SCQF level 6
Unit Specification

# Chemical Changes and Structure

## SCQF: level 6 (3 SCQF credit points)

## Unit code: H4KH 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 chemical changes and structure. Candidates will apply these skills when considering the applications of chemical changes and structure 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: controlling the rate, periodicity, structure and bonding. 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:

- National 5 Chemistry Course or relevant 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 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 freestanding unit are:

- Controlling the rate
- Periodicity
- Structure and bonding

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

| **Assessment Standard** | **Evidence** |
|---|---|
| Planning an experiment | The plan should include:<br>♦ a clear statement of the aim<br>♦ a hypothesis<br>♦ a dependent and independent variable<br>♦ variables to be kept constant<br>♦ measurements/observations to be made<br>♦ the equipment/materials<br>♦ 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 |
| Drawing 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:<br>♦ make generalisation/predictions<br>♦ selecting information<br>♦ processing information including calculations as appropriate<br>♦ 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 Chemistry in Society 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

**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 |
|---|---|
| **Controlling the rate**<br>Importance of controlling reaction rate. | Controlling reaction rate is important in industrial processes. If they are too low a manufacturing process will not be economically viable, too high and there is a risk of thermal explosion. |
| Collision theory can be used to explain the effects of concentration, pressure, surface area, temperature and collision geometry on reaction rates. | Collision theory can be used to explain the effects of the following on reaction rates:<br>♦ concentration<br>♦ pressure<br>♦ surface area (particle size)<br>♦ temperature<br>♦ collision geometry |
| Calculations involving relative rate. | Relative rate for a reaction is the reciprocal of the time taken for the reaction.<br>Calculating relative rate from raw experimental data<br>Units for relative rate are $s^{-1}$. |
| **Controlling the rate**<br>Reaction profiles can be shown using potential energy diagrams.<br><br>Interpretation of and calculations from potential energy diagrams for both forward and reverse reactions. | Potential energy diagrams for reactions can be used to:<br>♦ show the energy pathway<br>♦ show and calculate the enthalpy change<br>♦ show and calculate the activation energy<br>♦ show where the activated complex forms |

| Areas | Exemplification of areas |
|---|---|
| Enthalpy changes for exothermic and endothermic reactions.<br><br>Activation energy and activated complexes. | Be able to sketch the potential energy diagram for a reaction given relevant data, eg activation energy, enthalpy change etc.<br><br>Enthalpy change is the energy difference between the products and the reactants. The enthalpy change has a negative value for exothermic reactions a positive value for endothermic reactions<br><br>The activation energy is the minimum energy required by colliding particles to form an activated complex.<br><br>An activated complex is an unstable arrangement of atoms formed at the maximum of the potential energy barrier, during a reaction. |
| **Controlling the rate**<br>A catalyst provides an alternative reaction pathway with a lower activation energy.<br><br>A potential energy diagram can be used to show the effect of a catalyst on activation energy. | Be able to sketch the line on a potential energy diagram for a reaction where a catalyst is used. Be able to calculate activation energy or enthalpy change for a catalysed reaction from the potential energy diagram. |
| **Controlling the rate**<br>Temperature is a measure of the average kinetic energy of the particles of a substance.<br><br>The activation energy is the minimum kinetic energy required by | |

| Areas | Exemplification of areas |
|---|---|
| colliding particles before a reaction may occur.<br><br>Energy distribution diagrams can be used to explain the effect of changing temperature on the kinetic energy of particles and reaction rate. | Maxwell-Boltzmann distribution to show the number of particles with particular energies at various temperatures can be used to illustrate why increasing temperature increases rate of reaction.<br><br>The effect of temperature on reaction rate can be explained in terms of an increase in the number of particles with energy greater than the activation energy. |
| **Periodicity**<br>The first 20 elements in the Periodic Table are categorised according to bonding and structure. | Candidates should be familiar with the Periodic Table in terms of elements being arranged in order of increasing atomic number.<br><br>The first 20 elements in the Periodic Table are categorised according to bonding and structure:<br><br>♦ metallic (Li, Be, Na, Mg, Al, K, Ca)<br>♦ covalent molecular ($H_2$, $N_2$, $O_2$, $F_2$, $Cl_2$, $P_4$, $S_8$ and fullerenes (eg $C_{60}$))<br>♦ covalent network (B, C (diamond, graphite), Si)<br>♦ monatomic (noble gases) |
| **Periodicity**<br>The trends in covalent radius across periods and down groups. | The covalent radius is a measure of the size of an atom. The trends in covalent radius across periods and down groups can be explained in terms of the number of occupied shells, and the nuclear charge. |

