SCOTTISH QUALIFICATIONS AUTHORITY

CHEMISTRY
Higher

Fourth edition – published December 1999

SCOTTISH QUALIFICATIONS AUTHORITY

NOTE OF CHANGES TO ARRANGEMENTS
FOURTH EDITION PUBLISHED ON CD-ROM DECEMBER 1999

COURSE TITLE: Chemistry (Higher)

COURSE NUMBER: C012 12

National Course Specification

Course Details: Core skills statements expanded

National Unit Specification:

All Units: Core skills statements expanded

National Course Specification

CHEMISTRY (HIGHER)

COURSE NUMBER C012 12

COURSE STRUCTURE

The course has three mandatory units as follows:

D069 12	***Energy Matters (H)***	***1 credit (40 hours)***
D070 12	***The World of Carbon (H)***	***1 credit (40 hours)***
D071 12	***Chemical Reactions (H)***	***1 credit (40 hours)***

All courses include 40 hours over and above the 120 hours for component units. This may be used for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning and preparation for external assessment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained one of the following awards or its equivalent:

- Standard Grade Chemistry at Grades 1 and 2
- the Intermediate 2 Chemistry course or its component units

together with

- Standard Grade Mathematics at Grades 1 and 2 or Intermediate 2 Mathematics.

(The preferred entry level from Standard Grade is based on achievement in the Knowledge and Understanding and Problem Solving elements.)

Administrative Information

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CORE SKILLS

This course gives automatic certification of the following:

Complete core skills for the course	Problem Solving	H
	Numeracy	Int 2
Additional core skills for the course	Using Graphical Information	H

For information about the automatic certification of core skills for any individual unit in this course, please refer to the general information section at the beginning of the unit.

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Course Specification: course details

COURSE Chemistry (Higher)

RATIONALE

The study of chemistry at Higher extends the candidates' knowledge and understanding of the physical and natural environments and the development of the problem solving and practical skills associated with scientific enquiry beyond Intermediate 2. A grounding for the future study of chemistry and chemistry-related subjects in higher education is provided for candidates who wish to pursue a career in a science-based area.

As such, the course is designed to provide opportunities in appropriate contexts for the candidates to acquire:

- knowledge and understanding of chemical facts, theories and symbols
- the ability to solve chemical problems
- the ability to carry out chemical techniques and investigations
- positive attitudes, by helping candidates to be open-minded and willing to recognise alternative points of view, and to be interested in science and aware that they can take decisions which affect the well-being of themselves and others, and the quality of their environment

In problem solving, the candidates will be expected to:

- select and present information
- carry out calculations
- plan, design and evaluate experimental procedures
- draw conclusions and give explanations
- make generalisations and predictions

As a result of engaging in practical work candidates will be expected to:

- describe experimental procedures
- record relevant measurements and observations
- analyse experimental information
- draw valid conclusions
- evaluate experimental procedures with supporting argument

In addition, the learning experiences make an important contribution to candidates' general education by:

- emphasising the relevance of chemistry to everyday living
- developing core skills
- raising awareness of the links between the subject and the world of work in general, and the chemical industry in particular
- providing opportunities for independent and cooperative learning

National Course Specification: course details (cont)

COURSE Chemistry (Higher)

COURSE CONTENT

The Content Statements given in the left-hand column of the tables on the following pages describe in detail the knowledge and understanding associated with the three units of the course, all of which will be subject to sampling in the external assessment. Achievement will require to be shown in a variety of ways, that is, candidates will be expected to 'state', 'describe', 'explain', 'identify', etc, as appropriate. The right-hand column gives Suggested Activities related to the Content Statements. Opportunities to make use of information technology are indicated by (ITO).

It should be noted that the content has been arranged to tie in with the performance criteria and evidence requirements for each of the units. Teachers and lecturers may wish to re-order for learning and teaching purposes.

It should also be noted that, while the units are valuable in their own right, candidates will gain considerable additional benefit from completing this course, since there will be opportunities for the integration of skills across the units, and for tackling problem solving of a more complex nature than that required for attainment of the individual units.

All candidates will be expected to carry out the Prescribed Practical Activities listed below. These are highlighted in italics under Suggested Activities.

ACTIVITY	**UNIT**
Effect of Concentration Changes on Reaction Rate	1
Effect of Temperature Changes on Reaction Rate	1
Enthalpy of Combustion	1
Oxidation	2
Making Esters	2
Factors Affecting Enzyme Activity	2
Hess's Law	3
Quantitative Electrolysis	3
A Redox Titration	3

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
a) Reaction rates **Following the course of a reaction** Reactions can be followed by measuring changes in concentration, mass and volume of reactants and products.	Carry out a selection of experiments. Present and analyse experimental information in the form of tables and graphs (ITO).
The average rate of a reaction, or stage in a reaction, can be calculated from initial and final quantities and the time interval.	
The rate of a reaction, or stage in a reaction, is proportional to the reciprocal of the time taken.	
Factors affecting rate The rates of reactions are affected by changes in concentration, particle size and temperature.	Make a list of everyday reactions which are affected by changes in concentration, particle size and temperature. *Investigate the effect of concentration, particle size and temperature on the rate of reaction (ITO).*
The collision theory can be used to explain the effects of concentration and surface area on reaction rates.	Use models.
Temperature is a measure of the average kinetic energy of the particles of a substance. The activation energy is the minimum kinetic energy required by colliding particles before reaction will occur. Energy distribution diagrams can be used to explain the effect of changing temperature on the kinetic energy of particles. The effect of temperature on reaction rate can be explained in terms of an increase in the number of particles with energy greater than the activation energy.	Use a computer program.
With some chemical reactions, light can be used to increase the number of particles with energy greater than the activation energy.	Demonstrate a photochemical reaction.

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
The idea of excess The reactant that is in excess can be calculated.	 Predict the excess acid in a metal/acid reaction and carry out an experiment to check.
Catalysts Catalysts can be classified as either heterogeneous or homogeneous.	 Demonstrate/carry out a selection of reactions involving heterogeneous and homogeneous catalysts (ITO). View a videotape.
Catalysts are used in many industrial processes.	Find out about catalysts used in industry.
Heterogeneous catalysts work by the adsorption of reactant molecules. The surface activity of a catalyst can be reduced by poisoning. Impurities in the reactants result in the industrial catalysts having to be regenerated or renewed.	
Catalytic convertors are fitted to cars to catalyse the conversion of poisonous carbon monoxide and oxides of nitrogen to carbon dioxide and nitrogen. Cars with catalytic converters only use 'lead-free' petrol to prevent poisoning of the catalyst.	Find out why costly rhodium, platinum and palladium are used for the converters, rather than cheaper copper and nickel.
Enzymes catalyse the chemical reactions which take place in the living cells of plants and animals.	Investigate enzyme activity.
Enzymes are used in many industrial processes.	Find out about enzymes used in industry.

