SCQF level 6
Unit Specification

Nature's Chemistry

SCQF: level 6 (6 SCQF credit points)

Unit code: H21J 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 nature's chemistry. Candidates will apply these skills when considering the applications of nature's chemistry 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: esters, fats and oils, proteins, the chemistry of cooking, oxidation of food, soaps detergents and emulsions, fragrances and skincare products. 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 Unit are:

- Esters, fats and oils
- Proteins
- Chemistry of cooking
- Oxidation of food.
- Soaps, detergents and emulsions.
- Fragrances
- Skin care.

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

Assessment Standard	Higher
Planning an experiment	The plan should include: ♦ 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: ♦ make generalisations/predictions ♦ select information ♦ process information including calculations as appropriate ♦ analyse information

Exemplification of assessment is provided in *Unit Assessment Support*.

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 Chemistry in Society 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

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
Esters, fats and oils An ester can be identified from the ester group and by the name containing the '–yl–oate' endings.	At Higher, structural formula may be shortened or full.
Naming esters.	An ester can be named given the names of the parent carboxylic acid and alcohol or from structural formulae.
Structural formulae for esters.	Structural formulae for esters can be drawn given the names of the parent alcohol and carboxylic acid or the names of esters.
Characteristics and uses of esters.	Esters have characteristic smells and are used as flavourings and fragrances. Esters are also used as industrial solvents.
Making esters by condensation reactions.	Esters are formed by the condensation reaction between carboxylic acid and an alcohol. The ester link is formed by the reaction of a hydroxyl group and the carboxyl group. In condensation reactions, the molecules join together with the elimination of a small stable molecule, in this case water.
Hydrolysis of esters.	Esters can be hydrolysed to produce the parent carboxylic acid and parent alcohol. Given the name of an ester or its structural formula, the hydrolysis products can be named and their structural formulae drawn. In a hydrolysis reaction, a molecule reacts with water breaking down into smaller molecules. Fats and oils are esters formed from the condensation of glycerol (propane-1,2,3-triol) and three carboxylic acid molecules. The carboxylic

Areas	Exemplification of areas
Fats and oils are esters formed glycerol and three carboxylic acid molecules.	acids are known as ‘fatty acids’ and are saturated or unsaturated straight-chain carboxylic acids, usually with long chains of carbon atoms. The lower melting points of oils compared to those of fats is related to the higher degree of unsaturation of oil molecules. The low melting points of oils are a result of the effect that the shapes of the molecules have on close packing, hence on the strength of van der Waals’ forces of attraction.
The melting points of fats and oils.	Oils can be converted to fats by hydrogenation, an addition reaction with hydrogen. This reduces the degree of unsaturation which increases the melting point. Candidates should be familiar with addition reactions. Fats and oils are: ♦ a concentrated source of energy ♦ essential for the transport and storage of fat-soluble vitamins in the body
Oils can be converted to fats by hydrogenation.	
The importance of fats and oils.	

Areas	Exemplification of areas
Proteins Proteins are the major structural materials of animal tissue and are also involved in the maintenance and regulation of life processes.	
The formation of proteins from amino acids.	Amino acids, the building blocks from which proteins are formed, are relatively small molecules which all contain an amino group (NH_2), and a carboxyl group (COOH).
The link which forms between two amino acids can be recognised as a peptide link (CONH) also known as an amide link.	Proteins are made of many amino acid molecules linked together by condensation reactions. In these condensation reactions, the amino group on one amino acid and the carboxyl group on a neighbouring amino acid join together, with the elimination of water. Proteins which fulfil different roles in the body are formed by linking differing sequences of amino acids together.
Essential amino acids.	The body cannot make all the amino acids required for body proteins and is dependent on dietary protein for supply of certain amino acids known as essential amino acids.
Enzyme hydrolysis of dietary proteins to produce amino acids.	During digestion, enzyme hydrolysis of dietary proteins can produce amino acids. The structural formulae of amino acids obtained from the hydrolysis of proteins can be identified from the structure of a section of the protein.

Areas	Exemplification of areas
Enzymes are proteins which act as biological catalysts.	
Chemistry of cooking Shapes of protein molecules. Denaturing of proteins. Many flavour and aroma molecules are aldehydes. Aldehydes and ketones both contain the carbonyl functional group. Aldehydes and ketones can be identified from the '-al' and '-one' name endings respectively. Naming and formulae for straight-chain and branched-chain aldehydes and ketones, with no more than eight carbon atoms	Within proteins, the long-chain molecules may be twisted to form spirals, folded into sheets, or wound around to form other complex shapes. The chains are held in these forms by intermolecular bonding between the side chains of the constituent amino acids. When proteins are heated, during cooking, these intermolecular bonds are broken allowing the proteins to change shape (denature).These changes alter the texture of foods. Straight-chain and branched-chain aldehydes and ketones, with no more than eight carbon atoms in their longest chain: ♦ can be named from structural formulae.

