GCE AS

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Part of WJEC

WJEC Eduqas GCE AS in

CHEMISTRY

ACCREDITED BY OFQUAL

SPECIFICATION

Teaching from 2015
For award from 2016

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This Ofqual regulated qualification is not available for candidates in maintained schools and colleges in Wales.

WJEC Eduqas GCE AS in CHEMISTRY

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AS CHEMISTRY

SUMMARY OF ASSESSMENT

Component 1: The Language of Chemistry, Structure of Matter and Simple Reactions
Written examination: **1 hour 30 minutes (80 marks)**
50% of qualification

Section A: short answer questions – 10 marks
Section B: structured and extended answer questions set in a range of contexts – 70 marks

Component 2: Energy, Rate and Chemistry of Carbon Compounds
Written examination: **1 hour 30 minutes (80 marks)**
50% of qualification

Section A: short answer questions – 10 marks
Section B: structured and extended answer questions set in a range of contexts – 70 marks

This linear qualification will be available in the months of May and June of each year. It will be awarded for the first time in summer 2016.

Qualification Accreditation Number: 601/5501/2

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AS CHEMISTRY

1 INTRODUCTION

1.1 Aims and objectives

The WJEC Eduqas AS in Chemistry provides a broad, coherent, satisfying and worthwhile course of study. It encourages learners to develop confidence in, and a positive attitude towards, chemistry and to recognise its importance in their own lives and to society.

Studying this AS in Chemistry encourages learners to:

- develop essential knowledge and understanding of different areas of the subject and how they relate to each other
- develop and demonstrate a deep appreciation of the skills, knowledge and understanding of scientific methods
- develop competence and confidence in a variety of practical, mathematical and problem solving skills
- develop their interest in and enthusiasm for the subject, including developing an interest in further study and careers associated with the subject
- understand how society makes decisions about scientific issues and how the sciences contribute to the success of the economy and society.

The specification lends itself to a variety of teaching and learning styles and offers learners of all abilities an enjoyable and positive learning experience.

Practical work is an intrinsic part of chemistry, and is greatly valued by higher education. It is imperative that practical skills are developed throughout the course and that an investigative approach is promoted wherever possible.

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1.2 Prior learning and progression

Any requirements set for entry to a course following this specification are at the discretion of centres. It is reasonable to assume that many learners will have achieved qualifications equivalent to Level 2 at KS4. Skills in Numeracy/Mathematics, Literacy/English and Information Communication Technology will provide a good basis for progression to this Level 3 qualification.

This specification builds on the skills, knowledge and understanding set out in the GCSE criteria/content for science. Most learners will have followed chemistry at GCSE and all are expected to demonstrate knowledge and understanding of standard content covered at that level.

Mathematical requirements are specified in Appendix B of this specification.

This specification provides a suitable foundation for the study of chemistry at A level. In addition, the specification provides a coherent, satisfying and worthwhile course of study for learners who do not progress to further study in this subject.

This specification is not age specific and, as such, provides opportunities for candidates to extend their life-long learning.

1.3 Equality and fair assessment

This specification may be followed by any learner, irrespective of gender, ethnic, religious or cultural background. It has been designed to avoid, where possible, features that could, without justification, make it more difficult for a learner to achieve because they have a particular protected characteristic.

The protected characteristics under the Equality Act 2010 are age, disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation.

The specification has been discussed with groups who represent the interests of a diverse range of learners, and the specification will be kept under review.

Reasonable adjustments are made for certain learners in order to enable them to access the assessments (e.g. candidates are allowed access to a Sign Language Interpreter, using British Sign Language). Information on reasonable adjustments is found in the following document from the Joint Council for Qualifications (JCQ): *Access Arrangements and Reasonable Adjustments: General and Vocational Qualifications.*

This document is available on the JCQ website (www.jcq.org.uk). As a consequence of provision for reasonable adjustments, very few learners will have a complete barrier to any part of the assessment.

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2 SUBJECT CONTENT

This section outlines the knowledge, understanding and skills to be developed by learners studying AS Chemistry. Learners should be prepared to apply the knowledge, understanding and skills specified in a range of theoretical, practical, industrial and environmental contexts. It is a requirement of all AS specifications that learners must demonstrate a holistic understanding of the links between different areas of content. In practice this means that questions set in any component may require learners to draw upon knowledge from other parts of the specification.

Each topic area includes an overview outlining the content and how it contributes to the wider aims of the specification. Knowledge of specific contexts and/or examples included in the overview will not be directly assessed.