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
b) Enthalpy **Potential energy diagrams** Exothermic changes cause heat to be released to the surroundings; endothermic changes cause absorption of heat from the surroundings. A potential energy diagram can be used to show the energy pathway for a reaction. The enthalpy change is the energy difference between products and reactants. The enthalpy change can be calculated from a potential energy diagram. The enthalpy change has a negative value for exothermic reactions and a positive value for endothermic reactions.	Demonstrate/carry out a selection of exothermic and endothermic reactions (ITO).
The activated complex is an unstable arrangement of atoms formed at the maximum of the potential energy barrier, during a reaction. The activation energy is the energy required by colliding molecules to form an activated complex. The activation energy can be calculated from potential energy diagrams. The effect of a catalyst can be explained in terms of alternative reaction pathways with lower activation energy. A potential energy diagram can be used to show the effect of a catalyst on activation energy.	View a videotape.
Enthalpy changes The enthalpy of combustion of a substance is the enthalpy change when one mole of the substance burns completely in oxygen. The enthalpy of solution of a substance is the enthalpy change when one mole of the substance dissolves in water. The enthalpy of neutralisation of an acid is the enthalpy change when the acid is neutralised to form one mole of water. The enthalpy changes can be calculated using $c\ m\ \Delta T$.	*Carry out experiments to find enthalpies of combustion, enthalpies of neutralisation and enthalpies of solution.*

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
c) Patterns in the Periodic Table The modern Periodic Table is based on the work of Mendeleev who arranged the known elements in order of increasing atomic masses in conjunction with similar chemical properties, leaving gaps for yet to be discovered elements.	Find out about the history of the Periodic Table and the origins and the discovery of the elements. Use a database to obtain information (ITO). View a videotape.
There are variations in the densities, melting points and boiling points of the elements across a period and down a group. The atomic size decreases across a period and increases down a group. The first ionisation energy is the energy required to remove one mole of electrons from one mole of gaseous atoms. The second and subsequent ionisation energies refer to the energies required to remove further moles of electrons. The trends in the first ionisation energy across periods and down groups can be explained in terms of the atomic size, nuclear charge and the screening effect due to inner shell electrons. Atoms of different elements have different attractions for bonding electrons. Electronegativity is a measure of the attraction an atom involved in a bond has for the electrons of the bond. Electronegativity values increase across a period and decrease down a group.	Use a database to obtain information and identify variations and periodic patterns (ITO). Draw graphs to show variations and periodic patterns. Make a simplified database and identify variations and periodic patterns (ITO).

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
d) Bonding, structure and properties **Types of bonding** Metallic bonding is the electrostatic force of attraction between positively charged ions and delocalised outer electrons.	Use a computer program.
Atoms in a covalent bond are held together by electrostatic forces of attraction between positively charged nuclei and negatively charged shared electrons. The polarity of a covalent bond depends on the difference in electronegativity between the bonded atoms.	Use a computer program. Use models.
Ionic bonding is the electrostatic force of attraction between positively and negatively charged ions.	Use a computer program. Use models.
The type of bonding in a compound is related to the positions of its constituent elements in the Periodic Table.	
Intermolecular forces of attraction Van der Waals' forces are forces of attraction which can operate between all atoms and molecules. Van der Waals' forces are much weaker than all other types of bonding. Van der Waals' forces are a result of electrostatic attraction between temporary dipoles and induced dipoles caused by movement of electrons in atoms and molecules. The strength of van der Waals' forces is related to the size of the atoms or molecules.	Use models.

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
A molecule is described as polar if it has a permanent dipole. Permanent dipole-permanent dipole interactions are additional electrostatic forces of attraction between polar molecules. Permanent dipole-permanent dipole interactions are stronger than van der Waals' forces for molecules of equivalent size. The spatial arrangement of polar covalent bonds can result in a molecule being polar.	Use a charged rod to test liquids for polarity of molecules.
Bonds consisting of a hydrogen atom bonded to an atom of a strongly electronegative element such as fluorine, oxygen or nitrogen are highly polar. Hydrogen bonds are electrostatic forces of attraction between molecules which contain these highly polar bonds. A hydrogen bond is stronger than other forms of permanent dipole-dipole interaction but weaker than a covalent bond.	
Structure A metallic structure consists of a giant lattice of positively charged ions and delocalised outer electrons.	
A covalent molecular structure consists of discrete molecules held together by weak intermolecular forces. A covalent network structure consists of a giant lattice of covalently bonded atoms.	Use models.
An ionic structure consists of a giant lattice of oppositely charged ions. A monatomic structure consists of discrete atoms held together by van der Waals' forces.	Use models.
The first 20 elements in the Periodic Table can be categorised according to bonding and structure: • metallic (Li, Be, Na, Mg, Al, K, Ca) • covalent molecular (H_2, N_2, O_2, F_2, Cl_2, P_4, S_8 and C (fullerenes)) • covalent network (B, C (diamond, graphite), Si) • monatomic (noble gases)	Use models. Use a database to obtain information (ITO).

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
Compounds each adopt one of three structures in the solid state: • covalent molecular • covalent network, including silicon dioxide and silicon carbide • ionic	Use models.
Properties The melting points, boiling points and hardness/softness of elements and compounds are related to their bonding and structures. The melting and boiling points of polar substances are higher than the melting and boiling points of non-polar substances with similar molecular sizes.	Compare the melting points, boiling points and hardness/softness of selected substances. Use a database to obtain information (ITO). Compare the viscosities of liquids.
Ionic compounds and polar molecular compounds tend to be soluble in polar solvents such as water and insoluble in non-polar solvents. Non-polar molecular substances tend to be soluble in non-polar solvents and insoluble in polar solvents.	Investigate the solubilities of substances in water and non-polar solvents.
The anomalous boiling points of ammonia, water and hydrogen fluoride are a result of hydrogen bonding. Boiling points, melting points, viscosity and miscibilty in water are properties of substances which are affected by hydrogen bonding. Hydrogen bonding between molecules in ice results in an expanded structure which causes the density of ice to be less than that of water at low temperatures.	Compare boiling points with other hydrides of elements in Group 5, Group 6 and Group 7. Carry out experiments to show the effects of hydrogen bonding.
The uses of diamond, graphite and silicon carbide are related to their structures and properties.	Examine a sample of graphite, carborundum and industrial diamond. Use a diamond coated abrasive to illustrate hardness. Use a piece of carborundum as an abrasive.
Fullerenes are the subject of current research and applications are being sought.	Refer to scientific magazines. Obtain information from the World Wide Web (ITO)

National Course Specification: course details (cont)

Unit 1: Energy Matters

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
e) The mole **The Avogadro Constant** One mole of any substance contains 6.02×10^{23} formula units. Equimolar amounts of substances contain equal numbers of formula units.	 Display one mole of different substances. View a videotape.
Molar volume The molar volume (in units of mol l^{-1}) is the same for all gases at the same temperature and pressure. The volume of a gas can be calculated from the number of moles and vice versa.	 Carry out experiments to calculate the molar volume for several gases.
Reacting volumes The volumes of reactant and product gases can be calculated from the number of moles of each reactant and product.	

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
a) Fuels **Petrol** Petrol can be produced by the reforming of naphtha. Reforming alters the arrangement of atoms in molecules without necessarily changing the number of carbon atoms per molecule. As a result of the reforming process, petrol contains branched-chain alkanes, cycloalkanes and aromatic hydrocarbons as well as straight-chain alkanes.	Compare the power output of petrol with other sources. Examine equations for typical reforming reactions. Use models. View a videotape.
Any petrol is a blend of hydrocarbons of different volatilities which takes account of prevailing temperatures.	Investigate the difference between winter and summer blends of petrol.
In a petrol engine, the petrol-air mixture is ignited by a spark.	Demonstrate the explosion of a petrol/oxygen mixture. Examine a diagram of a compression chamber in a petrol engine.
'Knocking' is caused by auto-ignition. The tendency of alkanes to auto-ignite is reduced by the addition of lead compounds. Unleaded petrol uses components which have a high degree of molecular branching and/or aromatics and/or cycloalkanes to improve the efficiency of burning.	Compare the tendency of different alkanes to auto-ignite. Find out about the use of leaded and unleaded petrol, the relationship between molecular structures of hydrocarbons and their octane numbers and the addition of 'oxygenates' to petrol.
Alternative fuels Sugar cane is a renewable source of ethanol for mixing with petrol.	Find out about the use of ethanol as a fuel. Demonstrate the explosive combustion of ethanol. View a videotape.
There are both advantages and disadvantages associated with the use of methanol as an alternative fuel to petrol.	Find out about the use of methanol as a fuel. Investigate the rusting of iron nails immersed in petrol alone and in a methanol/petrol mixture.
Some biological materials, under anaerobic conditions, ferment to produce methane.	Find out about the use of methane as a fuel. Demonstrate the explosive combustion of methane.