| Areas | Exemplification of areas |
|---|---|
| The trends in ionisation energies across periods and down groups.<br><br>The trends in electronegativity across periods and down groups. | The trends in ionisation energies across periods and down groups can be explained in terms of the atomic size, nuclear charge and the screening effect due to inner shell electrons.<br><br>Atoms of different elements have different attractions for bonding electrons. Electronegativity is a measure of the attraction an atom involved in a bond has for the electrons of the bond. Electronegativity values increase across a period and decrease down a group.<br><br>Electronegativity trends can be rationalised in terms of nuclear charge, covalent radius and the presence of 'screening' inner electrons. |
| **Structure and bonding**<br><br>Covalent bonding.<br><br>Polar covalent bonding. | Candidates should be familiar with ionic and covalent bonding.<br><br>In a covalent bond, atoms share pairs of electrons. The covalent bond is a result of two positive nuclei being held together by their common attraction for the shared pair of electrons.<br><br>Polar covalent bonds are formed when the attraction of the atoms for the pair of bonding electrons is different. Delta positive ($\delta^+$) and delta negative ($\delta^-$) notation can be used to indicate the partial charges on atoms, which give rise to a dipole (eg $H^{\delta+}–Cl^{\delta-}$).<br><br>Pure covalent bonding and ionic bonding can be considered as being at opposite ends of a bonding continuum with polar covalent bonding |

| Areas | Exemplification of areas |
|---|---|
| The bonding continuum.<br><br>The larger the difference in electronegativities between bonded atoms, the more polar the bond will be. | lying between these two extremes.<br><br>If the difference is large then the movement of bonding electrons from the element of lower electronegativity to the element of higher electronegativity is complete resulting in the formation of ions. Compounds formed between metals and non-metals are often, but not always ionic.<br><br>Candidates should be familiar with using the physical properties of a compound to deduce the type of bonding and structure in the compound. |
| **Structure and bonding**<br>The evidence for attractive forces between the molecules or discrete atoms.<br><br>Intermolecular forces acting between molecules are known as van | All molecular elements and compounds and monatomic elements condense and freeze at sufficiently low temperatures. For this to occur, some attractive forces must exist between the molecules or discrete atoms.<br><br>There are several different types of van der Waals' forces such as London dispersion forces and permanent dipole-permanent dipole interactions, which include hydrogen bonding. |

| Areas | Exemplification of areas |
|---|---|
| der Waals' forces and there are several different types of these.<br><br>London dispersion forces are forces of attraction that can operate between all atoms and molecules.<br><br>The strength of London dispersion forces is related to the number of electrons within an atom or molecule.<br><br>A molecule is described as polar if it has a permanent dipole.<br><br>Permanent dipole-permanent dipole interactions are additional electrostatic forces of attraction between polar molecules.<br><br>Hydrogen bonding.<br><br>Physical properties can be rationalised in terms of the nature and strength of the intermolecular forces which exist between molecules. | London dispersion forces are forces of attraction that can operate between all atoms and molecules. These forces are much weaker than all other types of bonding. They are formed as a result of electrostatic attraction between temporary dipoles and induced dipoles caused by movement of electrons in atoms and molecules.<br><br>The spatial arrangement of polar covalent bonds can result in a molecule being polar.<br><br>Permanent dipole-permanent dipole interactions are stronger than London dispersion forces for molecules with similar numbers of electrons.<br><br>Bonds consisting of a hydrogen atom bonded to an atom of a strongly electronegative element such as fluorine, oxygen or nitrogen are highly polar. Hydrogen bonds are electrostatic forces of attraction between molecules which contain these highly polar bonds. A hydrogen bond is stronger than other forms of permanent dipole-permanent dipole interaction but weaker than a covalent bond.<br><br>Melting points, boiling points and viscosity can all be rationalised in terms of the nature and strength of the intermolecular forces which exist between molecules. By considering the polarity and number of electrons present in molecules, it is possible to make qualitative predictions of the strength of the intermolecular forces. |

| Areas | Exemplification of areas |
|---|---|
| Solubility of ionic compounds, polar molecules and non-polar molecules. | The melting and boiling points of polar substances are higher than the melting and boiling points of non-polar substances with similar numbers of electrons.<br><br>The anomalous boiling points of ammonia, water and hydrogen fluoride are a result of hydrogen bonding.<br><br>Boiling points, melting points, viscosity and solubility/miscibility in water are properties of substances which are affected by hydrogen bonding.<br><br>Hydrogen bonding between molecules in ice results in an expanded structure which causes the density of ice to be less than that of water at low temperatures.<br><br>Ionic compounds and polar molecular compounds tend to be soluble in polar solvents such as water and insoluble in non-polar solvents. Non-polar molecular substances tend to be soluble in non-polar solvents and insoluble in polar solvents. |

## 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

**Published:** September 2018 (version 2.0)

**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.<br>Unit support notes added.<br>Assessment standard threshold added. | Qualifications Manager | September 2018 |
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