Practical work is an intrinsic part of this specification. It is vitally important in developing a conceptual understanding of many topics and it enhances the experience and enjoyment of chemistry. The practical skills developed are also fundamentally important to learners going on to further study in chemistry and related subjects, and are transferable to many careers. This section includes **specified practical work** that **must** be undertaken by learners in order that they are suitably prepared for the written examinations. The completion of this practical work will develop the practical skills listed in Appendix A.

Individual topic areas include details of the mathematical skills to be developed through that content. Appendix B lists the mathematical requirements with exemplification in the context of AS Chemistry and some topic areas which provide opportunities for their development.

The specification provides wide-ranging opportunities to increase learners' awareness and understanding of How Science Works. Content should be introduced in such a way that it develops learners' ability to:

- use theories, models and ideas to develop scientific explanations
- use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas
- use appropriate methodology, including information and communication technology (ICT), to answer scientific questions and solve scientific problems
- carry out experimental and investigative activities, including appropriate risk management, in a range of contexts
- analyse and interpret data to provide evidence, recognising correlations and causal relationships
- evaluate methodology, evidence and data, and resolve conflicting evidence
- know that scientific knowledge and understanding develops over time
- communicate information and ideas in appropriate ways using appropriate terminology

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- consider applications and implications of science and evaluate their associated benefits and risks
- consider ethical issues in the treatment of humans, other organisms and the environment
- evaluate the role of the scientific community in validating new knowledge and ensuring integrity
- evaluate the ways in which society uses science to inform decision making.

Individual topic areas include a list detailing which of these skills could be developed through that particular content and Appendix C shows a sample of coverage.

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2.1 Component 1

THE LANGUAGE OF CHEMISTRY, STRUCTURE OF MATTER AND SIMPLE REACTIONS

Written examination: 1 hour 30 minutes
50% of qualification

This component covers the following areas of study

C1.1 Formulae and equations

C1.2 Basic ideas about atoms

C1.3 Chemical calculations

C1.4 Bonding

C1.5 Solid structures

C1.6 The Periodic Table

C1.7 Simple equilibria and acid-base reactions

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C1.1 Formulae and equations

Overview
The ability to represent reactions using chemical formulae and equations is an essential part of communicating knowledge and understanding in chemistry. This skill is of course required throughout the specification.

Mathematical Skills
Leaners will develop their ability to use ratios by writing chemical formulae and constructing balanced chemical equations.

How Science Works
There are opportunities here for learners to:
use theories, models and ideas to develop scientific explanations;
communicate information and ideas in appropriate ways using appropriate terminology.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) formulae of common compounds and common ions and how to write formulae for ionic compounds

(b) oxidation numbers of atoms in a compound or ion

(c) how to construct balanced chemical equations, including ionic equations, with appropriate use of state symbols

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C1.2 Basic ideas about atoms

Overview

The study of the structure of the atom is essential to understanding chemical reactions and radioactivity. There is an opportunity here to consider how the model of the atom has developed over time and how different models can be useful in explaining different observations.

Mathematical Skills

Learners will develop their ability to:
use ratios by solving problems on half-life of radioactive decay;
use expressions in decimal and standard form, use powers, change the subject of an equation and substitute values into an equation in frequency/energy calculations.

How Science Works

There are opportunities here for learners to:
use theories, models and ideas to develop scientific explanations;
know that scientific knowledge and understanding develops over time;
consider applications and implications of science and evaluate their associated benefits and risks;
consider ethical issues in the treatment of humans, other organisms and the environment.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) nature of radioactive decay and the resulting changes in atomic number and mass number (including positron emission and electron capture)

(b) behaviour of α-, β- and γ-radiation in electric and magnetic fields and their relative penetrating power

(c) half-life of radioactive decay

(d) adverse consequences for living cells of exposure to radiation and use of radioisotopes in many contexts, including health, medicine, radio-dating, industry and analysis

(e) significance of standard molar ionisation energies of gaseous atoms and their variation from one element to another

(f) link between successive ionisation energy values and electronic structure

(g) shapes of *s*- and *p*-orbitals and order of *s*-, *p*- and *d*-orbital occupation for elements 1-36

(h) origin of emission and absorption spectra in terms of electron transitions between atomic energy levels

(i) atomic emission spectrum of the hydrogen atom

(j) relationship between energy and frequency ($E = hf$) and that between frequency and wavelength ($f = c/\lambda$)

(k) order of increasing energy of infrared, visible and ultraviolet light

(l) significance of the frequency of the convergence limit of the Lyman series and its relationship with the ionisation energy of the hydrogen atom

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C1.3 Chemical calculations

Overview

An understanding of the amount of substance is fundamental to all chemical reactions. The majority of calculations appearing here are relevant throughout the course.