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
In the future a 'hydrogen economy' could see the use of hydrogen as a means of storing and distributing energy. Hydrogen could be produced by the electrolysis of water using solar energy, a renewable source of energy. The use of hydrogen in the internal combustion engine instead of petrol would reduce the build up of carbon dioxide in the atmosphere.	Evaluate the use of hydrogen as a fuel for the future and the solar-hydrogen energy economy. Electrolyse water to make a hydrogen/oxygen fuel cell. Carry out demonstrations using hydrogen.
b) Nomenclature and structural formulae **Hydrocarbons** Systematic names, full and shortened structural formulae can be used for straight and branched-chain alkanes, alkenes and alkynes (only to C_8). The functional group in an alkene is the carbon to carbon double bond. The functional group in an alkyne is the carbon to carbon triple bond.	Use models. View a videotape. Use a computer program.
Substituted alkanes An alcohol can be identified from the hydroxyl functional group and the '-ol' name ending. Alkanols are a homologous series of alcohols based on the corresponding parent alkanes. Systematic names, full and shortened structural formulae can be used for straight- and branched-chain alkanols (only C_1 to C_8).	Use models. View a videotape. Use a computer program. Use models. View a videotape. Use a computer program.
An aldehyde and ketone can be identified from the carbonyl functional group. Alkanals are a homologous series of aldehydes based on the corresponding parent alkanes. Alkanones are a homologous series of ketones based on the corresponding parent alkanes. Alkanals and alkanones can be identified from the '-al' and '-one' name endings. Systematic names, full and shortened structural formulae can be used for straight- and branched-chain alkanals and alkanones (only C_1 to C_8).	

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
A carboxylic acid can be identified from the carboxyl functional group and the '-oic' name ending. Alkanoic acids are a homologous series of carboxylic acids based on the corresponding parent alkanes. Systematic names, full and shortened structural formulae can be used for straight- and branched-chain alkanoic acids (only C_1 to C_8).	Use models. View a videotape. Use a computer program.
Esters An ester can be identified from the functional group and the '-oate' ending. An ester can be named given the names of the parent alkanol and alkanoic acid, or from shortened and full structural formulae. Shortened and full structural formulae for esters can be drawn given the names of the parent alkanol and alkanoic acid, or the names of esters. The products of the breakdown of an ester can be named or shortened, and full structural formulae can be drawn, given the name of the ester or the shortened or full structural formula of the ester.	 Use models. View a videotape. Use a computer program.
Aromatic hydrocarbons Benzene is the simplest member of the class of aromatic hydrocarbons. The benzene ring has a distinctive structural formula. The stability of the benzene ring is due to the delocalisation of electrons. A benzene ring in which one hydrogen atom has been substituted by another group is known as the phenyl group. The phenyl group has the formula $-C_6H_5$.	 Use models. View a videotape.

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
c) Reactions of carbon compounds **Addition** The characteristic reaction of an alkene is the addition reaction. Alkenes can undergo the addition of hydrogen, hydrogen halides, halogens and water to form saturated products. Ethyne can also undergo the addition of hydrogen, hydrogen halides and halogens to form saturated products in two stages. To meet market demand ethanol is made by means other than fermentation. Direct catalytic hydration of alkenes is another way of making alkanols. Alkanols can be converted to alkenes by dehydration. The benzene ring resists addition reactions. **Oxidation** Alcohols burn in oxygen and air to produce carbon dioxide and water. Alcohols can be classified as primary, secondary or tertiary. Primary and secondary alcohols can be oxidised by a number of oxidising agents, including copper (II) oxide and acidified potassium dichromate solution. Primary alcohols are oxidised, first to aldehydes and then to carboxylic acids. Secondary alcohols are oxidised to ketones. Aldehydes, but not ketones, can be oxidised by a number of oxidising agents, including Benedict's solution, to carboxylic acids. When applied to carbon compounds, oxidation results in an increase in the oxygen to hydrogen ratio. When applied to carbon compounds, reduction results in a decrease in the oxygen to hydrogen ratio.	 Test hydrocarbons for unsaturation. Test ethyne for unsaturation. View a videotape. Carry out the dehydration of ethanol. Investigate the stability of the benzene ring. Use suitable reagents to oxidise primary and secondary alcohols. *Use suitable reagents to distinguish between aldehydes and ketones.* Use models.

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
Making and breaking down esters Esters are formed by the condensation reaction between a carboxylic acid and an alcohol. The ester link is formed by the reaction of a hydroxyl group with a carboxyl group. The parent carboxylic acid and the parent alcohol can be obtained by hydrolysis of an ester. The formation and hydrolysis of an ester is a reversible reaction.	*Prepare a selection of esters.* Note the smell of some common esters. Carry out/demonstrate the hydrolysis of an ester. Use models.
Percentage yields Percentage yields can be calculated from mass of reactant(s) and product(s) using balanced equations.	
d) Uses of carbon compounds There are competing demands for the use of crude oil for fuels and the manufacture of petroleum-based consumer products. Many consumer products are compounds of carbon.	Examine a variety of consumer products, with the structural formulae shown, which are manufactured using carbon compounds as feedstocks. Use a database to obtain information (ITO). View a videotape.
Uses of esters include flavourings, perfumes and solvents.	Examine a variety of substances which contain esters.
Carboxylic acids are used in a variety of ways.	Find out about the uses of carboxylic acids.
Halogenoalkanes have properties which make them useful in a variety of consumer products. In the atmosphere, ozone, O_3, forms a protective layer which absorbs ultraviolet radiation from the sun. The depletion of the ozone layer is believed to have been caused by the extensive use of certain CFCs.	Find out about the properties and uses of halogenoalkanes. Find out about the effects of damage to the ozone layer and replacements for CFCs. Investigate the efficiency of sunscreens. View a videotape.
Benzene and its related compounds are important as feedstocks. One or more hydrogen atoms of a benzene molecule can be substituted to form a range of consumer products.	Examine a variety of consumer products, with the structural formulae shown, which are manufactured using benzene compounds as feedstocks.

