

NATIONAL UNIT SPECIFICATION

Researching Chemistry (Higher)

SCQF level 6: credit, 3 points

Unit Code:

Summary

In this Unit learners will develop the key skills necessary to undertake research in chemistry and demonstrate the relevance of chemical theory to everyday life by exploring the chemistry behind a topical issue. Learners will develop skills associated with collecting and synthesising information from a number of different sources. Equipped with a knowledge of common chemistry apparatus and techniques they will plan and undertake a practical investigation related to the topical issue. Learners will prepare a scientific communication presenting the aim, results and conclusions of their practical investigation. The unit offers opportunities for learners to work in partnership and in teams set within the context of the evaluation of a current scientific issue. This Unit is suitable for learners who are interested in pursuing a career in Chemistry, as well as those whose interest is more general.

Learners who complete this Unit will be able to:

1. Research the Chemistry underlying a topical issue to a given brief.
2. Plan and carry out investigative practical work related to a topical issue in Chemistry
3. Prepare a scientific communication which presents the aim, results and conclusions from a practical investigation related to a topical issue in Chemistry.

This Unit is a mandatory/optional Unit of the Chemistry (Higher) Course and is also available as a free-standing unit. The Unit specification should be read in conjunction with the *Unit Support Pack* and the *National Assessment Resource* which provide advice and guidance on delivery, assessment approaches and development of skills for learning, life and work.

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

- Standard Grade Chemistry with Knowledge and Understanding and Problem Solving at Grades 1 and 2
- or
- the Intermediate 2 Chemistry course at grade “B”
- and
- Standard Grade Mathematics at Grades 1 and 2 or Intermediate 2 Mathematics.

Draft

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STANDARDS

Outcomes and assessment standards

OUTCOME 1

The learner will:

Research the Chemistry underlying a topical issue to a given brief.

The learner can:

1. Obtain and record information from suitable sources relating to a focus question from a given brief.
2. Record the sources of information selected.

OUTCOME 2

The learner will:

Plan and carry out investigative practical work related to a topical issue in Chemistry.

The learner can:

1. Plan an appropriate experimental procedure.
2. Carry out the experimental procedure effectively.

OUTCOME 3

The learner will:

Prepare a scientific communication which presents the aim, results and conclusions from a practical investigation related to a topical issue in Chemistry.

The learner can:

1. Clearly identify the aim of the investigative work.
2. Present and analyse information in an appropriate format.
3. Draw valid conclusions.
4. Make a valid evaluation of procedures.

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Skills and knowledge

The following skills must be covered in this unit:

- Reading skills
- Writing skills
- Information handling skills
- Analysis and evaluation skills
- Communication skills

There is no specified content in this unit and the topic chosen will determine the chemistry knowledge that learners will develop. The scientific communications they produce will allow learners to demonstrate an understanding of the chemistry of the chosen topic.

Evidence requirements for the Unit

Evidence is required to demonstrate that learners have met the requirements of the outcomes. Assessors should use their professional judgement to determine the most appropriate instruments of assessments for generating evidence and the conditions and contexts in which they are used. Exemplification of possible approaches may be found in the Unit Support Pack and the National Assessment Resource.

Outcome 1

Learners will be provided with a briefing document which contains focus questions relating to key points of background information and/or chemical theory likely to be unfamiliar to the learner. Learners must produce:

- A clear and accurate answer to a focus question selected from those contained in the brief.
- A record of at least two sources of information relating to the answer provided. These should be identified in sufficient detail to allow a third party to retrieve the source article.

Outcome 2

Learners will contribute to the planning and carrying out of investigative practical work. An assessor observation checklist will be used to produce evidence for this Outcome.

Outcome 3

Outcome 3 is assessed by a single scientific communication describing the investigative activity and its findings. The scientific communication must be the individual work of the learner. Depending on the activity, the collection of information may involve group work. The scientific communication can take any format in which the results of scientific research are commonly reported including: conference poster format, scientific paper format, PowerPoint presentation, video presentation, web page or traditional lab report.

Assessor observation checklists and written and/or video and/or electronic and/or oral evidence may be used to provide evidence that: the aim of the investigative work is clearly identified; information is analysed and presented in an appropriate format; valid conclusions are drawn and procedures are evaluated with respect to the selection of apparatus, the details of experimental method and/or the reliability of results as appropriate.

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OTHER ESSENTIAL INFORMATION

The following information must be read in conjunction with the standards in the Unit specification.

Development of skills for learning, life and work

It is expected that learners will also develop the following skills for learning, life and work through this Unit:

- Literacy skills
- Numeracy skills
- Employability, enterprise and citizenship skills
- Thinking skills

Equality and equity

This Unit Specification is intended to ensure that there are no artificial barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative evidence. For further information please refer to the *Unit Support Pack*.

