

Chemical Changes and Structure

SCQF: level 5 (6 SCQF credit points)

Unit code: J239 75

Unit outline

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

The Unit covers the key areas of rates of reaction, atomic structure and bonding related to properties of materials, formulae and reaction quantities and acids and bases. Learners will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

Learners 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, learners 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:

- ◆ National 4 Chemistry Course or relevant component Units
- ◆ National 4 Science Course or relevant component Units

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 learners 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 learners, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used.

The key areas covered in this Unit are:

- ◆ **rates of reaction**
- ◆ **atomic structure and bonding related to properties of materials**
- ◆ **formulae and reaction quantities**
- ◆ **acids and bases**

Evidence can be drawn from a variety of sources and presented in a variety of formats. The table below describes the evidence for the Assessment Standards which require exemplification. Evidence may be presented for individual Outcomes, or gathered for the Unit. If the latter approach is used, it must be clear how the evidence covers each Outcome.

Assessment Standard	National 5
Planning an experiment	The plan should include: <ul style="list-style-type: none"> ◆ an aim ◆ a dependent and independent variable ◆ key variables to be kept constant ◆ measurements/observations to be made ◆ the resources ◆ the method including safety considerations
Presenting results in an appropriate format	One format from: table, line graph, chart, key, diagram, flow chart, summaries or other appropriate formats
Draw a valid conclusion	Include reference to the aim
Evaluating experimental procedures	Suggest an improvement with justification
Accurate statements	At least half of the statements should be correct across the key areas of this Unit.
Solving problems	One of each: <ul style="list-style-type: none"> ◆ make generalisation/predictions ◆ selecting information ◆ processing information including calculations as appropriate ◆ analyse information

Transfer of evidence

Evidence for the achievement of 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 freestanding SCQF Level 5 *Nature's Chemistry* and *Chemistry in Society* Units.

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

Assessment Standard Thresholds

Outcome 1:

Candidates are not 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 is in place to reduce the volume of re-assessment where that is required.

Candidates have the opportunity to re-draft their original Outcome 1 report or to carry out a new experiment/practical investigation.

Outcome 2:

Assessment Standards 2.1 (making accurate statements) and 2.2 (solving problems) are not required to be passed independently. Assessment Standards 2.1 and 2.2 can 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: Single Assessment

Candidates are 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.

Option 2:

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.

Centres can use the Unit assessment support packs from SQA's secure site or centre devised assessments.

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 this package contains questions covering Assessment Standard 2.1 for each Unit and a set of questions assessing the problem solving skills, they may be 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, the existing problem solving questions could be used for one of the Units and different questions, covering each of the four problem solving skills, would need to be added to the tests for the other Units. A minimum of 1 mark per problem solving skill per unit would be acceptable.

These marks should be combined with the marks added to assess the problem solving skills (AS 2.2) before the 50% cut-off score is applied.

The problem solving questions included in package 2 would be allocated a total of 5 marks. 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 learners will develop broad, generic skills through this Unit. The skills that learners 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.

2 Numeracy

- 2.1 Number processes
- 2.2 Money, time and measurement
- 2.3 Information handling

5 Thinking skills

- 5.3 Applying
- 5.4 Analysing and evaluating

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

Mandatory key areas	Exemplification of key areas
<p>Rates of reaction</p> <p>Learners should be familiar with the factors affecting rates of reaction.</p> <p>Calculations of the average rate of a chemical reaction from data.</p> <p>Average rate of reaction to show the change in rate of reaction as a reaction progresses.</p>	<p>Factors affecting rate of reaction that learners should be familiar with are; temperature, concentration, surface area and the presence of a catalyst.</p> <p>Calculations of the average rate of a chemical reaction from data eg a graph of the change in mass or volume against time, or a table of data or a passage containing relevant information. Awareness of appropriate units eg $\text{cm}^3 \text{s}^{-1}$ or g s^{-1}.</p> <p>Average rates of reaction over various time intervals during the reaction can be used to show that as a reaction progresses the rate of reaction decreases.</p>
<p>Atomic structure and bonding related to properties of materials</p> <p>Learners should have knowledge of sub-atomic particles, the periodic table, and diatomic elements.</p>	<p>Learners should have knowledge of:</p> <ul style="list-style-type: none"> ◆ sub-atomic particles, their charge, mass and position within the atom

Mandatory key areas	Exemplification of key areas
<p>Electron configuration for the first 20 elements in the periodic table.</p> <p>Atoms are neutral as the number of protons is equal to the number of electrons.</p> <p>Isotopes</p> <p>Relative atomic mass</p>	<ul style="list-style-type: none"> ◆ the structure of the periodic table, groups, periods and atomic number ◆ the seven diatomic elements <p>Elements in the periodic table are arranged in order of increasing atomic number. Groups are columns in the periodic table containing elements with similar chemical properties, owing to their electron configuration.</p> <p>Awareness of the electron configuration of the first 20 elements as shown on page 6 of the data booklet.</p> <p>Isotopes are atoms with the same atomic number but different mass numbers. They can also be defined as having the same number of protons but different numbers of neutrons.</p> <p>Relative atomic mass is the average mass of the isotopes present, taking into account their relative proportions. Given data, identifying the most or least abundant isotope or calculating relative atomic mass using a given formula.</p>