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
e) Polymers **Early plastics and fibres** Ethene is a starting material of major importance in the petrochemical industry especially for the manufacture of plastics. Ethene can be formed by cracking the ethane from the gas fraction or the naphtha fraction from oil. Propene can be formed by cracking the propane from the gas fraction or the naphtha fraction from oil.	Find out about the history of the plastics and synthetic fibres industries and the importance of ethene. Find out about high density and low density poly(ethene). Find out about isotactic and atactic poly(propene). Carry out the depolymerisation of polythene. Demonstrate the polymerisation of poly(phenyl ethene). View a videotape.
Condensation polymers are made from monomers with two functional groups per molecule. The repeating unit or the structure of a condensation polymer can be drawn given the monomer structures and vice-versa.	Use models.
Polyesters are examples of condensation polymers. Polyesters are manufactured for use as textile fibres and resins. Polyesters used for textile fibres have a linear structure whereas cured polyester resins have a three-dimensional structure.	View a videotape. Find out the manufacture of Terylene. Find out about the uses of polyesters. Compare the physical properties of textile fibres with resins. Investigate the effect of temperature or amount of hardener on the setting time of a resin.
An amine can be identified from the functional group. Polyamides are examples of condensation polymers. The amide link is formed by the reaction of an amine group with a carboxyl group. An example of a polyamide is nylon which is a very important engineering plastic. The strength of nylon is related to the hydrogen bonding between polymer chains.	Use models. Find out about the uses of engineering plastic. Demonstrate the nylon rope-trick.

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
Methanal is an important feedstock in the manufacture of thermosetting plastics. Methanol, a feedstock for methanal, is made industrially from synthesis gas, a mixture of carbon monoxide and hydrogen. Synthesis gas can be obtained by steam reforming of methane from natural gas, or by steam reforming of coal. **Recent developments** Kevlar is an aromatic polyamide which is extremely strong because of the way in which the rigid, linear molecules are packed together. Kevlar has many important uses. Poly(ethenol) is a plastic which readily dissolves in water. Poly(ethenol) is made from another plastic by a process known as ester exchange. The percentage of acid groups which have been removed in the production process influences the strengths of the intermolecular forces upon which the solubility depends. Poly(ethenol) has many important uses. Poly(ethyne) can be treated to make a polymer which conducts electricity. The conductivity depends on delocalised electrons along the polymer chain. Poly(ethyne) is used to make the membrane for high-performance loudspeakers. Poly(vinyl carbazole) is a polymer which exhibits photoconductivity and is used in photocopiers. Biopol is an example of a biodegradable polymer. The structure of low density polythene can be modified during manufacture to produce a photodegradable polymer.	View a videotape. Demonstrate the urea-methanal polymerisation. Find out about the bonding, structure, properties and uses of Kevlar. Find out about the production process and the bonding, structure, properties and uses of poly(ethenol). Investigate the solubility of poly(ethenol) in water. Investigate the properties of 'slime'. Find out about the bonding, structure, properties and uses of poly(ethyne). Find out about the manufacture, uses and degradability of biopol. Find out about the manufacture, uses and degradability of photodegradable low density polythene.

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
f) Natural products	
Fats and oils	
Natural fats and oils can be classified according to their origin as animal, vegetable or marine.	Look at samples of fats and oils with source and formulae shown.
The lower melting points of oils compared to those of fats is related to the higher unsaturation of oil molecules.	View a videotape. Test fats and oils for unsaturation.
The low melting points of oils is a result of the effect that the shapes of the molecules have on close packing, hence on the strength of van der Waals' forces of attraction.	
The conversion of oils into hardened fats involves the partial removal of unsaturation by addition of hydrogen.	Demonstrate the hydrogenation of an oil.
Fats and oils in the diet supply the body with energy and are a more concentrated source of energy than carbohydrates.	Refer to medical information leaflets to find out about the importance of fats and oils in a balanced diet and a link between high intake of saturated fat in the diet and heart disease.
Fats and oils are esters.	
The hydrolysis of fats and oils produces fatty acids and glycerol in the ratio of three moles of fatty acid to one mole of glycerol.	Find out about the structures of fats and oils. Use models.
Glycerol (propane - 1, 2, 3 - triol) is a trihydric alcohol.	
Fatty acids are saturated or unsaturated straight-chain carboxylic acids containing even numbers of carbon atoms ranging from C_4 to C_{24}, primarily C_{16} and C_{18} .	
Fats and oils consist largely of mixtures of triglycerides in which the three fatty acid molecules which are combined with each molecule of glycerol may or may not be identical.	
Soaps are produced by the hydrolysis of fats and oils.	Demonstrate the making of soap. Observe the action of oven cleaner or dishwasher powder on oil or fat. Find out about how soaps and detergents work.

National Course Specification: course details (cont)

Unit 2: The World of Carbon

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
Proteins Nitrogen is essential for protein formation by plants and animals. Proteins are condensation polymers made up of many amino acid molecules linked together. The structure of a section of protein is based on the constituent amino acids. Condensation of amino acids produces the peptide (amide) link. The peptide link is formed by the reaction of an amine group with a carboxyl group. Proteins specific to the body's needs are built up within the body. The body cannot make all the amino acids required for body proteins and is dependent on dietary protein for supply of certain amino acids known as essential amino acids. During digestion, the hydrolysis of proteins produces amino acids. The structural formulae of amino acids obtained from the hydrolysis of proteins can be identified from the structure of a section of the protein. Proteins can be classified as fibrous or globular. Fibrous proteins are long and thin and are the major structural materials of animal tissue. Globular proteins have the spiral chains folded into compact units. Globular proteins are involved in the maintenance and regulation of life processes and include enzymes and many hormones, eg insulin and haemoglobin. Enzyme function is related to the molecular shapes of proteins. Denaturing of a protein involves physical alteration of the molecules as a result of temperature change or pH change. The ease with which a protein is denatured is related to the susceptibility of enzymes to changes in temperature and pH. Enzymes are most efficient within a narrow range of temperature and pH.	 Find out about the importance of proteins. Use models. View a videotape. Make a table to give the names of some amino acids and their structures. Carry out the hydrolysis of a protein. Separate amino acids using chromatography. Use models. Draw diagrams to illustrate the difference in structures. Make a list of fibrous proteins. Find out about the forces of attraction which lead to secondary and tertiary structures. Use 'lock and key' models. Investigate the effect of pH and temperature on a selection of proteins. *Investigate the effect of pH and/or temperature change on enzyme activity (ITO).*

National Course Specification: course details (cont)

Unit 3: Chemical Reactions

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
a) The chemical industry The UK chemical industry is a major contributor to both the quality of our life and our national economy.	Find out about the importance and historical development of the chemical industry. Find out about the uses of some of the major products.
Stages in the manufacture of a new product can include research, pilot study, scaling-up, production and review.	
A chemical manufacturing process usually involves a sequence of steps.	Find out about the steps in different processes.
A feedstock is a reactant from which other chemicals can be extracted or synthesised. The major raw materials in the chemical industry are fossil fuels, metallic ores and minerals, air and water.	Find out about the feedstocks/raw materials used in different processes. Use audio-visual material.
Chemical manufacturing may be organised as a batch or as a continuous process.	Make a table to compare the advantages and disadvantages of the two kinds of process.
Process conditions are chosen to maximise economic efficiency.	Find out about the conditions for different processes. Use audio-visual material.
Manufacturing costs include capital costs, fixed costs and variable costs. The UK chemical industry is, by and large, capital rather than labour intensive.	Find out about capital, fixed and variable costs.
Safety and environmental issues are of major importance to the chemical industry. Both historical and practical factors affect the location of chemical industries.	
The efficient use of energy is significant in most chemical processes.	Find out about the ways by which chemical industries have increased energy efficiency.
Factors influencing the choice of a particular route include cost, availability and suitability of feedstock(s), yield of product(s), opportunities for the recycling of reactants and marketability of by-products.	Find out about the factors influencing different processes (ITO).

