal (acetaldehyde)from ethanol (ethyl alcohol)			
carry out calculations involving percentage yield of ethanal (the balanced equation will be given)			
demonstrate the properties of ethanal (acetaldehyde) (limited to reactions with (i) acidified potassium manganate(VII) solution, (ii) Fehling's reagent and (iii) ammoniacal silver nitrate)			
relate the production of ethanal to the metabolism of ethanol (ethyl alcohol) in the human body			
prepare a sample of ethanoic acid (acetic acid) from ethanol (ethyl alcohol)			
carry out calculations involving percentage yield of ethanoic acid (the balanced equation will be given)			
carry out diagnostic tests on ethanoic acid (limited to reactions with sodium carbonate, magnesium and **ethanol (ethyl alcohol)**)			
account for the lower susceptibility of ketones than aldehydes to oxidation			
write balanced equations using structural formulas for the reduction of carbonyl compounds using a H_2/Ni catalyst			
recall that combustion is a reaction common to most organic compounds			
recall that the fully halogenated alkanes are non-flammable, relate this property to their use in flame retardants and fire extinguishers			
write balanced equations using structural formulas for the combustion of alcohols			
discuss the application of alcohols as motor fuels			
<u>Reactions as acids</u> write balanced equations using structural formulas for the reactions of alcohols with sodium			
account for the acidic nature of the carboxylic acid group			
write balanced equations using structural formulas for the reactions of carboxylic acids with magnesium, with sodium hydroxide and with sodium			

carbonate **<u>Organic synthesis: principles and examples</u>** recall that chemical synthesis involves (i) bond breaking and (ii) bond forming describe the organic synthesis of PVC from ethene (ethylene) (structures and synthetic route not required) **work out reaction schemes of up to three conversions recalling familiar reactions**			
7.4 Organic Natural Products (4 class periods) By the end of this section pupils should be able	**Good**	**Fair**	**Poor**
describe some commonly used extraction techniques, e.g. solvent extraction, steam distillation extract clove oil from cloves (or similar alternative) by steam distillation indicate the range and scope of organic natural product chemistry using two examples of useful organic natural products (structures not required)			
7.5 Chromatography and Instrumentation in Organic Chemistry (3 class periods) By the end of this section pupils should be able	**Good**	**Fair**	**Poor**
describe chromatography as a separation technique in which a mobile phase carrying a mixture is caused to move in contact with a selectively absorbent stationary phase separate a mixture of indicators using paper chromatography or thin-layer chromatography or column chromatography describe the use of thin-layer chromatography (TLC) in the separation of dyes taken from fibres in forensic work describe GC and HPLC as more advanced separation techniques give examples of instrumental methods of separation or analysis referring briefly to the principles involved in each case for the following: • mass spectrometry- analysis of gases from a waste dump, trace organic pollutants in water • gas chromatography (GC)- drug tests on athletes, blood alcohol tests • high-performance liquid chromatography (HPLC)- growth-promoters in meat, vitamins in foods • **infra-red absorption spectrometry (IR)- identification of organic compounds, e.g. plastics and drugs** • **ultraviolet absorption spectrometry- quantitative determination of organic compounds (e.g. drug metabolites, plant pigments)** Brief reference to the principles of each method. interpretation of spectra etc. not required (It should be noted that these techniques are applicable not only to organic chemistry but also to many other areas of chemistry)			