## SQA Advanced Unit Specification

## General information for centres

## Unit title: Aromatic Chemistry

## Unit code: HV9A 48

**Unit purpose:** This Unit is a specialised Unit designed as part of the SQA Advanced Diploma awards in Chemistry and Applied Sciences. Candidates will develop a knowledge of synthetic routes to a wide range of aromatic compounds. By understanding the mechanisms of the reactions, synthetic routes can be planned and compounds prepared.

On completion of the Unit the candidate should be able to:

1 Devise synthetic routes and illustrate mechanisms for the preparation of a range of aromatic compounds.
2 Perform a range of aromatic syntheses.

**Credit points and level:** 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

**Recommended prior knowledge and skills:** Access to this Unit is at the discretion of the centre, but it is preferable for candidates to be able to demonstrate a knowledge of organic Chemistry at SCQF level 7. Where the Unit is delivered as part of an SQA Advanced science Group Award, it is anticipated that candidates will have completed level 7 Units in Fundamental Chemistry: Theory and Practice (HV4H 47) and Fundamental Concepts of Organic Chemistry (HV97 47) prior to commencing this Unit.

**Core skills:** There may be opportunities to gather evidence towards the core skill of Problem Solving and Communication at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

**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.

**Assessment:** Outcome 1 will be assessed using a closed-book, supervised assessment, while Outcome 2 will be assessed using a number of laboratory exercises.

# Unit specification: statement of standards

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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

Devise synthetic routes and illustrate mechanisms for the preparation of a range of aromatic compounds

### Knowledge and/or skills

- Mono-substituted benzene compounds
- Di-substituted compounds
- Multi-ringed compounds
- Heterocyclic compounds
- Mechanisms for preparation

### Evidence requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can pass an end of Unit test, which will be carried out under closed-book, supervised conditions. Structured questions should be used, which allow the candidate to demonstrate an understanding of reaction mechanisms.

The question paper should reflect the range of compounds covered in the course. Candidates should demonstrate a knowledge of aromaticity and the types of reactions found in aromatic chemistry. Reaction mechanisms should be assessed as well as the candidates' knowledge of the effect the aromatic rings have on selected functional groups. Directing properties of groups will also form part of the assessment, as well as the effect of the hetero atom on substitution reactions.

Candidates should be allowed access to a periodic table and a data sheet which shows the directing properties of selected functional groups.

### Assessment guidelines

The assessment will be a closed-book test and could be worth 50 marks, with the marks allocated as follows:

- 8 marks on mono-substituted benzene compounds
- 18 marks on di-substituted compounds
- 8 marks on multi-ringed compounds
- 16 marks on heterocyclic compounds

The pass mark will be 60%.

## Outcome 2

Perform a range of aromatic syntheses

### Knowledge and/or skills

- follow instructions to perform a range of chemical experiments
- work in a safe manner regarding current health and safety regulations
- achieve consistent and accurate results
- report the results clearly and concisely
- achieves satisfactory yields of good quality product
- identify sources of experimental errors and estimate size of errors as appropriate

### Evidence requirements

Candidates should perform a range of synthesis experiments, with a minimum of two used for assessment purposes. The assessment should be based on the ability of the candidate to obtain product of good quality and with an acceptable yield. Parity of product should be deemed to be acceptable based on analysis of product based on standard techniques. The yield obtained should be acceptable under experimental conditions. The candidate must also produce one report, which demonstrates the candidate's ability to plan and evaluate the laboratory exercise.

### Assessment guidelines

As part of the laboratory work candidates should be introduced to a range of synthetic techniques. Experiments should also cover the range of compounds covered in Outcome 1. It may be that some experiments will be two or three-stage preparations and this should be considered when deciding which experiments to use for assessment. Some form of product analysis should also be involved. This may mean that the practical exercise used here could be integrated with another Unit. For example, analysis of the product may involve Infra Red spectroscopy, allowing integration with the Instrumentation: Theory and Practice Units.

## Administrative information

**Unit code:** HV9A 48

**Unit title:** Aromatic Chemistry

**Superclass category:** RD

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FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

# Unit specification: support notes

## Unit title: Aromatic Chemistry

This part of the Unit specification is offered as guidance. The support notes 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

**Outcome 1**

This Outcome should cover the concept of aromaticity. Candidates should use the Huckel Rule to explain the aromatic nature of benzene, naphthalene, anthracene, phenanthracene, pyridine and five membered heterocyclic compounds such as furan, thiophene and pyrole.

The Unit should also cover the effect of functional groups on an aromatic ring. Any changes in the aromatic nature of the ring and the reactivity of the functional group should be explained.