Areas	Exemplification of areas
in their longest chain.	♦ structural formulae can be drawn from names ♦ molecular formulae can be written from names
Isomers of straight and branch chain aldehydes and ketones.	Structural formulae and names of isomers of straight and branch chain aldehydes and ketones.
Tests to differentiate between an aldehyde and a ketone.	Aldehydes, but not ketones, can be oxidised to carboxylic acids. Fehling's solution, Tollens' reagent and acidified dichromate solution can be used to differentiate between an aldehyde and a ketone. Positive test results: ♦ Fehling's — blue solution to a brick red precipitate ♦ Tollens' — formation of a silver mirror ♦ acidified dichromate test — colour change from orange to green
Explain the influence of functional groups on physical properties.	In terms of intermolecular forces, explain the influence of functional groups, including hydroxyl, carbonyl and carboxyl, on solubility, boiling points and volatility.
Oxidation of food Naming and formulae for branched-chain alcohols, with no	Branched-chain alcohols, with no more than eight carbon atoms in their

Areas	Exemplification of areas
more than eight carbon atoms in their longest chain. Alcohols can be classified as primary, secondary or tertiary Structural formulae and names of isomeric alcohols Hydrogen bonding can be used to explain the properties of alcohols. Structure and properties of diols and triols. Oxidation of alcohols.	longest chain: ♦ can be named from structural formulae ♦ structural formulae can be drawn from names ♦ molecular formulae can be written from names Draw the structural formula for, and name isomeric alcohols, including primary secondary and tertiary alcohols where appropriate. Hydrogen bonding can be used to explain the properties of alcohols including, boiling points, melting points, viscosity and solubility/miscibility in water. Structures of diols and triols and the effect of hydrogen bonding on properties, including, boiling points, melting points, viscosity and solubility/miscibility in water, of these molecules. In the laboratory, hot copper(II) oxide or acidified dichromate(VI) solutions can be used to oxidise primary and secondary alcohols: ♦ Primary alcohols are oxidised, first to aldehydes and then to carboxylic acids. ♦ Secondary alcohols are oxidised to ketones ♦ Tertiary alcohols cannot be oxidised When applied to carbon compounds, oxidation results in an increase in the

Areas	Exemplification of areas
Naming and formulae for branched-chain carboxylic acids, with no more than eight carbon atoms in their longest chain. Reactions of carboxylic acids. Antioxidants in foods.	oxygen to hydrogen ratio and reduction results in a decrease in the oxygen to hydrogen ratio. Branched-chain carboxylic acids, with no more than eight carbon atoms in their longest chain: ♦ can be named from structural formulae ♦ structural formulae can be drawn from names ♦ molecular formulae can be written from names Reactions of carboxylic acids to include: ♦ reduction in terms of products and effect on the oxygen to hydrogen ratio ♦ reactions with bases to form salts ♦ reaction with alcohols to form esters Oxygen reacts with edible oils giving the food a rancid flavour. Antioxidants are molecules which will prevent these oxidation reactions taking place.

Areas	Exemplification of areas
From an ion-electron equation recognise that a substance is acting as an antioxidant.	
Soaps, detergents and emulsions Production of soaps.	Production of soaps by the alkaline hydrolysis of fats and oils to form water-soluble ionic salts called soaps.
Structure of soap ions.	Soap ions have a long covalent tail, readily soluble in covalent compounds (hydrophobic), and an ionic carboxylate head which is negatively charged and water soluble (hydrophilic).
How soaps work.	During cleaning using soaps the hydrophobic tails dissolve in a droplet of oil or grease, whilst the hydrophilic heads face out into the surrounding water. Agitation of the mixture results in ball-like structure forming with the hydrophobic tails on the inside and the negative hydrophilic head on the outside. Repulsion between these negative charges results in an emulsion being formed and the dirt released. During cleaning using detergents the hydrophobic tails dissolve in a droplet of oil or grease, whilst the hydrophilic heads face out into the surrounding water. Agitation of the mixture results in ball-like structure forming with the hydrophobic tails on the inside and the hydrophilic head on the outside.

Areas	Exemplification of areas
How detergents work. Detergents are particularly useful in hard water areas because they do not form scum. An emulsion contains small droplets of one liquid dispersed in another liquid. Structure and use of emulsifiers	Emulsions in food are mixtures of oil and water. To prevent oil and water components separating into layers, a soap-like molecule known as an emulsifier is added. Emulsifiers for use in food are commonly made by reacting edible oils with glycerol to form molecules in which either one or two fatty acid groups are linked to a glycerol backbone rather than the three normally found in edible oils. The one or two hydroxyl groups present in these molecules are hydrophilic whilst the fatty acid chains are hydrophobic.

Areas	Exemplification of areas
Fragrances Essential oils are concentrated extracts from plants, and are mixtures of organic compounds. Terpenes are key components in most essential oils. Terpenes are unsaturated compounds formed by joining together isoprene (2-methylbuta-1,3-diene) units.	Essential oils are concentrated extracts of the volatile, non-water soluble aroma compounds from plants. They are widely used in perfumes, cosmetic products, cleaning products and as flavourings in foods. Terpenes are components in a wide variety of fruit and floral flavours and aromas. Terpenes can be oxidised within plants to produce some of the compounds responsible for the distinctive aroma of spices.
Skin care The damaging effect of ultraviolet radiation (UV) in sunlight on skin and the action of sun-block. Free radical formation, structure and chain reactions.	Ultraviolet radiation (UV) is a high-energy form of light, present in sunlight. Exposure to UV light can result in molecules gaining sufficient energy for bonds to be broken. This is the process responsible for sunburn and also contributes to aging of the skin. Sun-block products prevent UV light reaching the skin. When UV light breaks bonds, free radicals are formed. Free radicals have unpaired electrons and, as a result, are highly reactive. Free radical chain reactions include the following steps: initiation, propagation and termination. Recognise initiation, propagation and termination steps of a free radical chain reaction. Be able to write equations for these steps given relevant information. Many cosmetic products contain free radical scavengers; molecules which

Areas	Exemplification of areas
Free radical scavengers.	can react with free radicals to form stable molecules and prevent chain reactions. Free radical scavengers are also added to food products and to plastics.

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. Unit support notes added. Assessment standard threshold added.	Qualifications Manager	September 2018