Higher National Unit specification

General information

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Unit code: HE3G 34

Superclass: WE

Publication date: June 2016

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to enable learners to understand key aspects of the chemistry and chemical process technology of chemical engineering. This Unit is suitable for learners studying at HNC level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of chemical engineering at HND level or to seek employment in the chemical, oil or allied industries.

Outcomes

On successful completion of the Unit the learner will be able to:

1 Explain oil refinery processes.
2 Describe the synthesis of a range of industrial products.
3 Describe the processes involved in the synthesis of a selected industrial chemical.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Recommended entry to the Unit

Entry is at the discretion of the centre, however it is recommended that learners have prior knowledge of Chemistry at SCQF level 6 or equivalent.

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

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.

Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

Higher National Unit specification: Statement of standards

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Explain oil refinery processes.

Knowledge and/or Skills

- Crude oil stabilisation/distillation
- Catalytic cracking
- Hydrocracking
- Catalytic reforming
- Catalytic alkylation
- Products from refinery processes
- Pollution on receiving environment

Outcome 2

Describe the synthesis of a range of industrial products.

Knowledge and/or Skills

- Synthetic routes of chemical products
- Commercial manufacture of chemical products
- Environmental impact

Outcome 3

Describe the processes involved in the synthesis of a selected industrial chemical.

Knowledge and/or Skills

- The synthetic process to manufacture
- Environmental considerations and hazards
- Health and safety implications of the process
- The commercial value of the synthetic route

Higher National Unit specification: Statement of standards (cont)

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Evidence Requirements for this Unit

Written and/or oral recorded evidence for Outcomes 1 and 2 could be assessed using a holistic closed-book assessment under supervised conditions. Outcomes may also be assessed individually. The assessment will use a sampling approach to the Knowledge and/or Skills as detailed below. It is recommended that the assessment — whether holistically or individually — be completed within 90 minutes. Learners can only have access to non-programmable calculators when sitting the assessment.

Written and/or oral recorded evidence for Outcome 3 should be assessed by production of a report carried out in open-book, unsupervised conditions.

Outcome 1

The assessment will sample four of the seven Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows the learner can:

- explain the processes of crude oil stabilisation including preheating, dehydration, degassing.
- explain the process of atmospheric and vacuum distillation including the major fractions obtained and their uses.
- explain catalytic cracking. The explanation must include two items from: catalyst, reactions, plant description, uses of products.
- explain hydrocracking. The explanation must include two items from: typical reactions, feedstocks, catalysts, plant description, uses of products
- explain catalytic reforming. The explanation must include two items from: typical reactions, catalyst, plant description, uses of products.
- explain catalytic alkylation. The explanation must include two items from: typical reactions, catalyst, plant description, uses of products.
- explain the environmental considerations of the refining processes and products.

Higher National Unit specification: Statement of standards (cont)

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Outcome 2

The assessment will cover all of the Knowledge and/or Skills items.

A learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe the synthesis of two chemical products.
- explain the conditions for the synthesis of the two chemical products described. The explanation must include two items from: operating conditions, feedstocks, product yields.
- explain the effects of pollution on the receiving environment for the two chemical products described.

Outcome 3

The assessment will cover all of the Knowledge and/or Skills items.

A learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe the synthetic process to manufacture an industrial chemical.
- describe the environmental aspects of the chosen synthetic process or product.
- describe the health and safety implications of the chosen synthetic process or product.
- describe the commercial value of the manufacture of the selected chemical.

The chemical should be chosen from a pharmaceutical compound, a speciality chemical (eg inks, biocides, dyestuff, pigments) or an agrochemical.

Higher National Unit Support Notes

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit is intended as part of the framework for HNC/HND Chemical Process Technology and HNC Chemical Engineering but may be suitable for inclusion in other HN Engineering and Science awards. It is designed to enable learners to understand key aspects of the chemistry and chemical process technology of chemical engineering.