National Course Specification: course details (cont)

Unit 3: Chemical Reactions

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
b) Hess's law Hess's law states that the enthalpy change for a chemical reaction is independent of the route taken. Enthalpy changes can be calculated by application of Hess's law.	*Carry out an experiment to confirm Hess's law.*
c) Equilibrium **The concept of dynamic equilibrium** Reversible reactions attain a state of dynamic equilibrium when the rates of forward and reverse reactions are equal. At equilibrium, the concentrations of reactants and products remain constant, although not necessarily equal.	Demonstrate a simulation of equilibrium. Use a computer program.
Shifting the equilibrium position Changes in concentration, pressure and temperature can alter the position of equilibrium. A catalyst speeds up the rate of attainment of equilibrium but does not affect the position of equilibrium.	Carry out a selection of experiments. Use a computer program.
The effects of pressure, temperature, the use of a catalyst, recycling of unreacted gases and the removal of product can be considered in relation to the Haber Process.	Use audio-visual material.

National Course Specification: course details (cont)

Unit 3: Chemical Reactions

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
d) Acids and bases **The pH scale** The pH scale is a continuous range from below 0 to above 14. Integral values of pH from 0 to 14 can be related to concentrations of $H^+(aq)$ in mol l^{-1}. In water and aqueous solutions with a pH value of 7 the concentrations of $H^+(aq)$ and $OH^-(aq)$ are both 10^{-7} mol l^{-1} at 25 °C. The concentration of $H^+(aq)$ or $OH^-(aq)$ in a solution can be calculated from the concentration of the other by using $[H^+(aq)]\,[OH^-(aq)]=10^{-14}$ mol^2 l^{-2}. In water and aqueous solutions there is an equilibrium between $H^+(aq)$ and $OH^-(aq)$ ions and water molecules.	 Use a pH meter or narrow range pH paper to measure the pH of a range of solutions of known $H^+(aq)$. Use a pulley model to show the reciprocal relationship between $H^+(aq)$ and $OH^-(aq)$. Investigate the effect of dilution on the pH of an acid and an alkali.
The concept of strong and weak In aqueous solution, strong acids are completely dissociated but weak acids are only partially dissociated. Equimolar solutions of weak and strong acids differ in pH, conductivity, and reaction rates, but not in stoichiomery of reactions. The weakly acidic nature of solutions of ethanoic acid, sulphur dioxide and carbon dioxide can be explained by reference to equations showing the equilibrium. In aqueous solution, strong bases are completely ionised but weak bases are only partially ionised. Equimolar solutions of weak and strong bases differ in pH and conductivity, but not in stoichiometry of reactions. The weakly alkaline nature of a solution of ammonia can be explained by reference to an equation showing the equilibrium.	 Compare the properties of substances dissolved in water and other solvents. Compare the properties of equimolar solutions of ethanoic acid and hydrochloric acid. Investigate the relative strengths of weak acids. Find the pH values of soft drinks. Compare the properties of equimolar solutions of ammonia and sodium hydroxide solution.

National Course Specification: course details (cont)

Unit 3: Chemical Reactions

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
The pH of salt solutions A soluble salt of a strong acid and a strong base dissolves in water to produce a neutral solution. A soluble salt of a weak acid and a strong base dissolves in water to produce an alkaline solution. A soluble salt of a strong acid and a weak base dissolves in water to produce an acidic solution.	Investigate the pH of salt solutions.
Soaps are salts of weak acids and strong bases.	Test the pH of soap solutions. Find out about the structure and properties of soaps and detergents.
The acidity, alkalinity or neutrality of the above kinds of salt solution can be explained by reference to the appropriate equilibria.	
e) Redox reactions **Oxidising and reducing agents** An oxidising agent is a substance which accepts electrons; a reducing agent is a substance which donates electrons. Oxidising and reducing agents can be identified in redox reactions.	
Ion-electron equations can be written for oxidation and reduction reactions. Ion-electron equations can be combined to produce redox equations.	Demonstrate/carry out a range of test-tube experiments. Use a database to find out about redox reactions (ITO).
Given reactant and product species, ion-electron equations which include $H^+(aq)$ and $H_2O(l)$ can be written.	
Redox titrations The concentration of a reactant can be calculated from the results of redox titrations.	*Carry out a redox titration.*

National Course Specification: course details (cont)

Unit 3: Chemical Reactions

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
Electrolysis The production of one mole of an element from its ion, by electrolysis, always requires n times 96,500 C where n is the number of electrons in the relevant ion-electron equation. 96,500 C is the charge associated with one mole of electrons. The mass or volume of an element discharged can be calculated from the quantity of electricity passed and vice-versa.	*Carry out an experiment to find out the quantity of electricity required to produce one mole of an element by electrolysis*
f) Nuclear chemistry **Types of radiation** Radioactive decay involves changes in the nuclei of atoms. Unstable nuclei (radioisotopes) are transformed into more stable nuclei by releasing energy. The stability of nuclei depends on the proton/neutron ratio. The natures and properties of alpha, beta and gamma radiation can be described. Balanced nuclear equations, involving neutrons, protons, alpha particles and beta particles, can be written.	Demonstrate the absorption of radiation (ITO). Detect background radiation. View a videotape. Draw a graph to show the band of stability.
Half-lives The half-life is the time taken for the activity or mass of a radioisotope to halve. The decay of individual nuclei within a sample is random and is independent of chemical or physical state. The quantity of radioisotope, half-life or time elapsed can be calculated given the value of the other two variables.	Simulate the decay of a radioisotope. Use a computer program. Draw a typical decay curve (ITO). Use a database to obtain information about radioactive decay (ITO).

National Course Specification: course details (cont)

Unit 3: Chemical Reactions

CONTENT STATEMENTS	SUGGESTED ACTIVITIES
Radioisotopes Radioisotopes are used in medicine, in industry, for scientific research including carbon dating, and to produce energy by uranium fission and nuclear fusion. Nuclear fuels and fossil fuels can be compared in terms of safety, pollution and the use of finite resources.	Find out about the uses of radioisotopes. Find out about the benefits and problems associated with radioisotopes. Analyse such information in terms of the nature of the radiation emitted and its consequent properties, the intensity of the radiation emitted and the half-life of the radioisotope(s) present. Refer to newspaper articles. View a videotape.
Elements are created in the stars from simple elements by nuclear fusion. All naturally occurring elements, including those found in our bodies, originated in stars.	Find out about the formation of elements. View a videotape.

ASSESSMENT

To gain the award of the course, the candidate must achieve all the component units of the course as well as the external assessment. External assessment will provide the basis for grading attainment in the course award.

When units are taken as component parts of a course, candidates will have the opportunity to demonstrate achievement beyond that required to attain each of the unit outcomes. This attainment may, where appropriate, be recorded and used to contribute towards course estimates, and to provide evidence for appeals. Additional details are provided, where appropriate, with the exemplar assessment materials. Further information on the key principles of assessment are provided in the paper *Assessment* (HSDU, 1996) and in *Managing Assessment* (HSDU, 1998).

DETAILS OF THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

External assessment will be through an examination which will sample across the performance criteria associated with the three outcomes in each of the three units which comprise the course. The detailed knowledge and understanding required for each unit is listed in the course content.

The examination will consist of one paper of 2 hours 30 minutes with a total allocation of 100 marks.

The paper will consist of two sections

Section A	Fixed-response questions	40 marks
Section B	Extended-answer questions	60 marks

Section A will be in two parts. The first part will be made up of 30 multiple choice questions; the second part will be made up of grid questions which will account for the remaining 10 marks.