Electrophilic substitution should be covered in depth. Candidates should know the mechanism and the main reagents required for, halogenation, sulphonation, nitration, alkylation and acylation. These reactions should be covered for the range of aromatic compounds listed above.

The synthetic routes to di-substituted benzene compounds should be covered, with candidates able to discuss the electron withdrawing, and electron donating nature of certain functional groups, and how this can direct the position of the second group.

Other reactions of aromatic compounds should be covered including nucleophilic substitution. The benzyne mechanism should be described and the need for more extreme reaction conditions.

Topics such as the use of blocking groups etc. should be covered as the different synthesis are covered.

Mechanisms — electrophilic substitution, nucleophilic substitution and use of curly arrow convention.

**Outcome 2**

This practical Outcome should give the candidates the opportunity to carry out a number of the syntheses covered in Outcome 1 and to carry out some preliminary analysis of the products they obtain. Many of the possible experiments may well be more than single stage preparations and therefore will have to be carried out over a number of laboratory periods. Possible experiments include:

- preparation of Iodobenzoic acid
- preparation of p-bromoaniline
- preparation of Aspirin

Experiments must not involve compounds deemed to have a significant health and safety risk to candidates.

There is scope to integrate the practical work of this Unit with that from other Units in the SQA Advanced Diploma in Chemistry course. For example the preparation of p-bromoaniline is a three-stage reaction which can be followed using infra-red spectroscopy. This could lead to this experiment being use in the instrumentation Unit as well as this one. Integration with other Units may also be possible, particularly if candidates are covering the Medicinal Chemistry optional Unit.

## Guidance on the delivery and assessment of this Unit

This Unit will require a mixture of delivery methods. Formal classes will be needed to cover the main theory aspects, while extended laboratory time will be required for Outcome 2. Tutorial support could be used to enhance the learning. Self-directed study might well be a good way to cover the range of compounds suggested in the support notes.

Assessment for Outcome 1 will be by an end of Unit test, it is recommended that the assessment is worth 50 marks, with a pass mark of 30(60%). The suggested format for the paper is given under the evidence requirements. Lecturers should ensure that the question paper covers the range of topics given in the support notes. There is plenty of scope within the suggested content to allow a large number of different question papers to be prepared. While the weighting of the marks should remain as stated, the actual topics covered can vary from paper to paper.

Outcome 2 is assessed in the laboratory, and via lab reports. The evidence requirements are that one laboratory report is required. It may be that a particular experiment, such as the preparation p-bromoaniline, which is a three-stage process could be seen as separate experiments.

A laboratory diary or pro forma will be kept and learners should be introduced to Standard Operating Procedures (SOPs). Laboratory reports should be in an appropriate format. Health and Safety, in regard to risk and COSHH assessments should be emphasised at all times.

## Open learning

While Outcome 1 could be covered via distance learning, it is harder to see how this would be possible for Outcome 2. If a candidate was employed in a laboratory position, then it may be possible for the experimental work to be carried out away from college. Steps would have to be taken to ensure that the work could be verified as that of the candidate. A blended learning approach may be possible, with candidates only attending college for the laboratory work.

## 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.

# General information for candidates

## Unit title: Aromatic Chemistry

This Unit is designed as a specialist Unit, which will be delivered in the second year of the SQA Advanced Diploma Chemistry or SQA Advanced Diploma in Applied Science courses. It is unlikely to be delivered as a stand-alone Unit, although some colleges may see some merit in having it as an option in other science based SQA Advanced Diploma courses.

On completion of this Unit you should be able to:

- devise synthetic routes to a wide range of aromatic compounds, including mono and di-substituted benzene derivatives, multi-ringed systems and heterocyclic derivatives
- use a wide range of synthetic techniques to produce a range of aromatic compounds

The main components of the Unit are described in more detail below:

**Outcome 1**

In this Outcome you will define the meaning of the term 'aromaticity' and how various compounds can be described as aromatic. You will discuss the effect on a range of functional groups when they are attached to an aromatic compound. Electrophilic substitution reactions will be covered in depth, as will the directing nature of various functional groups. Finally other reactions of aromatic compounds will be covered, such as nucleophilic substitution.

**Outcome 2**

In this Outcome you will be encouraged to develop a range of synthetic techniques, such as reflux, solvent extraction, distillation and recrystallisation etc. You will use these techniques to prepare a number of aromatic compounds, before analysing the product you produced. It may be that the college will use the experiments in conjunction with other Units in your course.

**Assessment**

Outcome 1 will be covered using a closed-book end of Unit test. The paper could be worth 50 marks, with a pass mark of 30 (60%).

Outcome 2 will be assessed on the basis of your performance in the laboratory, and on the laboratory report you produce. A minimum of two practical exercises will be given along with one laboratory report.