Outcome 1 — Explain oil refinery processes

Outcome 1 is intended to give a broad overview of refinery processes. It is envisaged that this would include crude oil stabilisation including pre-heating, dehydration and degassing. It would also include atmospheric and vacuum distillation of oil or oil fractions. Catalytic cracking and hydrocracking should be taught including feedstocks, plant description, typical reactions and operating conditions, typical catalysts used, and uses of final products.

Catalytic reforming and catalytic alkylation should also be taught, including plant descriptions, typical reactions, typical catalysts used, and uses of final products.

The environmental considerations of each of these refinery processes should be taught concurrently with each individual refinery process.

Outcome 2 — Describe the synthesis of a range of industrial products

Outcome 2 is intended to give a broad overview of a selection of industrial processes. Examples of suitable industrial processes include:

- Eethane
- Polyethene
- Ethanol
- Butadiene
- Dyes/pigments

A minimum of two industrial processes must be taught and assessed, although it is envisaged that no more than four processes be studied.

Higher National Unit Support Notes (cont)

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Depending on the particular industrial processes chosen, teaching of each industrial process should include the feedstocks, the plant description, typical reactions, typical catalysts used (where applicable), yields and uses of final products. Environmental considerations of the manufacturing process or product should also be studied.

As an example, this Outcome could be used to describe the synthesis of ethene from a broad range of feedstocks such as ethane, propane, butane and naphtha. The cracking conditions, equipment and typical chemical reactions could be compared for different feedstocks. The importance of residence time, dilution steam and reaction quenching as well as environmental considerations during manufacturing should be covered. Yields and product variations between the different feedstocks should be studied and compared. Finally the typical uses of ethene should be covered, as well as the environmental concerns of the material itself.

Alternatively, the broad conversion of ethane to finished goods such as polyethene could be studied. This would include a study of the synthesis, use of copolymers and additives and extrusion, moulding and finishing techniques. Another example could be the manufacture of dyes/pigments from the raw materials through the various processing stages and material testing to finished products.

Outcome 3 — Describe the processes involved in the synthesis of a selected industrial chemical

Preparation of a clear and concise report based on an industrial chemical.

It is recommended that learners choose their own topic, as this will allow learners to choose an area of particular interest or relevance for them.

The topic chosen should allow the learner to describe the processes involved in the synthesis of a selected industrial chemical. The following should be covered:

- synthetic process to manufacture the industrial chemical
- environmental aspects of the chosen synthetic process or product
- health and safety implications of the chosen synthetic process or product
- commercial value of the manufacture of the industrial chemical

Examples of suitable industrial chemicals include:

- Aspirin/Paracetamol/Brufen
- Ammonium Phosphate
- Potassium Nitrate
- Azo-dyes
- Prescription medications

Please note that this list is not prescriptive. Other industrial chemicals may be chosen by the learner.

Higher National Unit Support Notes

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Care should be taken when selecting an industrial process for study. Information on industrial manufacturing processes and their commercial value can be commercially confidential or sensitive for many companies (particularly for pharmaceutical and speciality chemicals). This information may therefore be difficult to obtain. Learners should be advised to check that this information is readily available on their chosen topic.

During delivery of Outcome 3 learners should be supported when carrying out:

- On-line and/or off-line literature searching
- Authentication and referencing of source materials

Guidance on approaches to delivery of this Unit

It is envisaged that Outcome 1 be taught prior to Outcome 2. However, Outcome 3 may be progressed concurrently with either or both of the other Outcomes.

Outcome 1 is intended to give a broad overview of refinery processes, as an example of a large scale industrial process. The petrochemical industry is used as an example, with the various stages in refining detailed. Delivery could commence with crude oil stabilisation including pre-heating, dehydration and degassing. This could then be followed by a description of atmospheric distillation followed by vacuum distillation including operating conditions, fractions produced and their uses. Catalytic cracking and hydrocracking could be taught next, both of which should include feedstocks, plant description, typical reactions and operating conditions, typical catalysts used, and uses of final products. Catalytic reforming could be taught next, followed by catalytic alkylation. In both cases, learners should learn of the plant description, typical reactions, typical catalysts used, and uses of final products. The environmental considerations of each of these refinery processes should be taught concurrently with each individual refinery process.