In section B approximately 6 marks will be allocated to questions that draw on the candidates' experience of the prescribed practical activities.

Of the remaining marks in the examination approximately 60% will be for the assessment of knowledge and understanding and approximately 40% will be allocated to the assessment of problem solving.

Up to 10 marks over the paper can be allocated to questions based on content which is common to Standard Grade and Intermediate 2, with assessment at a level appropriate to Higher.

Candidates will be expected to answer all questions.

National Course Specification: course details (cont)

COURSE Chemistry (Higher)

GRADE DESCRIPTIONS

Grade C

As well as meeting the performance criteria for the three outcomes in each of three course units, candidates achieving a course award at C will have, in addition, demonstrated an overall satisfactory level of performance by:

- retaining knowledge and understanding over a longer period of time
- integrating knowledge and understanding across the three component units of the course
- displaying problem solving skills in less familiar contexts

Grade A

As well as meeting the performance criteria for the three outcomes in each of three course units, candidates achieving a course award at A will have, in addition, demonstrated a high overall level of performance by:

- retaining knowledge and understanding over a longer period of time
- showing a deeper level of knowledge and understanding
- integrating knowledge and understanding across the three component units of the course
- displaying problem solving skills in less familiar and more complex contexts

APPROACHES TO LEARNING AND TEACHING

Appropriate selection from a variety of learning and teaching approaches is required to deliver both knowledge-based and skill-based objectives to candidates with different needs and abilities. In doing so, opportunities should be provided for candidates to work independently, sometimes in small groups and on other occasions as a whole class. Exposition, used in conjunction with questioning and discussion, is a very effective way of developing candidates' knowledge and understanding of the more theoretical chemical concepts as well as a good means of introducing new topics and consolidating completed topics. Resource-based learning can help candidates to acquire knowledge and understanding through the practice of the problem solving and practical skills associated with scientific enquiry. Where resource-based approaches are used, careful thought should be given to the selection of resources, including worksheets, and to the provision of opportunities for blending in whole-class presentations. Both teachers and candidates should make full use of opportunities to use models to help the understanding of concepts in chemistry and to use information technology to support learning and to process data.

Practical work should include a balance of illustrative teacher-demonstrated experiments, which can help to make knowledge more memorable and facilitate learning, and techniques which will develop the skills associated with the types of practical activity which have a clear and important place within the normal study of chemistry. Candidates should also have the opportunity to carry out investigations to enable problem solving skills to be developed within a practical context.

COURSE Chemistry (Higher)

The chemistry courses have been designed to give emphasis to applications and issues and should be presented in a manner which allows candidates to recognise the relevance of the theoretical knowledge to their lives and everyday experiences. In addition, the learning and teaching approaches which are employed should provide opportunities for the development of core skills.

Effective learning and teaching in chemistry cannot take place without effective communication, from the candidates as well as the teacher, and at all times the safety of the candidates should be a matter of priority.

Use of the additional 40 hours

This time may be used:

- to provide an introduction to the course and assessment methods
- to allow candidates to develop their ability to integrate knowledge, understanding and skills acquired through the study of the different component units
- to allow some more practical work, on an individual basis if appropriate, within the units to enhance skills and understanding
- for consolidation and integration of learning
- for remediation
- for practice in examination techniques and preparation for the external examination

SPECIAL NEEDS

This course specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

SUBJECT GUIDES

A Subject Guide to accompany the Arrangements document has been produced by the Higher Still Development Unit (HSDU) in partnership with the Scottish Consultative Council on the Curriculum (SCCC) and Scottish Further Education Unit (SFEU). The Guide provides further advice and information about:

- support materials for each course
- learning and teaching approaches in addition to the information provided in the Arrangements document
- assessment
- ensuring appropriate access for candidates with special educational needs

The Subject Guide is intended to support the information contained in the Arrangements document. The SQA Arrangements documents contain the standards against which candidates are assessed.

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Energy Matters (Higher)

NUMBER D069 12

COURSE Chemistry (Higher)

SUMMARY

The unit seeks to develop knowledge and understanding, problem solving and practical abilities in the context of reaction rates; enthalpy; patterns in the Periodic Table; bonding, structure and properties; and the mole.

OUTCOMES

1 Demonstrate knowledge and understanding related to *Energy Matters*.
2 Solve problems related to *Energy Matters*.
3 Collect and analyse information related to *Energy Matters* obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained one of the following awards:

- Standard Grade Chemistry at Grades 1 and 2
- the Intermediate 2 Chemistry course or its component units

together with

- Standard Grade Mathematics at Grades 1 and 2 or Intermediate 2 Mathematics.

(The preferred entry level from Standard Grade is based on achievement in the Knowledge and Understanding and Problem Solving elements.)

Administrative Information

Superclass: RD

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 04

National Unit Specification: general information (cont)

UNIT Energy Matters (Higher)

CREDIT VALUE

1 credit at Higher.

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit	Problem Solving	H
Additional core skills for the unit	Using Graphical Information	H

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Energy Matters (Higher)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Demonstrate knowledge and understanding related to *Energy Matters*.

Performance criteria

(a) Knowledge and understanding of reaction rates is clearly shown in appropriate ways.
(b) Knowledge and understanding of enthalpy is clearly shown in appropriate ways.
(c) Knowledge and understanding of patterns in the Periodic Table is clearly shown in appropriate ways.
(d) Knowledge and understanding of bonding, structure and properties is clearly shown in appropriate ways.
(e) Knowledge and understanding of the mole is clearly shown in appropriate ways.

Evidence requirements

Evidence of an appropriate level of achievement from a closed-book test with items covering all of the following aspects of the above performance criteria.

Knowledge and understanding of reaction rates

- Following the course of a reaction
- Factors affecting rate
- The idea of excess
- Catalysts

Knowledge and understanding of enthalpy

- Potential energy diagrams
- Enthalpy changes

Knowledge and understanding of patterns in the Periodic Table

- Further detail not needed

Knowledge and understanding of bonding, structure and properties

- Types of bonding
- Intermolecular forces of attraction
- Structure
- Properties

Knowledge and understanding of the mole

- The Avogadro Constant
- Molar volume
- Reacting volumes

National Unit Specification: statement of standards (cont)

UNIT Energy Matters (Higher)

OUTCOME 2

Solve problems related to *Energy Matters*.

Performance criteria

(b) Information is accurately processed using calculations where appropriate.
(c) Conclusions drawn are valid and explanations given are supported by evidence.
(d) Experimental procedures are planned, designed and evaluated in an appropriate way.
(e) Predictions and generalisations made are based on available evidence.

Note: The lettering system for PCs is common to all units in the Higher Chemistry course. Not all of the PCs feature in all of the units. For example, PC (a) does NOT feature in this unit, although it does feature in other units in the course.

Evidence requirements

Evidence of an appropriate level of achievement from a closed-book test with items covering all of the above performance criteria.

OUTCOME 3

Collect and analyse information related to *Energy Matters* obtained by experiment.

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) The experimental procedures are described accurately.
(c) Relevant measurements and observations are recorded in an appropriate format.
(d) Recorded experimental information is analysed and presented in an appropriate format.
(e) Conclusions drawn are valid.

Evidence requirements

A report of one experimental activity covering the performance criteria and related to one of the following experiments:

- the effect of concentration changes on reaction rate
- the effect of temperature changes on reaction rate
- enthalpy of combustion

The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment involving the candidate planning the experiment; deciding how it is managed; identifying and obtaining the necessary resources, some of which must be unfamiliar; carrying out the experiment. Depending on the activity, the collection of the information may be group work.

