

Higher National Unit Specification

General information for centres

Unit title: Main Group Inorganic Chemistry

Unit code: DV9F 35

Unit purpose: This Unit is a specialised Unit designed to be part of the HND Applied Chemistry award. It may also be suitable for inclusion in the HND Applied Sciences course. Candidates will study a more advanced bonding theory, be introduced to ionic structures and learn more about the chemistry of specific groups within the periodic table.

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

- 1 Explain the properties of a range of compounds in terms of relevant bonding theories.
- 2 Describe the trends in chemical behaviour for different elements within the periodic table.
- 3 Perform experiments which demonstrate the behaviour of certain elements.

Credit points and level: 1 HN 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 Access 1 to Doctorates.*

Recommended prior knowledge and skills: Access to this Unit is at the discretion of centres, but it would be a distinct advantage if candidates had prior knowledge of inorganic chemistry. A pass in Unit *Fundamental concepts in Inorganic Chemistry (DP2N 34)* or its equivalent is recommended.

Core Skills: There are opportunities to develop the Core Skill of Problem Solving at Higher level 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: Assessment for this Unit will be on an Outcome by Outcome basis. Outcome 1 will be assessed using a closed-book assessment. Outcome 2 will require completion of an extended answer paper which candidates see in advance, while Outcome 3 will be assessed using a series of laboratory exercises.

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

Higher National Unit specification: statement of standards

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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

Explain the properties of a range of compounds in terms of relevant bonding theories

Knowledge and/or skills

- ◆ Molecular orbital theory of diatomic molecules
- ◆ Bond length, bond strength, magnetic properties
- ◆ Structures of ionic compounds
- ◆ Lattice enthalpy related to properties of ionic substances

Evidence Requirements

Candidates will need to provide evidence to demonstrate their understanding of all the knowledge and/or skills by showing that they can pass an end of Outcome test, which will be sat under closed-book conditions.

Structured questions should be used, which allow the candidates to demonstrate that:

- ◆ they can explain the properties of diatomic molecules using molecular orbital theory
- ◆ they can relate the properties of ionic compounds to their ionic structure

Assessment guidelines

The question paper should test the candidates knowledge of molecular orbital theory. As well as being able to produce molecular orbital energy level diagrams, candidates should be given the opportunity to demonstrate an understanding of the principal's behind the theory. For the section on ionic lattices the paper should require the candidates to show that they understand the concepts of close-packing and how it applies to ionic lattices. Consideration of the energy involved in lattices should be used to explain some of the properties of ionic substances. A mark of 60% for the assessment would demonstrate competence in all the knowledge and skills.

Higher National Unit specification: statement of standards (cont)

Unit title: Main Group Inorganic Chemistry

Outcome 2

Describe the trends in chemical behaviour for different elements within the periodic table

Knowledge and/or skills

- ◆ Chemical and physical properties across a period
- ◆ Detailed chemistry of selected groups in the table
- ◆ Unique properties associated with the first and last element in a group

Evidence Requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can: produce answers to extended response questions covering the topics in this Outcome. The assignment should take the form of a series of questions given to the candidates one week prior to the assessment. Candidates will have the opportunity to prepare their answers before being presented with the paper under supervised conditions. Candidates will answer the questions as if it were a normal closed-book exam.

The question paper should test:

- ◆ the candidates knowledge of variations across a period
- ◆ the detailed chemistry of elements within a group
- ◆ The reasons why specific elements within a group show unexpected properties

The questions set must cover all the knowledge and skills. Given the wide range of topics covered in this Unit there is scope to offer a re-assessment which is significantly different from the first paper.

Assessment guidelines

The range of topics covered in this Outcome are very difficult to assess using a traditional closed-book exam. By allowing the candidates to prepare for the assessment in this way, more searching questions can be set. It is envisaged that the question paper should contain no more than five questions, with each question requiring an answer of no more than 150 words. Candidates should be expected to describe the chemical behaviour and explain why such behaviour is observed. By using this method of assessment candidates will have the opportunity to do their own research when preparing their answers. By having the final answers under closed-book conditions, it will be certain that the work is the candidates own. Some of the questions should require detailed chemistry of selected elements to be discussed. With candidates having the opportunity to prepare answers, a greater level of performance should be expected, with a pass mark of 75% required to demonstrate competence across all the knowledge and skills.

Higher National Unit specification: statement of standards (cont)

Unit title: Main Group Inorganic Chemistry

Outcome 3

Perform experiments, which demonstrate the behaviour of certain elements

Knowledge and/or skills

- ◆ Follow instructions to perform a range of chemical experiments
- ◆ Work in a safe manner regarding current health and safety regulations
- ◆ Consistent and accurate results
- ◆ clear and concise results
- ◆ identify sources of experimental errors and estimate size of errors

Evidence Requirements

The candidates should perform at least two experiments, which examine the behaviour of certain elements. Only one of these experiments should be used for assessment purposes. The assessment should be based on the candidates' ability to carry out accurate experimental work and on their ability to report the work accurately and to discuss the relationship between the results and the chemistry of the element being studied. Some suggested practicals are given in the support notes.