Outcome 2 is intended to give a broad overview of a selection of industrial processes. As an example within the petrochemical industry, the synthesis of ethene, polyethene, ethanol and butadiene could be studied. This Outcome could be equally well used to describe the broad conversion of ethane to finished goods such as polyethene, going into detail on the synthesis, use of copolymers and additives and extrusion, moulding and finishing techniques. Another example could be the manufacture of pigments/dyes from the raw materials through the various processing stages and material testing to finished products. Depending on the particular industrial processes chosen, teaching of each industrial process should include the feedstocks, the plant description, typical reactions, typical catalysts used where applicable, yields and uses of final products. Environmental considerations of the manufacturing process or product should also be studied.

Higher National Unit Support Notes (cont)

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Outcome 3 is intended to allow learners to research the processes involved in the synthesis of an industrial chemical. Learners, in discussion with their lecturer, should select the industrial chemical to be researched. Suggested industrial chemicals are given elsewhere in this document. Delivery of Outcome 3 should allow learners to research the synthetic process to manufacture the industrial chemical, the environmental aspects and the health and safety implications of the chosen synthetic process, and the commercial value of the manufacture of the industrial chemical. Learners will be expected to perform this activity independently, on the basis of their individual research.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Outcomes 1 and 2 could be assessed by a single holistic closed-book assessment with an appropriate cut-off score that covers the sampling requirements as detailed in the Evidence Requirements. Outcomes may also be assessed individually.

Assessment should be carried out in supervised conditions. It is recommended that the assessment be completed within 90 minutes when both Outcomes are assessed together, or 45 minutes when assessed separately. Learners can only have access to non-programmable calculators when sitting the assessment. The assessment could be composed of an appropriate balance of short answer, restricted response and structured questions.

Where evidence of Outcome 1 is assessed by sampling, the whole of the content listed in the Knowledge and/or Skills must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed, and different items should be sampled on each assessment occasion. Any items not sampled in the first assessment must be included in the alternative (re-sit) assessment.

Outcome 3 could be assessed though a case study approach. This could be in the form of a report detailing the industrial process involved in the synthesis of the selected industrial chemical. The report should be around 1,500 words or equivalent in length. The report should show a good understanding of the chemistry involved in the manufacture of the chosen material, as well as details of the commercial manufacture of the product. The environmental and health and safety implications must be addressed in some detail, demonstrating an understanding of the wider implications of the chemical processes involved. Finally the learner should have a clear view of their chosen chemical manufacturing route, ideally within a relevant marketplace either locally or globally.

It is recommended that an assessor's checklist is used for Outcome 3 to ensure that all of the Evidence Requirements are covered in learners' reports.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Higher National Unit Support Notes (cont)

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Opportunities for developing Core and other essential skills

The delivery and assessment of this Unit will provide learners with the opportunity to develop the Core Skills of *Numeracy* at SCQF level 6 and *Problem Solving* at SCQF level 6.

History of changes to Unit

Version	Description of change	Date

General information for learners

Unit title: Industrial Chemicals: Processes and Products (SCQF level 7)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This is a 1 credit Unit at SCQF level 7, which you are likely to be studying as part of the first year of an HNC/HND engineering or science programme. The Unit is designed to provide you with an understanding of the key aspects of the chemistry and chemical process technology of chemical engineering. Before progressing to this Unit it would be beneficial to have prior knowledge of Chemistry at SCQF level 6 or equivalent.

On completion of the Unit you should be able to:

1 Explain oil refinery processes.
2 Describe the synthesis of a range of industrial products.
3 Describe the processes involved in the synthesis of a selected industrial chemical.

Assessment

For Outcomes 1 and 2, depending on which centre you attend, assessment may be conducted on an Outcome by Outcome basis or by one single assessment. Assessment will be conducted under closed-book, supervised conditions.

For Outcome 3 you will be assessed by the production of a report based on a selected industrial chemical. Assessment will be conducted under open-book, unsupervised conditions.

Core Skills

Although there is no automatic certification of Core Skills in the Unit, you will have opportunities to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6.