Evidence submitted in support of attainment of PC (d) must be in the format of a table or graph(s) as appropriate. Conclusions drawn should be justified by reference to supporting evidence. Evaluation should cover all stages of the experiment, including the initial analysis of the situation, and planning and organising the experimental procedures.

National Unit Specification: statement of standards (cont)

UNIT Energy Matters (Higher)

The report should include an evaluation of all stages of the experiment, including the initial analysis of the situation, and planning and organising the experimental procedures. Conclusions drawn should be justified by reference to supporting evidence.

National Unit Specification: support notes

UNIT Energy Matters (Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

The recommended content together with suggested activities for this unit are detailed in the course specification. The subheadings in these tables correspond to the aspects mentioned in the evidence requirements for Outcome 1. The prescribed practical activities for the unit are listed in the *Course Contents*.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

General advice is contained in the course specification and more detailed advice will be contained in the Subject Guide for chemistry.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcomes 1 and 2

It is recommended that a holistic approach is taken for assessment of these outcomes. Outcomes 1 and 2 can be assessed by an integrated end of unit test with questions covering all the performance criteria. Within one question, assessment of knowledge and understanding and problem solving can occur. Each question can address a number of performance criteria from either Outcome 1 or 2. Appropriate assessment items will be available from the National Assessment Bank.

Outcome 3

Opportunities to generate evidence for attainment at Outcome 3 will arise during the practical work related to the prescribed practical activities.

Related to PC (a), the teacher/lecturer checks by observation that the candidate has taken an active part in the collection of information by experiment.

Candidates should provide a structured report with an appropriate title. The report should relate to the performance criteria as follows:

b) As experiments will follow a given procedure or method there is no need for a detailed description. The procedure, or the steps in the procedure, should be described briefly in outline. The impersonal passive voice should be used. The following should be used as appropriate:
   - aim of the experiment
   - a labelled diagram, description of apparatus, instruments used
   - how the independent variable was altered
   - how measurements were taken or observations made
   - comments on safety

c) Readings or observations should be recorded using the following, as appropriate:
- a table with correct headings and appropriate units
- a table with readings/observations entered correctly
- a statement of results

d) Readings or observations should be analysed/presented using the following, as appropriate:
- a table with suitable headings and units
- a table with ascending or descending independent variable
- a table showing appropriate computations
- a correct calculation
- a graph with independent and dependent variables plotted on horizontal and vertical axes respectively
- a graph with suitable scales and axes labelled with quantities and units
- a graph with data correctly plotted with a line or curve of best fit

e) Conclusions should contain, as appropriate:
- the overall pattern to readings
- the trends in analysed information or results
- the connection between variables
- an analysis of the observations
- the findings from completed calculations

Conclusions should also include evaluation of the experimental procedures and could make reference to one of the following:

- effectiveness of procedures
- control of variables
- limitations of equipment
- possible improvements
- possible source of error

The bullet points under each performance criterion give an indication of what should be addressed to achieve a pass. The relevance of the bullet points will vary according to the experiment. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to moderation) against the performance criteria. It is appropriate to support candidates in producing a report to meet the performance criteria. Re-drafting of reports after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT The World of Carbon (Higher)

NUMBER D070 12

COURSE Chemistry (Higher)

SUMMARY

The unit seeks to develop knowledge and understanding, problem solving and practical abilities in the context of fuels; nomenclature, structural formulae, reactions and uses of carbon compounds; polymers; and natural products.

OUTCOMES

1 Demonstrate knowledge and understanding related to *The World of Carbon*.
2 Solve problems related to *The World of Carbon*.
3 Collect and analyse information related to *The World of Carbon* obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following awards or its equivalent:

- Standard Grade Chemistry at Grades 1 and 2
- the Intermediate 2 Chemistry course or its component units

together with

- Standard Grade Mathematics at Grades 1 and 2 or Intermediate 2 Mathematics.

(The preferred entry level from Standard Grade is based on achievement in the Knowledge and Understanding and Problem Solving elements.)

Administrative Information

Superclass: RD

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 04

National Unit Specification: general information (cont)

UNIT The World of Carbon (Higher)

CREDIT VALUE

1 credit at higher.

CORE SKILLS

There is no automatic certification of core skills or core skills components in this unit.

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT The World of Carbon (Higher)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Demonstrate knowledge and understanding related to *The World of Carbon*.

Performance criteria

(a) Knowledge and understanding of fuels is clearly shown in appropriate ways.
(b) Knowledge and understanding of nomenclature and structural formulae is clearly shown in appropriate ways.
(c) Knowledge and understanding of reactions of carbon compounds is clearly shown in appropriate ways.
(d) Knowledge and understanding of uses of carbon compounds is clearly shown in appropriate ways.
(e) Knowledge and understanding of polymers is clearly shown in appropriate ways.
(f) Knowledge and understanding of natural products is clearly shown in appropriate ways.

Evidence requirements

Evidence of an appropriate achievement from a closed-book test with items covering all of the following aspects of the above performance criteria.

Knowledge and understanding of fuels

- Petrol
- Alternative fuels

Knowledge and understanding of nomenclature and structural formulae

- Hydrocarbons
- Substituted alkanes
- Esters
- Aromatic hydrocarbons

Knowledge and understanding of reactions of carbon compounds

- Addition
- Oxidation
- Making and breaking down esters
- Percentage yields

Knowledge and understanding of uses of carbon compounds

- Further detail not needed

Knowledge and understanding of polymers

- Early plastics and fibres
- Recent developments

National Unit Specification: statement of standards (cont)

UNIT The World of Carbon (Higher)

Knowledge and understanding of natural products

- Fats and oils
- Proteins

OUTCOME 2

Solve problems related to *The World of Carbon*.

Performance criteria

(a) Relevant information is selected and presented in an appropriate way.
(c) Conclusions drawn are valid and explanations given are supported by evidence.
(e) Predictions and generalisations made are based on available evidence.

Note: The lettering system for PCs is common to all units in the Higher Chemistry course. Not all of the PCs feature in all of the units. For example, PCs (b) and (d) do NOT feature in this unit, although they do feature in other units in the course.

Evidence requirements

Evidence of an appropriate level of achievement from a closed-book test with items covering all of the above performance criteria.

OUTCOME 3

Collect and analyse information related to *The World of Carbon* obtained by experiment.

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) The experimental procedures are described accurately.
(c) Relevant measurements and observations are recorded in an appropriate format.
(e) Conclusions are valid.

Note: The lettering system for PCs is common to all units in the Higher Chemistry course. Not all of the PCs feature in all of the units. For example, PC (d) does NOT feature in this unit, although it does feature in other units in the course.

Evidence requirements

A report of one experimental activity. The report must be the individual work of the candidate and based on an experiment in which the candidate has been involved. Depending on the activity, the collection of the information may be group work.

National Unit Specification: support notes

UNIT The World of Carbon (Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

The recommended content together with suggested activities for this unit are detailed in the course specification. The subheadings in these tables correspond to the aspects mentioned in the evidence requirements for Outcome 1. The Prescribed Practical Activities for the unit are listed in the *Course Contents*.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

General advice is contained in the course specification and more detailed advice will be contained in the Subject Guide for chemistry.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcomes 1 and 2

It is recommended that a holistic approach is taken for assessment of these outcomes. Outcomes 1 and 2 can be assessed by an integrated end of unit test with questions covering all the performance criteria. Within one question, assessment of knowledge and understanding and problem solving can occur. Each question can address a number of performance criteria from either Outcome 1 or 2. Appropriate assessment items will be available from the National Assessment Bank.