Mathematical Skills

Learners will develop their ability to:
find arithmetic means by calculating relative atomic mass from mass spectrum data
use ratios and percentages by solving empirical formula problems and calculating atom economy and yield of a reaction;
recognise and make use of units in calculations involving amounts of substance;
use powers in calculations using the Avogadro constant;
change the subject of an equation and substitute values into an equation in calculations relating to acid-base titrations and ideal gases;
estimate approximate volume required to reach a titration end-point;
select appropriate data to calculate mean titres;
use an appropriate number of significant figures in all calculations;
identify uncertainty in acid-base titration data.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) relative mass terms (atomic, isotopic, formula, molecular)

(b) principles of the mass spectrometer and its use in determining relative atomic mass and relative abundance of isotopes

(c) simple mass spectra, for example, that of chlorine gas

(d) how empirical and molecular formulae can be determined from given data

(e) relationship between the Avogadro constant, the mole and molar mass

(f) relationship between grams and moles

(g) concept of concentration and its expression in terms of grams or moles per unit volume (including solubility)

(h) molar volume and correction due to changes in temperature and pressure

(i) ideal gas equation ($pV = nRT$)

(j) concept of stoichiometry and its use in calculating reacting quantities, including in acid-base titrations

(k) concepts of atom economy and percentage yield

(l) how to estimate the percentage error in a measurement and use this to express numeric answers to the appropriate number of significant figures

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C1.4 Bonding

Overview
An understanding of bonding is fundamental in explaining why chemical reactions happen. This topic considers the electronic changes that take place in the formation of stable structures. These ideas will be referred to throughout the specification.

Mathematical Skills
Leaners will develop their ability to predict bond angles and shapes of molecules and to represent these shapes in 2D and 3D.

How Science Works
There are opportunities here for learners to:
use theories, models and ideas to develop scientific explanations;
communicate information and ideas in appropriate ways using appropriate terminology.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) ionic bonding in terms of ion formation and the interaction between positive and negative ions in an ionic crystal

(b) covalent bonding, including coordinate bonding, in terms of the sharing of electrons and the balance of forces of attraction and repulsion within the molecule

(c) intermediate character of many bonds between purely ionic and purely covalent

(d) concepts of electronegativity and bond polarity

(e) forces between molecules being much weaker than covalent (and ionic) bonds

(f) permanent and temporary dipoles and their relative effects on physical properties, such as boiling temperature and solubility

(g) hydrogen bonding and its effect on physical properties, such as boiling temperature and solubility

(h) VSEPR principle and its use in predicting the shapes of simple molecules and ions

(i) bond angles associated with linear, trigonal planar, tetrahedral and octahedral molecules and ions

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C1.5 Solid structures

Overview

This section relates the structures and properties of different types of solids to the bonding present within them. A thorough understanding of the differences between atoms, ions and molecules and of the difference between interactions within and between molecules is essential. A broader understanding could be developed by looking at the structures and properties of novel materials such as smart materials and 'bucky ball' structures.

How Science Works

There are opportunities here for learners to:
use theories, models and ideas to develop scientific explanations;
communicate information and ideas in appropriate ways using appropriate terminology;
evaluate the role of the scientific community in validating new knowledge and ensuring integrity.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) crystal structures of sodium chloride and caesium chloride

(b) structures of diamond and graphite

(c) structures of iodine and ice

(d) 'electron sea' model for bonding in metals

(e) relationship between physical properties (for example, melting temperature, solubility, hardness and electrical conductance) and structure and bonding in ionic compounds, giant molecular substances, simple molecular substances and metals

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C1.6 The Periodic Table

Overview

The location of the elements in the Periodic Table can be explained by their atomic structure, which in turn can be utilised to explain trends and patterns down groups and across periods. Consideration should be given to the fact that the modern form of the Periodic Table developed over time with separate advances made by several scientists. There are ample opportunities here to carry out a range of practical work, including qualitative and quantitative problem-solving tasks. Recall of reactions studied at GCSE is assumed prior knowledge, e.g., Group 1 metals with water and Group 2 metals with dilute acids.

