

Chemistry in Society

SCQF: level 6 (6 SCQF credit points)

Unit code: J23E 76

Unit outline

The general aim of this Unit is to develop skills of scientific inquiry, investigation, analytical thinking, independent working, and knowledge and understanding of chemistry in society. Candidates will apply these skills when considering the applications of chemistry in society on our lives, as well as the implications on society/the environment. This can be done using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of: getting the most from reactants, equilibria, chemical energy, oxidising and reducing agents, and chemical analysis. Candidates will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

Candidates who complete this Unit will be able to:

- 1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit, to carry out an experiment
- 2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills

This Unit is available as a free-standing Unit. The Unit Specification should be read in conjunction with the Unit Support Notes, which provide advice and guidance on delivery, assessment approaches and development of skills for learning, skills for life and skills for work. Exemplification of the standards in this Unit is given in *Unit Assessment Support*.

Recommended entry

Entry to this Unit is at the discretion of the centre. However, candidates would normally be expected to have attained the skills, knowledge and understanding required by one or more of the following or equivalent qualifications and/or experience:

Equality and inclusion

This Unit Specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of candidates should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence. For further information, please refer to the *Unit Support Notes*.

Standards

Outcomes and assessment standards

Outcome 1

The learner will:

1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit to carry out an experiment by:

- 1.1 Planning an experiment
- 1.2 Following procedures safely
- 1.3 Making and recording observations/measurements correctly
- 1.4 Presenting results in an appropriate format
- 1.5 Drawing valid conclusions
- 1.6 Evaluating experimental procedures

Outcome 2

The learner will:

2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills by:

- 2.1 Making accurate statements
- 2.2 Solving problems

Evidence Requirements for the Unit

Assessors should use their professional judgement, subject knowledge and experience, and understanding of their candidates, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used.

Evidence can be drawn from a variety of sources and presented in a variety of formats. Evidence may be presented for individual Outcomes or gathered for the Unit as a whole, through combining assessment holistically in a single activity. If the latter approach is used, it must be clear how the evidence covers each Outcome.

The key areas covered in this Unit are:

- ◆ Getting the most from reactants
- ◆ Equilibria
- ◆ Chemical energy
- ◆ Oxidising and reducing agents
- ◆ Chemical analysis

The table below describes the evidence for the Assessment Standards which require exemplification.

Assessment Standard	Higher
Planning an experiment	The plan should include: <ul style="list-style-type: none">◆ a clear statement of the aim◆ a hypothesis◆ a dependent and independent variable◆ variables to be kept constant◆ measurements/observations to be made◆ the equipment/materials◆ a clear and detailed description of how the experiment should be carried out, including safety considerations
Presenting results in an appropriate format	One format from: table, line graph, chart, key, diagram, flow chart, summaries or extended text or other appropriate formats
Draw a valid conclusion	Include reference to the aim
Evaluating experimental procedures	Suggest two improvements with justification
Accurate statements	At least half of the responses should be correct across the key areas for the set of questions provided.
Solving problems	One of each: <ul style="list-style-type: none">◆ make generalisations/predictions◆ select information◆ process information including calculations as appropriate◆ analyse information

Exemplification of assessment is provided in Unit assessment support packs. Advice and guidance on possible approaches to assessment is provided in the *Unit Support Notes*.

Transfer of evidence

When the Outcomes and Assessment Standards are the same for SCQF level 6 freestanding Chemistry units, differing only by context, evidence for Outcome 1 and Assessment Standard 2.2 for this unit can be used as evidence of the achievement of Outcome 1 and Assessment Standard 2.2 in the SCQF level 6 Nature's Chemistry and Chemical Changes and Structure units.

For the freestanding SCQF Level 6 Researching Chemistry unit (H4KK 76), where the candidate's evidence meets the standards for the Outcomes and Assessment Standards, this can be used as evidence for Outcome 1 of the Chemical Changes and Structure, Nature's Chemistry and Chemistry in Society freestanding Units, without the need to match the evidence against the Assessment Standards. (The converse does not apply – which means that Chemical Changes and Structure, Nature's Chemistry and Chemistry in Society cannot transfer evidence *into* Researching Chemistry).

This means that where a candidate's record of work or 'daybook' for the Researching Chemistry Unit satisfies the evidence requirements for Outcome 1 Assessment Standard 1.1 and Outcome 2 Assessment Standards 2.1 and 2.2 of that Unit, they can be credited with passing Outcome 1 in the Chemical Changes and Structure, Nature's Chemistry and Chemistry in Society Units. For the vast majority of candidates, ie those who successfully complete the Researching Chemistry Unit assessment, it will therefore be unnecessary to assess Outcome 1 in the other Units. This effectively removes an element of assessment for most candidates and the re-assessment that often accompanies it.