Unit Support Pack

Further information and guidance relating to this Unit is provided in the Unit Support Pack and the National Assessment Resource.

Changes from previous version

No changes- first draft

UNIT SUPPORT PACK

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Unit Code:

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this Unit is at the discretion of the centre, the notional design length is 20 hours.

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

In this Unit learners will develop the key skills necessary to undertake research in chemistry and demonstrate the relevance of chemical theory to everyday life by exploring the chemistry behind a topical issue. Learners will develop skills associated with collecting and synthesising information from a number of different sources. Equipped with a knowledge of common chemistry apparatus and techniques they will plan and undertake a practical investigation related to the topical issue. Learners will prepare a scientific communication presenting the aim, results and conclusions of their practical investigation. The unit offers opportunities for learners to work in partnership and in teams set within the context of the evaluation of a current scientific issue. This Unit is suitable for learners who are interested in pursuing a career in Chemistry, as well as those whose interest is more general.

National Assessment Resource (NAR) provides exemplar investigation briefs, containing focus questions, to allow centres the opportunity to select a topical issue suited to the available resources and/or the interests of their learners. Centres may wish to develop their own investigation briefs but these must be of a comparable standard.

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Outcome 1

Research briefs should allow learners to investigate the Chemistry underlying an issue or story currently featured in broadcast and publishing media. The research brief should contain a number of “focus questions” relating to key points of background information or chemical theory which are likely to be unfamiliar to learners undertaking the unit. The focus questions should be constructed to give a clear indication of the information required from the learner. The information required to answer the questions must also be readily available using printed resources, video or audio materials available to the learner, or from websites which can be identified by use of a search engine. Learners must not be provided with extracts from any of these sources compiled by a third party. Prior to undertaking the assessment of Outcome 1, teachers/lecturers should ensure that learners have experience of literature based research. In particular, if learners are carrying out web-based research, then they should be familiar with issues of reliability and they should be able to clearly state the source of the information they find.

Outcome 2

In order to be able to make informed choices and decisions during the planning stage of the investigation teachers/lecturers should ensure that learners are familiar with the following practical techniques prior to undertaking the investigation.

- Filtration
- Distillation
- Use of a balance
- Titration
- Methods for the collection of a gas: over water, using a gas syringe
- Safe Methods for heating: Bunsen burners, water baths or heating mantles

Learners should have knowledge of the following pieces of general laboratory apparatus:

- Conical flask
- Beaker
- Measuring cylinder
- Delivery tubes
- Dropper
- Test tubes / Boiling tubes
- Evaporating basin
- Pipette with safety filler
- Burette
- Volumetric flask
- Funnel
- Thermometer

Outcome 3

In order to be able to evaluate their procedures, and to arrive at valid conclusions, learners should have experience of the following techniques and concepts:

- Representing experimental data using a scatter graph.
- Sketching lines or curves of best fit.
- Calculation of averages (means) for experiments.
- Identification and elimination of “rogue” points from the analysis of results.
- **Qualitative** appreciation of the relative accuracy of apparatus used to measure the volume of liquids. Learners would be expected to know that the volume markings on beakers only provide a very rough indication of volume. While measuring cylinders generally provide sufficient accuracy for preparative work, analytic work will normally require the use of burettes, pipettes and volumetric flasks.
- When a measurement has been repeated, learners should appreciate that any variations in the value obtained give an indication of the reproducibility of the technique.
- The uncertainty associated with a measurement can be indicated in the form, *measurement \pm uncertainty*. Learners are not expected to conduct any form of quantitative error analysis.

Teachers/lecturers should note that the external examination for this Course contains questions requiring learners to demonstrate their ability to design and evaluate experimental procedures in addition to questions which test a learner’s ability to interpret experimental data. The bullet points for Outcomes 2 and 3 listed give a clear indication of the likely contexts and data analysis techniques learners may be expected to employ.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The Researching Chemistry unit (20 hours) develops and assesses key Chemistry skills identified by Higher Education and Industry. It is intended that the majority of this time be spent in teaching activities which development of the skills necessary to conduct investigative work in Chemistry. In addition to ensuring that learners are suitably prepared to conduct simple background research using the internet the learners should also have the opportunity to become familiar with the apparatus, practical techniques and data analysis strategies indicated below.