Mathematical Skills

Learners will develop their ability to change the subject of an equation and substitute values into an equation in calculations relating to gravimetric analysis.

How Science Works

There are opportunities here for learners to:
use theories, models and ideas to develop scientific explanations;
use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas;
carry out experimental and investigative activities;
know that scientific knowledge and understanding develops over time.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) elements being arranged according to atomic number in the Periodic Table

(b) electronic structures of the elements relate to their position in the *s*-, *p*- and *d*-blocks of the Periodic Table

(c) oxidation and reduction in terms of electron transfer in reactions of *s*-, *p*- and *d*-block elements/compounds/ ions

(d) general trends in ionisation energy, melting temperature and electronegativity across periods and down groups

(e) reactions of Group 2 elements with oxygen and water/steam

(f) reactions of the aqueous cations Mg^{2+}, Ca^{2+} and Ba^{2+} with OH^-, CO_3^{2-} and SO_4^{2-} ions

(g) characteristic flame colours shown by compounds of Li, Na, K, Ca, Sr and Ba (Mg compounds show no colour)

(h) trend in general reactivity of Group 1 and Group 2 metals

(i) trend in thermal stability of the Group 2 carbonates and hydroxides

(j) trends in solubility of Group 2 hydroxides and sulfates

(k) basic character of the oxides and hydroxides of Group 1 and Group 2 metals

(l) trend in volatility of Group 7 elements (halogens)

(m) reactions of the halogens with metals

(n) trend in reactivity of the halogens in terms of relative oxidising power

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(o) reaction between aqueous Ag^+ and halide ions followed by dilute aqueous NH_3

(p) displacement reactions of halogens in terms of redox

(q) use of chlorine and fluoride ions in water treatment and the related health and ethical issues

(r) soluble salt formation and crystallisation, insoluble salt formation by precipitation and simple gravimetric analysis

SPECIFIED PRACTICAL WORK

- Gravimetric analysis, for example, by precipitation of a Group 2 metal carbonate or a metal chloride
- Identification of unknown solutions by qualitative analysis

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C1.7 Simple equilibria and acid-base reactions

Overview
The concept of equilibrium could be introduced in the context of industrial processes such as the Haber and contact processes and developed in more depth by consideration of the effects of ocean acidification on the carbonate/hydrogencarbonate system. Acid-base reactions provide extensive opportunities for quantitative practical work linking with key chemical calculations. Recall of the reactions of dilute acids with bases and carbonates is assumed prior knowledge.

Mathematical Skills
Learners will develop their ability to:
estimate results when evaluating the effect of changing temperature on the value of K_c;
change the subject of an equation and substitute values into an equation in calculations relating to acid-base titrations and equilibrium constant, K_c;
estimate approximate volume required to reach a titration end-point;
select appropriate data to calculate mean titres;
use an appropriate number of significant figures in all calculations;
identify uncertainty in acid-base titration data;
use a calculator to solve logarithmic functions in simple pH calculations.

How Science Works
There are opportunities here for learners to:
use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas;
use appropriate methodology, including information and communication technology, to answer scientific questions and solve scientific problems;
carry out experimental and investigative activities, including appropriate risk management, in a range of contexts.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) reversible reactions and dynamic equilibrium

(b) Le Chatelier's principle in deducing the effect of changes in temperature, concentration and pressure

(c) equilibrium constant (K_c) and calculations involving given equilibrium concentrations

(d) acids as donors of H^+(aq) and bases as acceptors of H^+(aq)

(e) relationship between pH and H^+(aq) ion concentration (pH = –log[H^+(aq)])

(f) acid-base titrations

(g) difference between strong acids and weak acids in terms of relative dissociation

SPECIFIED PRACTICAL WORK

- Preparation of a soluble salt by titration
- Standardisation of an acid solution
- Back titration, for example, determination of the percentage of calcium carbonate in limestone
- Double titration, for example, analysis of a mixture of sodium hydroxide and sodium carbonate

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2.2 Component 2

ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

Written examination: 1 hour 30 minutes
50% of qualification

This component covers the following areas of study

C2.1 Thermochemistry

C2.2 Rates of reaction

C2.3 The wider impact of chemistry

C2.4 Organic compounds

C2.5 Hydrocarbons

C2.6 Halogenoalkanes

C2.7 Alcohols and carboxylic acids

C2.8 Instrumental analysis

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C2.1 Thermochemistry

Overview
A quantitative approach to the energy changes taking place during both chemical and physical processes is used to explain why some changes are exothermic and others endothermic. This is supported by a variety of practical work which offers opportunities for evaluation of methodology and data.