It would only be necessary to assess Outcome 1 of the Chemical Changes and Structure, Nature's Chemistry and Chemistry in Society Units in the case of a candidate who is taking these as standalone Units or who has not passed the Researching Chemistry Unit, if they wish to achieve those Units.

Assessment Standard Thresholds

Outcome 1: Candidates are no longer required to show full mastery of the Assessment Standards to achieve Outcome 1. Instead, five out of the six Assessment Standards for Outcome 1 must be met to achieve a pass. There is still the requirement for candidates to be given the opportunity to meet all Assessment Standards. The above threshold has been put in place to reduce the volume of re-assessment, where that is required.

Outcome 2: Assessment Standards 2.1 (making accurate statements) and 2.2 (solving problems) are no longer required to be passed independently. Assessment Standards 2.1 and 2.2 can now be assessed by means of a single assessment for each Unit.

Outcome 2 Assessment

Centres have two options when assessing Outcome 2 (AS 2.1 and 2.2).

Option 1

Candidates can be assessed by means of a single test that contains marks and a cut-off score. A suitable Unit assessment will cover all of the key areas (AS 2.1) and assess each of the problem solving skills (AS 2.2). Where a candidate achieves 50% or more of the total marks available in a single Unit assessment they will pass Outcome 2 for that Unit. Existing Unit assessment support packs can be used during session 2016–17. Guidance on the use of each Unit assessment support pack is noted below.

Option 2

Centres can continue to use the Unit assessment support packs from SQA's secure site or their own centre devised assessments in the same way as before. If this option is chosen, 50% or more of the KU statements (AS 2.1) made by candidates must be correct in the Unit assessment and at least one correct response for each problem solving skill (AS 2.2) is required to pass Outcome 2. However, if a candidate is given more than one opportunity in a Unit assessment to provide a response for a problem solving skill, then they must answer 50% or more correctly.

Guidance on Outcome 2 (Option 1) Assessment

Unit assessment support pack 1 (Unit-by-Unit approach)

As these packages contain questions on all of the key areas (AS 2.1) and questions covering each of the problem solving skills (AS 2.2), Unit assessment support pack 1 is suitable for use as a single assessment for its associated Unit. The number of marks available for each question should be combined to give the total number of marks available. A cut-off score of 50% should be applied to each of these Unit assessments.

Unit assessment support pack 2 (combined approach)

As these packages contain questions covering only Assessment Standard 2.1 they are not suitable for use as a single assessment for their associated Units. If a centre wishes to use Unit assessment support pack 2 as a single Unit assessment, questions covering each of the four problem solving skills would need to be added. A minimum of 1 mark per problem solving skill per Unit would be acceptable.

As with the Unit-by-Unit approach, centres may wish to supplement the existing questions in the Unit assessment support packs with additional questions, so that the

sampling of each Unit is increased, the tests are out of the same total mark and that total is an even number so that the cut-off is actually 50%. Where centres are adding additional questions, care should be taken that these questions are of an appropriate standard for Unit assessment and are not 'A grade' type questions that would appear in an exam.

Unit assessment support pack 3 (portfolio approach)

It is still acceptable for centres to use this method of assessment. Candidates should be given the opportunity to make accurate statements for all of the key areas of each Unit (AS 2.1). They must also be given opportunities throughout the session to answer questions on each of the four problem solving skills (AS 2.2). Evidence should be collected as candidates progress through the session. For Assessment Standard 2.1, candidates must achieve 50% or more of the total KU marks available for each Unit. For Assessment Standard 2.2, candidates must achieve 50% or more of the total marks available for all four problem solving skills.

Development of skills for learning, skills for life and skills for work

It is expected that candidates will develop broad, generic skills through this Unit. The skills that candidates will be expected to improve on and develop through the Unit are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and drawn from the main skills areas listed below. These must be built into the Unit where there are appropriate opportunities.

1 Literacy

1.2 Writing

2 Numeracy

2.1 Number processes

2.2 Money, time and measurement

2.3 Information handling

4 Employability, enterprise and citizenship

4.6 Citizenship

5 Thinking skills

5.3 Applying

5.4 Analysing and evaluating

5.5 Creating

Amplification of these is given in SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work*. The level of these skills should be at the same SCQF level of the Unit and be consistent with the SCQF level descriptor. Further information on building in skills for learning, skills for life and skills for work is given in the *Unit Support Notes*.