Mandatory key areas	Exemplification of key areas
<p>Formation of ions</p> <p>Determining the number of sub-atomic particles in atoms and ions from nuclide notation. Write nuclide notation for both atoms and ions.</p> <p>Ionic bonds are the electrostatic attraction between positive and negative ions.</p> <p>Ionic compounds form lattice structures of oppositely charged ions.</p> <p>Use of structure and bonding to explain the following physical properties of ionic compounds:</p> <ul style="list-style-type: none"> ◆ melting point and boiling point ◆ solubility (water molecules surround ions) ◆ electrical conductivity 	<p>When there is an imbalance in the number of protons and electrons the particle is known as an ion. Ions are formed by loss or gain of electrons which achieves a stable electron configuration.</p> <p>Nuclide notation is used to show the numbers of sub-atomic particles in an atom or ion. Determine numbers of protons, neutrons and electrons from nuclide notation for both atoms and ions.</p> <p>A lattice is a regular arrangement of ions where each positive ion is surrounded by negative ions and each negative ion is surrounded by positive ions</p> <p>Ionic compounds have high melting and boiling points because strong ionic bonds must be broken in order to break down the lattice. Dissolving also breaks down the lattice structure. Ionic compounds conduct electricity only when molten or in solution, due to the breakdown of the lattice resulting in the ions being free to move.</p>

Mandatory key areas	Exemplification of key areas
<p>In a covalent bond, the shared pair of electrons is attracted to the nuclei of the two bonded atoms. Draw diagrams to show how outer electrons are shared to form the covalent bond(s) in a molecule</p> <p>Covalent substances can form either discrete molecular or giant network structures.</p> <p>Shapes of simple two-element compounds.</p> <p>Use of structure and bonding to explain the following physical properties of covalent compounds:</p> <ul style="list-style-type: none"> ◆ melting point and boiling point ◆ solubility (covalent molecular substances dissolve in covalent solvents) ◆ electrical conductivity <p>Experimental procedures are required to confirm the type of bonding present in a substance.</p>	<p>More than one bond can be formed between atoms leading to double and triple covalent bonds.</p> <p>Shapes should include linear, angular, trigonal pyramidal and tetrahedral.</p> <p>Covalent molecular substances have low melting and boiling points as only weak forces of attraction between molecules are being broken. Giant covalent network structures have very high melting and boiling points because the network of strong covalent bonds must be broken. Measurement of melting point and boiling point can be used to indicate the type of bonding. Measurement of electrical conductivity can be used to confirm the type of bonding.</p>
<p>Formulae and reaction quantities Write chemical and ionic formulae for compounds including those containing group ions.</p>	<p>The chemical formula of a covalent molecular substance gives the number of atoms present in the molecule. The formula of a covalent network or ionic compound gives the simplest ratio of atoms/ions in the substance.</p>

Mandatory key areas	Exemplification of key areas
<p>Balanced equations, including state symbols.</p> <p>Calculations to determine the gram formula mass, concentration, volume, mass of a substance and the number of moles present.</p>	<p>Calculations using the following formulae:</p> <ul style="list-style-type: none"> ◆ $n = CV$ ◆ $n = \frac{m}{GFM}$ <p>includes calculating moles, masses, volumes and concentrations from given data using either one or both of these formulae.</p> <p>The concentration of solutions in moles per litre (mol l^{-1}).</p>
<p>Acids and bases</p> <p>Learners should have knowledge of pH including the pH scale, acids and bases neutralisation reactions and salt formation.</p>	<p>Knowledge includes:</p> <ul style="list-style-type: none"> ◆ names and formulae of acids and bases ◆ common household examples ◆ pH values ◆ definition of neutralisation ◆ examples of neutralisation reactions including those with metals, hydroxides, oxides and carbonates ◆ definition and recognition of a salt ◆ reactions that form salts

Mandatory key areas	Exemplification of key areas
<p data-bbox="237 236 517 260">Dissociation of water.</p> <p data-bbox="237 384 965 408">The pH is a measure of the hydrogen ion concentration.</p> <p data-bbox="237 722 1099 786">The effect of dilution of an acid or alkali with water is related to the concentrations of hydrogen and hydroxide ions.</p> <p data-bbox="237 1098 813 1121">The effect of adding soluble oxides to water.</p> <p data-bbox="237 1321 573 1345">Neutralisation reactions</p>	<p data-bbox="1133 236 1973 300">A very small proportion of water molecules will dissociate into an equal number of hydrogen and hydroxide ions.</p> <p data-bbox="1133 347 1939 411">A neutral solution has an equal concentration of hydrogen and hydroxide ions.</p> <p data-bbox="1133 459 1973 555">A solution with a greater concentration of hydrogen ions than hydroxide ions is an acid. When the reverse is true the solution is known as an alkali.</p> <p data-bbox="1133 722 1738 746">The effect of dilution of an acid or alkali on the:</p> <ul data-bbox="1133 802 1715 938" style="list-style-type: none"> ◆ concentration of hydrogen/hydroxide ions ◆ pH ◆ acidity/alkalinity ◆ conductivity <p data-bbox="1133 1098 1951 1233">When added to water, soluble metal oxides produce metal hydroxide solutions, which increases the hydroxide ion concentration. Soluble non-metal oxides increase the hydrogen ion concentration.</p> <p data-bbox="1133 1289 1574 1313">For these neutralisation reactions:</p>

Mandatory key areas	Exemplification of key areas
<p>Identifying the products and writing balanced equations for the reaction of acids with metals, oxides, hydroxides and carbonates.</p> <p>Titration as an analytical technique, including calculations.</p>	<ul style="list-style-type: none"> ◆ identify spectator ions ◆ determine the reacting species by omission of spectator ions <p>Titration is an analytical technique used to determine the accurate volumes involved in chemical reactions such as neutralisation. An indicator is normally used to show the end-point of the reaction. Using data from concordant titres to calculate an average volume used and the concentration of a solution.</p> <p>Volumes within 0.2 cm³ are considered to be concordant at National 5.</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
1.1	Assessment standard thresholds added Unit support notes added	Qualifications Manager	September 2018
2.0	Unit code updated	Qualifications Manager	July 2019

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