Mathematical Skills
Learners will develop their ability to:
change the subject of an equation, substitute values into an equation and solve algebraic equations in Hess's law calculations and in calculating enthalpy changes from experimental data;
translate information between graphical and numerical data and plot data from simple procedures to determine enthalpy changes.

How Science Works
There are opportunities here for learners to:
use appropriate methodology, including information and communication technology, to answer scientific questions and solve scientific problems;
carry out experimental and investigative activities, including appropriate risk management, in a range of contexts;
evaluate methodology, evidence and data, and resolve conflicting evidence.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) enthalpy change of reaction, enthalpy change of combustion and standard molar enthalpy change of formation, $\Delta_f H^\ominus$

(b) Hess's law and energy cycles

(c) concept of average bond enthalpies and how they are used to carry out simple calculations

(d) how to calculate enthalpy changes

(e) simple procedures to determine enthalpy changes

SPECIFIED PRACTICAL WORK

- Indirect determination of an enthalpy change of reaction, for example, for magnesium oxide and carbon dioxide to form magnesium carbonate
- Determination of an enthalpy change of combustion

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C2.2 Rates of reaction

Overview

Chemical reactions are monitored in various ways to determine rates of reaction. A particle approach is used to explain changes to rate during a reaction and changes occurring as a result of varying conditions. Practical work here presents the opportunity to plan a range of approaches and data collection methods and therefore good scope for evaluation.

Mathematical Skills

Learners will develop their ability to translate information between graphical and numerical data, plot data from simple procedures and find gradients in determining reaction rate.

How Science Works

There are opportunities here for learners to:
use theories, models and ideas to develop scientific explanations;
use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas;
use appropriate methodology, including information and communication technology, to answer scientific questions and solve scientific problems;
carry out experimental and investigative activities, including appropriate risk management, in a range of contexts;
analyse and interpret data to provide evidence, recognising correlations and causal relationships;
evaluate methodology, evidence and data, and resolve conflicting evidence.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) collision theory in explaining the effects of changing conditions on reaction rate

(b) how to calculate rates from experimental data and how to establish the relationship between reactant concentrations and rate

(c) concepts of energy profiles and activation energy

(d) rapid increase in rate with temperature in terms of changes in the Boltzmann energy distribution curve

(e) characteristics of a catalyst

(f) how catalysts increase reaction rates by providing alternative routes of lower activation energy

(g) how colorimetry can be used in studies of some reaction rates

(h) measurement of reaction rate by gas collection and precipitation methods and by an 'iodine clock' reaction

SPECIFIED PRACTICAL WORK

- Investigation of a rate of reaction by a gas collection method
- Study of an 'iodine clock' reaction

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C2.3 The wider impact of chemistry

Overview
This is an opportunity to reflect on how an understanding of chemical principles can be used to inform judgements on the correct balance between exploiting the Earth's natural resources and ensuring that future generations will not be adversely affected by our decisions. Should we develop the technologies to extract shale gas reserves in order to satisfy energy needs or should low-carbon energy be the focus?

How Science Works
There are opportunities here for learners to:
use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas;
analyse and interpret data to provide evidence, recognising correlations and causal relationships;
consider applications and implications of science and evaluate their associated benefits and risks;
consider ethical issues in the treatment of humans, other organisms and the environment;
evaluate the role of the scientific community in validating new knowledge and ensuring integrity.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) social, economic and environmental impact of chemical synthesis and the production of energy

(b) role of green chemistry in improving sustainability in all aspects of developments

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C2.4 Organic compounds

Overview
This topic provides the foundation skills and knowledge, including the representation and naming of organic structures, required to study organic chemistry.

Mathematical Skills
Learners will develop their ability to represent 3D forms in 2D and 3D in exploring structural isomerism.

How Science Works
There are opportunities here for learners to:
use theories, models and ideas to develop scientific explanations;
communicate information and ideas in appropriate ways using appropriate terminology.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) how to represent simple organic compounds using shortened, displayed and skeletal formulae

(b) nomenclature rules relating to alkanes, alkenes, halogenoalkanes, alcohols and carboxylic acids

(c) effect of increasing chain length and the presence of functional groups on melting/boiling temperature and solubility

(d) concept of structural isomerism

(e) description of species as electrophiles, nucleophiles and radicals and bond fission as homolytic or heterolytic

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C2.5 Hydrocarbons

Overview
This topic considers saturated and unsaturated hydrocarbons derived from the petroleum industry and their respective uses as fuels and in making plastics. Particular attention is given to understanding the very different ways is which alkanes and alkenes react.