Appendix: Unit support notes

Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing this Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- ◆ the Unit Specification
- ◆ the Unit Assessment Support packs

Developing skills, knowledge and understanding

Teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Approaches to learning and teaching

Areas	Exemplification of areas
<p>Getting the most from reactants Industrial processes are designed to maximise profit and minimise the impact on the environment.</p> <p>The factors influencing industrial process design.</p> <p>Environmental factors influencing industrial process design.</p> <p>Balanced equations show the mole ratio(s) of reactants and products.</p>	<p>Factors influencing process design include:</p> <ul style="list-style-type: none"> ◆ availability, sustainability and cost of feedstock(s) ◆ opportunities for recycling ◆ energy requirements ◆ marketability of by-products ◆ product yield <p>Environmental considerations include:</p> <ul style="list-style-type: none"> ◆ minimising waste ◆ avoiding the use or production of toxic substances ◆ designing products which will biodegrade if appropriate

Areas	Exemplification of areas
<p>The molar volume is the same for all gases at the same temperature and pressure. Calculations involving molar volume.</p> <p>Determination of quantities of reactants and/or products using balanced equations and moles.</p>	<p>The molar volume (in units of litres mol⁻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.</p> <p>Determination of quantities of reactants and/or products using balanced equation and:</p> <ul style="list-style-type: none"> ◆ gram formula masses (GFM) and mass ◆ moles ◆ concentrations and volumes of solutions ◆ masses of solutes ◆ molar volumes and volumes for gaseous reactions <p>The concentration of a solution can be expressed in mol l⁻¹.</p> <p>Balanced equations can be used in conjunction with concentrations and volumes of solutions and/or masses of solutes to determine quantities of reactants and/or products.</p> <p>The volumes of reactant and product gases can be calculated from the number of moles of each reactant and product.</p> <p>For a particular set of reaction conditions, the percentage yield provides a measure of the degree to which the limiting reagent is converted into the desired product. It is possible to calculate the percentage yield using the equation below.</p>

Areas	Exemplification of areas
<p>By considering a balanced equation, the limiting reactant and the reactant(s) in excess can be identified by calculation.</p> <p>The need for an economic/environmental balance in industrial processes.</p>	<p>Whilst the use of excess reactants may help to increase percentage yields, this will be at the expense of the atom economy so an economic/environmental balance must be struck.</p>
<p>Equilibria Many reactions are reversible, so products may be in equilibrium with reactants. This may result in costly reactants failing to be completely converted into products.</p> <p>In a closed system, reversible reactions attain a state of dynamic equilibrium when the rates of forward and reverse reactions are equal.</p> <p>Changes in concentration, pressure and temperature can alter the position of equilibrium.</p> <p>A catalyst increases the rate of attainment of equilibrium but does not affect the position of equilibrium.</p> <p>The effect of changing conditions can be explained using changes in rates of forward and reverse reactions and the</p>	<p>At equilibrium, the concentrations of reactants and products remain constant, but are rarely equal.</p> <p>To maximise profits, chemists employ strategies to move the position of equilibrium in favour of the products.</p>

Areas	Exemplification of areas
<p>position of the equilibrium</p>	<p>The effect of:</p> <ul style="list-style-type: none"> ◆ altering pressure ◆ altering temperature ◆ the addition or removal of reactants or products ◆ can be predicted for a given reversible reaction.
<p>Chemical energy Chemical energy is also known as enthalpy.</p> <p>Enthalpy calculations for industrial processes including the reasons they are necessary.</p> <p>.</p> <p>Calculate the enthalpy change for a reaction using $E_h = cm\Delta T$ The quantities c, m and ΔT can be calculated given relevant data.</p> <p>Enthalpy of combustion.</p> <p>Hess's law.</p>	<p>For industrial processes, it is essential that chemists can predict the quantity of heat energy taken in or given out.</p> <p>Endothermic reactions may incur costs in supplying heat energy in order to maintain the reaction rate. Exothermic reactions may require removal of heat to prevent the temperature rising</p> <p>The specific heat capacity, mass and temperature change can be used to calculate the enthalpy change for a reaction using $E_h = cm\Delta T$ The quantities c, m and ΔT can be calculated given relevant data.</p> <p>The enthalpy of combustion of a substance is the enthalpy change when one mole of the substance burns completely in oxygen.</p> <p>Hess's law states that the enthalpy change for a chemical reaction is independent of the route taken.</p> <p>Enthalpy of combustion values can often be directly measured using a</p>

Areas	Exemplification of areas
<p>Calculation of enthalpy changes by application of Hess's law.</p>	<p>calorimeter and values for common compounds are available from data books and online databases for use in Hess's law calculations.</p>
<p>Chemical energy Molar bond enthalpy.</p> <p>Mean molar bond enthalpy.</p> <p>Enthalpy changes for gas phase reactions can be calculated using bond enthalpies.</p>	<p>For a diatomic molecule, XY, the molar bond enthalpy is the energy required to break one mole of XY bonds.</p> <p>Mean molar bond enthalpies are average values which are quoted for bonds which occur in different molecular environments.</p> <p>Bond enthalpies can be used to estimate the enthalpy change occurring for a gas phase reaction by calculating the energy required to break bonds in the reactants and the energy released when new bonds are formed in the products.</p>
<p>Oxidising and reducing agents</p> <p>Oxidising and reducing agents can be identified in redox reactions.</p>	<p>Candidates should be familiar with oxidation, reduction and redox reactions including their ion-electron equations</p> <p>An oxidising agent is a substance which accepts electrons. A reducing agent is a substance which donates electrons.</p> <p>The elements with low electronegativities tend to form ions by losing</p>