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Learners should be familiar with the following apparatus

- Conical flask
- Beaker
- Measuring cylinder
- Delivery tubes
- Dropper
- Test tubes / Boiling tubes
- Evaporating basin
- Pipette with safety filler
- Burette
- Volumetric flask
- Funnel
- Thermometer

Learners should be familiar with the following techniques

- Filtration
- Distillation
- Use of a balance
- Titration
- Methods for the collection of a gas: over water, using a gas syringe
- Safe Methods for heating: Bunsen burners, water baths or heating mantles

Learners should be able to process experimental results by

- Representing experimental data using a scatter graph.
- Sketching lines or curves of best fit.
- Calculation of averages (means) for experiments.
- Identification and elimination of “rogue” points from the analysis of results.
- Qualitative appreciation of the relative accuracy of apparatus used to measure the volume of liquids. Learners would be expected to know that the volume markings on beakers provide only a rough indication of volume. While measuring cylinders generally provide sufficient accuracy for preparative work, for analytic work, burettes, pipettes and volumetric flasks are more appropriate.
- When a measurement has been repeated, learners should appreciate that any variations in the value obtained give an indication of the reproducibility of the technique.
- The uncertainty associated with a measurement can be indicated in the form, *measurement \pm uncertainty*. Candidates are not expected to conduct any form of quantitative error analysis.

Whilst centres are free to deliver this Unit at any point during the Higher Chemistry Course, the “*Possible Contexts and Activities*” associated with the other Units of the Course may be used to provide real-life contexts within which learners can become familiar with all of the practical techniques and apparatus listed above. Many teachers may wish to delay the Unit assessment investigation until the latter stages of the Course in recognition of the considerable exposure to relevant experimental techniques learners may experience whilst undertaking the other Higher Chemistry Units. This unit allows the learners to link and apply different kinds of learning in new situations.

Learners should be encouraged to see risk assessment as a natural part of the planning process for any practical activity. Whilst learners would **not** be expected to produce a full written risk assessment for their investigation themselves, this Unit provides an excellent opportunity to assess risks and take informed decisions regarding the use of appropriate control measures during the planning stage of the practical investigation.

As with all practical investigative work in Science, centres must ensure that appropriate risk assessments have been carried out for all practical activities and must comply with current health and safety legislation and regulation.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcome 1 is assessed by a written and/or oral report of the learner's review findings. The learner's report should be the result their individual research into one of the focus questions contained in the investigation brief.

- The learner's record should contain an extract or summary of information relevant to a focus question provided in the briefing document.
- The learner's record should contain mention of at least two sources of relevant information. The precise format in which these reference sources are to be recorded is not prescribed and any format that would successfully allow the source to be retrieved by a third party is sufficient.

Outcome 2 requires learners to take an active part in planning, designing and carrying out a practical investigation.

If learners are working as part of a group, it is unlikely that they will take an equal or similar role in the investigation. Teachers should exercise professional judgement in deciding if learners have taken an active part in the work.

Outcome 3 requires learners to produce, individually, a scientific communication which presents the results of the practical investigation

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undertaken. The table below is provided to indicate what might be addressed to achieve a specific performance criterion. The relevance of the items will vary according to the research activity being undertaken. The professional judgement of the teacher/lecturer will be important in deciding if a performance criterion has been met for a particular activity.

All the performance criteria given in the left-hand column must be achieved in order to attain outcome 3. The right-hand column gives suggestions which might aid the professional judgement of the assessor.

| Outcome 3 The learner will | Suggestions to aid professional judgement |
|--|---|
| Clearly identify the aim of the investigative work. | The communication should contain a clear statement of the aim of the research. |
| Present and analyse information in an appropriate format.. | The analysis might include: <ul style="list-style-type: none"> • correctly executed calculations • comparison of values with those in the literature |
| Draw valid conclusions.. | The communication should contain a conclusion which is valid on the basis of the evidence available to the learner. |
| Make a valid evaluation of procedures.. | The evaluation might include: <ul style="list-style-type: none"> • an assessment of the effectiveness of the procedure • suggestions for alternative or modified strategies, further work, predictions or generalisations • an assessment/explanation of the relevance of the results. |

The relevance of the bullet points listed above will vary according to the nature of research undertaken. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to verification) against the performance criteria. It is appropriate to support learners in producing a scientific communication to meet the performance criteria. Re-drafting of the communication after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment. Redrafting and resubmission is only required i.e. the entire scientific communication does not need to be rewritten.

Conditions required to prepare the scientific communication

Teachers and lecturers may wish learners prepare their communications under their direct supervision so that they can provide appropriate advice and support. However, they may feel confident that any redrafting required need not be undertaken under such close supervision as it will be evident in the learners' response that it is his or her unaided work. Under such circumstances it would be acceptable for such redrafting to take place outwith class time.

Learner absence during the unit assessment

At the conclusion of an investigation conducted for unit assessment purposes, it is possible that a learner may fail to have demonstrated attainment in all outcomes and performance criteria. This situation could arise either through absence or by the learner failing to achieve the required standard at the first attempt. Learners need only undertake those part(s) of an investigation required to allow them to demonstrate attainment in accordance with the evidence requirements stated in the unit specification.