Mathematical Skills
Learners will develop their ability to understand the symmetry of 3D shapes in studying *E–Z* isomerism.

How Science Works
There are opportunities here for learners to:
communicate information and ideas in appropriate ways using appropriate terminology;
consider applications and implications of science and evaluate their associated benefits and risks;
consider ethical issues in the treatment of humans, other organisms and the environment
evaluate the ways in which society uses science to inform decision making.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) combustion reaction of alkanes and benefits and drawbacks relating to the use of fossil fuels, including formation of carbon dioxide, acidic gases and carbon monoxide

(b) C—C and C—H bonds in alkanes as σ-bonds

(c) mechanism of radical substitution, such as the photochlorination of alkanes

(d) difference in reactivity between alkanes and alkenes in terms of the C=C bond as a region of high electron density

(e) C=C bond in ethene and other alkenes as comprising π-bond and σ-bond

(f) *E–Z* isomerism in terms of restricted rotation about a carbon-carbon double bond

(g) mechanism of electrophilic addition, such as in the addition of Br_2 to ethene, as a characteristic reaction of alkenes

(h) bromine/bromine water and potassium manganate(VII) tests for alkenes

(i) orientation of the normal addition of HBr to propene in terms of the relative stabilities of the possible carbocations involved

(j) conditions required for the catalytic hydrogenation of ethene and the relevance of this reaction

(k) nature of addition polymerisation and the economic importance of the polymers of alkenes and substituted alkenes

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C2.6 Halogenoalkanes

Overview
Nucleophilic substitution, including the factors that affect its rate, is considered here as the characteristic reaction of halogenoalkanes. This type of reaction is an important step in chemical synthesis and is carried out in the laboratory by refluxing. Important properties of halogenoalkanes are also discussed.

How Science Works
There are opportunities here for learners to:
carry out experimental and investigative activities, including appropriate risk assessments;
communicate information and ideas in appropriate ways using appropriate terminology;
consider applications and implications of science and evaluate their associated benefits and risks;
consider ethical issues in the treatment of humans, other organisms and the environment
evaluate the ways in which society uses science to inform decision making.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) elimination reaction of halogenoalkanes forming alkenes, for example, HBr eliminated from 1-bromopropane to form propene

(b) mechanism of nucleophilic substitution, such as in the reaction between OH^-(aq) and primary halogenoalkanes

(c) effect of bond polarity and bond enthalpy on the ease of substitution of halogenoalkanes

(d) hydrolysis/Ag^+(aq) test for halogenoalkanes

(e) halogenoalkanes as solvents, anaesthetics and refrigerants, and tight regulation of their use due to toxicity or adverse environmental effects

(f) adverse environmental effects of CFCs and the relevance of the relative bond strengths of C–H, C–F and C–Cl in determining their impact in the upper atmosphere

(g) how to carry out a reflux (for example, for nucleophilic substitution reaction of halogenoalkanes with hydroxide ions)

SPECIFIED PRACTICAL WORK

- Nucleophilic substitution reaction, for example, 1-bromobutane with aqueous sodium hydroxide

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C2.7 Alcohols and carboxylic acids

Overview
Reactions of two groups of oxygen-containing compounds are considered here, including the oxidation of an alcohol to a carboxylic acid and the reaction of one with the other to form an ester. Each of these reactions can be carried out in the laboratory. This is the first opportunity to use a distillation apparatus.

How Science Works
There are opportunities here for learners to carry out experimental and investigative activities, including appropriate risk assessments.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) industrial preparation of ethanol from ethene

(b) preparation of ethanol and other alcohols by fermentation followed by distillation, and issues relating to the use of biofuels

(c) dehydration reactions of alcohols

(d) classification of alcohols as primary, secondary and tertiary

(e) oxidation of primary alcohols to aldehydes/carboxylic acids and secondary alcohols to ketones

(f) dichromate(VI) test for primary/secondary alcohols and sodium hydrogencarbonate test for carboxylic acids

(g) reactions of carboxylic acids with bases, carbonates and hydrogencarbonates forming salts

(h) esterification reaction that occurs when a carboxylic acid reacts with an alcohol

(i) separation by distillation

SPECIFIED PRACTICAL WORK

- Preparation of an ester and separation by distillation

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C2.8 Instrumental analysis

Overview
An introduction to the spectroscopic techniques that have replaced chemical tests in many applications in recent years, e.g. in the drivers' breathalyser test. The focus here should be on data interpretation in order to identify a compound's key characteristics and to draw conclusions together in finding its structure.