Areas	Exemplification of areas
<p>The strongest reducing agents are found in group 1 whilst the strongest oxidising agents come from group 7.</p> <p>Compounds, group ions and molecules can also act as oxidising or reducing agents.</p> <p>The electrochemical series can be used to indicate the effectiveness of oxidising and reducing agents.</p> <p>Oxidation and reduction reactions can be represented by ion-electron equations, including those involving molecules or group ions.</p>	<p>elements (oxidation) and so react as reducing agents. The elements with high electronegativities tend to form ions by gaining electrons (reduction) and so can act as oxidising agents.</p> <p>The dichromate and permanganate ions are strong oxidising agents in acidic solutions. Hydrogen peroxide is an example of a molecule which is an oxidising agent.</p> <p>Carbon monoxide is an example of a gas that can be used as a reducing agent.</p> <p>The electrochemical series is a series of reduction reactions. It indicates the effectiveness of oxidising and reducing agents. Oxidising and reducing agents can be selected using an electrochemical series from a data booklet or can be identified in the equation showing a redox reaction.</p> <p>Oxidation and reduction reactions can be represented by ion-electron equations. When molecules or group ions are involved, if the reactant and product species are known, a balanced ion-electron equation can be written by adding appropriate numbers of water molecules, hydrogen ions and electrons.</p> <p>Candidates would not be expected to complete and balance ion-electron equations for reactions occurring in alkaline solutions.</p>

Areas	Exemplification of areas
<p>Ion-electron equations can be combined to produce redox equations.</p> <p>Uses of oxidising agents.</p>	<p>Oxidising agents are widely employed because of the effectiveness with which they can kill fungi and bacteria, and can inactivate viruses. The oxidation process is also an effective means of breaking down coloured compounds making oxidising agents ideal for use as 'bleach' for clothes and hair.</p>
<p>Chemical analysis In chromatography, differences in the polarity and/or size of molecules are exploited to separate the components present within a mixture.</p> <p>Interpretation of the results of chromatography.</p>	<p>Candidates are not required to know the details of any specific chromatographic method or experiment.</p> <p>Depending on the type of chromatography in use, the identity of a component can be indicated either by the distance it has travelled or by the time it has taken to travel through the apparatus (retention time). The results of a chromatography experiment can sometimes be presented graphically showing an indication of the quantity of substance present on the y-axis and retention time on the x-axis.</p>
<p>Chemical analysis Volumetric analysis.</p>	<p>Volumetric analysis involves using a solution of accurately known concentration in a quantitative reaction to determine the concentration of</p>

Areas	Exemplification of areas
<p>A solution of accurately known concentration is known as a standard solution.</p> <p>Titration</p> <p>Redox titrations.</p> <p>The concentration of a substance can be calculated from experimental results by use of a balanced equation.</p>	<p>another substance.</p> <ul style="list-style-type: none"> ◆ Preparation of a standard solution. <p>The volume (usually measured to one decimal place) of reactant solution required to complete the reaction is determined by titration. Data from concordant titres is used to calculate an average volume used and hence the concentration of a solution. Volumes within 0.2 cm³ are considered to be concordant at Higher.</p> <p>The end-point is the point at which the reaction is just complete. An indicator is a substance which changes colour at the end-point.</p> <p>Redox titrations are based on redox reactions. Substances such as potassium manganate(VII), which can act as their own indicators, are very useful reactants in redox titrations.</p>

Combining assessment within Units

Assessment could be combined in this Unit by holistically assessing all the Outcomes of the Unit in a single assessment. When assessment within the Unit is holistic, teachers and lecturers should take particular care to track the evidence for each individual Outcome. Centres should adhere to the conditions of assessment, outlined within the unit assessment support packs available via SQA secure.

Re-assessment

SQA's guidance on re-assessment is that there should be one or, in exceptional circumstances, two re-assessment opportunities. Re-assessment should be carried out under the same conditions as the original assessment. It is at a centre's discretion as to how they re-assess their candidates. Candidates may be given a full re-assessment opportunity, or be re-assessed on individual key areas and/or problem solving skills. Regardless of which option is chosen, candidates must achieve 50% or more of each re-assessment opportunity.

Administrative information

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Superclass: RD

History of changes to National Unit Specification

Version	Description of change	Authorised by	Date
2.0	Level changed from Higher to SCQF level 6. Assessment standard thresholds added. Unit support notes added.	Qualifications Manager	September 2018
3.0	Unit code updated	Qualifications Manager	July 2019

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