Outcome 3

Opportunities to generate evidence for attainment at Outcome 3 will arise during the practical work related to the Prescribed Practical Activities.

Related to PC (a), the teacher/lecturer checks by observation that the candidate has taken part in the collection of information by experiment.

Candidates should provide a structured report with an appropriate title. The report should relate to the performance criteria as follows:

b) As experiments will follow a given procedure or method there is no need for a detailed description. The procedure, or the steps in the procedure, should be described briefly in outline. The impersonal passive voice should be used. The following should be used as appropriate:
   - aim of the experiment
   - a labelled diagram, description of apparatus, instruments used
   - how the independent variable was altered
   - how measurements were taken or observations made
   - comments on safety

c) Readings or observations should be recorded using the following, as appropriate:
- a table with correct headings and appropriate units
- a table with readings/observations entered correctly
- a statement of results

e) Conclusions should contain, as appropriate:
- the overall pattern to readings
- the trends in analysed information or results.
- the connection between variables
- an analysis of the observations
- the findings from completed calculations

The bullet points under each performance criterion give an indication of what should be addressed to achieve a pass. The relevance of the bullet points will vary according to the experiment. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to moderation) against the performance criteria. It is appropriate to support candidates in producing a report to meet the performance criteria. Re-drafting of reports after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Chemical Reactions (Higher)

NUMBER D071 12

COURSE Chemistry (Higher)

SUMMARY

The unit seeks to develop knowledge and understanding, problem solving and practical abilities in the context of the chemical industry; Hess's law; equilibrium; acids and bases; redox reactions; and nuclear chemistry.

OUTCOMES

1 Demonstrate knowledge and understanding related to *Chemical Reactions*.
2 Solve problems related to *Chemical Reactions*.
3 Collect and analyse information related to *Chemical Reactions* obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained one of the following:

- Standard Grade Chemistry at Grades 1 and 2
- the Intermediate 2 Chemistry course or its component units

together with

- Standard Grade Mathematics at Grades 1 and 2 or Intermediate 2 Mathematics.

(The preferred entry level from Standard Grade is based on achievement in the Knowledge and Understanding and Problem Solving elements.)

Administrative Information

Superclass: RD

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 04

National Unit Specification: general information (cont)

UNIT Chemical Reactions (Higher)

CREDIT VALUE

1 credit at Higher.

CORE SKILLS

There is no automatic certification of core skills or core skills components in this unit.

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Chemical Reactions (Higher)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Demonstrate knowledge and understanding related to *Chemical Reactions*.

Performance criteria

(a) Knowledge and understanding of the chemical industry is clearly shown in appropriate ways.
(b) Knowledge and understanding of Hess's Law is clearly shown in appropriate ways.
(c) Knowledge and understanding of equilibrium is clearly shown in appropriate ways.
(d) Knowledge and understanding of acids and bases is clearly shown in appropriate ways.
(e) Knowledge and understanding of redox reactions is clearly shown in appropriate ways.
(f) Knowledge and understanding of nuclear chemistry is clearly shown in appropriate ways.

Evidence requirements

Evidence of an appropriate achievement from a closed-book test with items covering all of the following aspects of the above performance criteria.

Knowledge and understanding of the chemical industry

- Further detail not needed

Knowledge and understanding of Hess's Law

- Further detail not needed

Knowledge and understanding of equilibrium

- The concept of dynamic equilibrium
- Shifting the equilibrium position

Knowledge and understanding of acids and bases

- The pH scale
- The concept of strong and weak
- The pH of salt solutions

Knowledge and understanding of redox reactions

- Oxidising and reducing agents
- Redox titrations
- Electrolysis

Knowledge and understanding of nuclear chemistry

- Types of radiation
- Half-lives
- Radioisotopes

National Unit Specification: statement of standards (cont)

## UNIT		Chemical Reactions (Higher)

OUTCOME 2

Solve problems related to *Chemical Reactions*.

Performance criteria

(a) Relevant information is selected and presented in an appropriate way.
(c) Conclusions drawn are valid and explanations given are supported by evidence.
(d) Experimental procedures are planned, designed and evaluated in an appropriate way.

Note: The lettering system for PCs is common to all units in the Higher Chemistry course. Not all of the PCs feature in all of the units. For example, PCs (b) and (e) do NOT feature in this unit, although they do feature in other units in the course.

Evidence requirements

Evidence of an appropriate level of achievement from a closed-book test with items covering all of the above performance criteria.

OUTCOME 3

Collect and analyse information related to *Chemical Reactions* obtained by experiment.

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) The experimental procedures are described accurately.
(c) Relevant measurements and observations are recorded in an appropriate format.
(d) Recorded experimental information is analysed and presented in an appropriate format.
(e) Conclusions drawn are valid.

Evidence requirements

A report of one experimental activity. The report must be the individual work of the candidate and based on an experiment in which the candidate has been involved. Depending on the activity, the collection of the information may be group work.

National Unit Specification: support notes

UNIT Chemical Reactions (Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

The recommended content together with suggested activities for this unit are detailed in the course specification. The subheadings in these tables correspond to the aspects mentioned in the evidence requirements for Outcome 1. The prescribed practical activities for the unit are listed in the *Course Contents*.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

General advice is contained in the course specification and more detailed advice will be contained in the Subject Guide for chemistry.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcomes 1 and 2

It is recommended that a holistic approach is taken for assessment of these outcomes. Outcomes 1 and 2 can be assessed by an integrated end of unit test with questions covering all the performance criteria. Within one question, assessment of knowledge and understanding and problem solving can occur. Each question can address a number of performance criteria from either Outcome 1 or 2. Appropriate assessment items are available from the National Assessment Bank.

Outcome 3

Opportunities to generate evidence for attainment at Outcome 3 will arise during the practical work related to the prescribed practical activities.

Related to PC (a), the teacher/lecturer checks by observation that the candidate has taken part in the collection of information by experiment.

Candidates should provide a structured report with an appropriate title. The report should relate to the performance criteria as follows:

b) As experiments will follow a given procedure or method there is no need for a detailed description. The procedure, or the steps in the procedure, should be described briefly in outline. The impersonal passive voice should be used. The following should be used as appropriate:
   - aim of the experiment
   - a labelled diagram, description of apparatus, instruments used
   - how the independent variable was altered
   - how measurements were taken or observations made
   - comments on safety

c) Readings or observations should be recorded using the following, as appropriate:
- a table with correct headings and appropriate units
- a table with headings/observations entered correctly
- a statement of results

d) Readings or observations should be analysed/presented using the following, as appropriate:
- a table with suitable headings and units
- a table with ascending or descending independent variable
- a table showing appropriate computations
- a graph with independent and dependent variables plotted on horizontal and vertical axes respectively
- a graph with suitable scales and axes labelled with quantities and units
- a graph with data correctly plotted with a line or curve of best fit

e) Conclusions should contain, as appropriate:
- the overall pattern to readings
- the trends in analysed information or results
- the connection between variables
- an analysis of the observations
- the findings from completed calculations

The bullet points under each performance criterion give an indication of what should be addressed to achieve a pass. The relevance of the bullet points will vary according to the experiment. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to moderation) against the performance criteria. It is appropriate to support candidates in producing a report to meet the performance criteria. Re-drafting of reports after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).