Mathematical Skills
Learners will develop their ability to translate information between graphical and numerical forms while analysing and interpreting spectra.

How Science Works
There are opportunities here for learners to:
use appropriate methodology, including information and communication technology (ICT) to answer scientific questions and solve scientific problems
analyse and interpret data to provide evidence, recognising correlations and causal relationships.

Learners should be able to demonstrate and apply their knowledge and understanding of

(a) use of mass spectra in identification of chemical structure

(b) use of IR spectra in identification of chemical structure

(c) use of ^{13}C and low resolution ^{1}H NMR spectra in identification of chemical structure

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3 ASSESSMENT

3.1 Assessment objectives and weightings

Below are the assessment objectives for this specification. Learners must:

AO1
Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures

AO2
Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:

- in a theoretical context
- in a practical context
- when handling qualitative data
- when handling quantitative data

AO3
Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:

- make judgements and reach conclusions
- develop and refine practical design and procedures

The table below shows the weighting of each assessment objective for each component and for the qualification as a whole.

	AO1	AO2	AO3
Component 1	18.1 %	21.9 %	10 %
Component 2	18.1 %	21.9 %	10 %
Overall weighting	36.2 %	43.8 %	20 %

For each series:

- The weighting for the assessment of mathematical skills will be a minimum of 20 %.
- The weighting for the indirect assessment of practical skills will be a minimum of 15 %.

The ability to select, organise and communicate information and ideas coherently using appropriate scientific conventions and vocabulary will be tested across the assessment objectives.

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4 TECHNICAL INFORMATION

4.1 Making entries

This is a linear qualification in which all assessments must be taken at the end of the course. Assessment opportunities will be available in the months of May and June from 2016 until the end of the life of this specification.

Where candidates wish to re-sit the qualification, all components must be re-taken.

The entry code appears below.

WJEC Eduqas AS Chemistry B410QS

The current edition of our *Entry Procedures and Coding Information* gives up-to-date entry procedures.

4.2 Grading, awarding and reporting

AS qualifications are reported as a grade on the scale from A to E. Results not attaining the minimum standard for the award will be reported as U (unclassified).

AS qualifications are free-standing and are awarded in their own right. Assessments at AS cannot contribute to an A level grade.

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APPENDIX A

WORKING SCIENTIFICALLY

Practical skills identified for indirect assessment and developed through teaching and learning

Question papers will assess learners' abilities to:

Independent thinking

- solve problems set in practical contexts
- apply scientific knowledge to practical contexts

Use and application of scientific methods and practices

- comment on experimental design and evaluate scientific methods
- present data in appropriate ways
- evaluate results and draw conclusions with reference to measurement uncertainties and errors
- identify variables including those that must be controlled

Numeracy and the application of mathematical concepts in a practical context

- plot and interpret graphs
- process and analyse data using appropriate mathematical skills as exemplified in the mathematical appendix (see Appendix B)
- consider margins of error, accuracy and precision of data

Instruments and equipment

- know and understand how to use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification

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APPENDIX B

MATHEMATICAL REQUIREMENTS AND EXEMPLIFICATION

Mathematical skills	**Exemplification of mathematical skill in the context of AS Chemistry (assessment is not limited to the examples given below)**	**Topic areas providing opportunities to develop skill**
Arithmetic and numerical computation		
Recognise and make use of appropriate units in calculation	Learners may be tested on their ability to: • convert between units e.g. cm^3 to dm^3 as part of volumetric calculations	C1.2(j) C1.3(e)(f)(g)(h)(i)(j)
Recognise and use expressions in decimal and ordinary form	Learners may be tested on their ability to: • use an appropriate number of decimal places in calculations e.g. for concentration • carry out calculations using numbers in standard and ordinary form e.g. use of Avogadro's number • convert between numbers in standard and ordinary form • understand that significant figures need retaining when making conversions between standard and ordinary form e.g. 0.0050 mol dm^{-3} is equivalent to 5.0×10^{-3} mol dm^{-3}	C1.2(j)
Use ratios, fractions and percentages	Learners may be tested on their ability to: • calculate percentage yields • calculate the atom economy of a reaction • construct and/or balance equations using ratios	C1.1(a)(c) C1.2(c) C1.3(d)
Use calculators to find and use power and logarithmic functions	Learners may be tested on their ability to: • carry out calculations using the Avogadro constant • carry out simple pH calculations	C1.2(j) C1.3(e) C1.7(e)

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Handling data		
Use an appropriate number of significant figures	Learners may be tested on their ability to: • report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures • understand that calculated results can only be reported to the limits of the least accurate measurement	C1.3(e)(f)(g)(h)(i)(j) C1.7(f) C2.1(e) C2.2(h)
Find arithmetic means	Learners may be tested on their ability to: • calculate weighted means e.g. calculation of an atomic mass based on supplied isotopic abundances • select appropriate titration data (i.e. identification of outliers) in order to calculate mean titres	C1.3(b)(j)
Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined	Learners may be tested on their ability to: • determine uncertainty when two burette readings are used to calculate a titre value	C1.3(l) C1.7(f) C2.1(e) C2.2(h)
Algebra		
Understand and use the symbols: =, <, <<, >>, >, ∝, ~, equilibrium sign	No exemplification required	
Change the subject of an equation	Learners may be tested on their ability to: • carry out structured and unstructured mole calculations • use the ideal gas equation	C1.2(j) C1.3(e)(f)(g)(h)(i)(j) C1.6(r) C1.7(f) C2.1(b)(c)(d)
Substitute numerical values into algebraic equations using appropriate units for physical quantities	Learners may be tested on their ability to: • carry out structured and unstructured mole calculations • use the ideal gas equation	C1.2(j) C1.3(e)(f)(g)(h)(i)(j) C1.6(r) C1.7(f) C2.1(b)(c)(d)(e)
Solve algebraic equations	Learners may be tested on their ability to: • carry out Hess' law calculations	C2.1(b)(c)(d)

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Graphs		
Translate information between graphical, numerical and algebraic forms	Learners may be tested on their ability to: • interpret and analyse spectra	C2.1(e) C2.2(b)(g)(h) C2.8(a)(b)(c)
Plot two variables from experimental or other data	Learners may be tested on their ability to: • plot concentration–time graphs from collected or supplied data and draw an appropriate best-fit curve	C2.1(e) C2.2(b)(g)(h)

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Geometry and trigonometry		
Use angles and shapes in regular 2D and 3D structures	Learners may be tested on their ability to: • predict/identify shapes of and bond angles in molecules with and without a lone pair(s) for example NH_3, CH_4, H_2O etc.	C1.4(h)(i)
Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects	Learners may be tested on their ability to: • draw different forms of isomers	C1.4(h)(i) C2.4(d)
Understand the symmetry of 2D and 3D shapes	Learners may be tested on their ability to: • describe the types of stereoisomerism shown by molecules/complexes	C2.5(f)

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APPENDIX C

HOW SCIENCE WORKS

How Science Works skill	Sample of topic areas providing opportunities to develop skill
use theories, models and ideas to develop scientific explanations	C1.1(c) C1.2(f) C1.4 C1.5 C2.2(a)
use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas	C1.6(d) C1.7(b) C2.2(a)
use appropriate methodology, including information and communication technology (ICT), to answer scientific questions and solve scientific problems	C1.7(f) C2.1(e) C2.2(h)
carry out experimental and investigative activities, including appropriate risk management, in a range of contexts	C1.6(r) C1.7(f) C2.1(e) C2.2(h) C2.6(g) C2.7(i)
analyse and interpret data to provide evidence, recognising correlations and causal relationships	C2.2(h) C2.3(a) C2.8
evaluate methodology, evidence and data, and resolve conflicting evidence	C2.1(e) C2.2(h)
know that scientific knowledge and understanding develops over time	C1.2(f) C1.6(a)
communicate information and ideas in appropriate ways using appropriate terminology	C1.1(c) C1.4 C1.5 C2.4(a)(b)
consider applications and implications of science and evaluate their associated benefits and risks	C1.2(d) C2.3(a) C2.5(a) C2.6(e)(f)
consider ethical issues in the treatment of humans, other organisms and the environment	C1.2(d) C2.3(a) C2.5(a) C2.6(e)(f)
evaluate the role of the scientific community in validating new knowledge and ensuring integrity	C1.5(e) C2.3(a)
evaluate the ways in which society uses science to inform decision making	C2.5(a) C2.6(e)(f)

AS Chemistry specification for teaching from 2015/GH
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