Assessment guidelines

Outcome 1 does not lend itself to much practical work, although some sessions using models or computer programmes may be appropriate, particularly for the ionic structures. Outcome 2 on the other hand can be illustrated using a number of laboratory exercises. Some of these are suggested in the support notes. It is proposed that a more advanced redox titration is used for assessment purposes. The candidates could be working out the stoichiometry of a particular reaction, or studying the different oxidation states formed by a particular element. If accurate volumetric work is being assessed, candidates should be judged on the accuracy of their results as well as their ability to produce a laboratory report.

Administrative Information

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Higher National Unit specification: support notes

Unit title: Main Group Inorganic 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 Unit should cover the various bonding models, valence bond theory etc. before focussing on molecular orbital theory. Only the period 2 diatomic molecules should be covered, but this should include both homo and heteronuclear systems. Molecular orbital energy level diagrams should be covered and candidates shown how they can be used to explain various properties of the compounds. The effect on bond length, bond strength and magnetic behaviour when an electron is removed or added should also be discussed.

Solid state structures should be introduced starting with metallic structures, explaining cubic and hexagonal close packing and body centred cubic. The presence of octahedral and tetrahedral gap sites should be described. This work should be extended to ionic lattices, with a discussion of radius ratio and its relationship to coordination number. Specific lattices should be described, starting with the 1:1 systems caesium chloride, rocksalt, nickel arsenide, zincblende and wurtzite. 2:1 lattices could also be covered such as rutile cadmium iodide and fluorite.

The energy involved in forming ionic lattices should be covered. A revision of Born-Haber cycles should be followed by looking in more detail at lattice enthalpy. The Born-Landé equations should be covered as well as a discussion of the key terms in the expression and how they might influence the properties of the substance.

Outcome 2

Horizontal and vertical trends in the periodic table should be covered in some detail. Candidates should be introduced to looking at the specific chemistry of period 3 compounds looking at the differences in the chemistry of the oxides, halides and the hydrides. Trends across other periods could also be studied. It should be emphasised that this information gives us an insight to the nature of the elements themselves.

The chemistry of specific groups should be covered. At least 2 different groups should be looked at, but the choice of which is at the discretion of the lecturer. The topics covered should definitely include looking at the unique nature of the first element in any group and also the anomalous behaviour of the heaviest element. Candidates need to be able to explain the inert pair effect. Candidates should use oxidation state diagrams to explain the chemistry of specific elements.

Higher National Unit specification: support notes (cont)

Unit title: Main Group Inorganic Chemistry

Outcome 3

While a number of qualitative experiments can be carried out to demonstrate the chemistry of various elements, there are also some quantitative experiments, which can be used to study the various oxidation states shown by elements. In particular, redox titrations can be used to study the halogens and/or nitrogen. This would allow the use of oxidation state diagrams etc. when the candidates explain their results.

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 3. Tutorial support could be used to enhance the learning. Self directed study might well be a good way to cover some of the topics in Outcome 2.

Assessment for Outcome 1 could be by a closed-book test. 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 scope within the suggested content to allow a large number of different question papers to be prepared.

Outcome 2 has a different form of assessment with candidates asked to prepare answers for questions before producing them under closed-book conditions. This approach is being suggested to allow a more in depth assessment of the candidates' knowledge, while minimising the risk of plagiarism. The questions should stretch the candidates and the higher pass mark is in recognition that the questions are known prior to the assessment.

Opportunities for developing Core Skills

There are opportunities to develop the Core Skill of Problem Solving at Higher level in this Unit. This is mainly demonstrated in Outcome 3 through the use of practical laboratory experiments.

Open learning

While Outcomes 1 and 2 could be covered via distance learning, it is harder to see how this would be possible for Outcome 3. 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.

Candidates with disabilities and/or additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Alternative Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs*, which is available on SQA's website: www.sqa.org.uk.

General information for candidates

Unit title: Main Group Inorganic Chemistry

This Unit is designed as a specialist Unit, which will be delivered in the second year of the HND Chemistry or HND 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 HND courses.

On completion of this Unit you should be able to:

Explain the properties of a range of compounds in terms of relevant bonding theories, including small gas phase molecules and some ionic lattices.

Discuss the trends in chemical behaviour for different elements within the periodic table, looking at changes across a period and within specific groups.

Perform experiments, which demonstrate the behaviour of certain elements.

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

Outcome 1

In this Outcome you will be introduced to Molecular Orbital Theory, which is used to explain bonding in mainly covalent systems. In this Unit only the diatomic molecules of period 2 will be covered, but this will provide you with the foundation if you proceed to degree level chemistry. In the second part of this Outcome you will be introduced to solid state structures, firstly for metals then looking at some basic ionic lattices. You will also look at lattice enthalpy and how it is a large energy term which can influence the chemistry of ionic salts.

Outcome 2

In this Outcome some general chemistry of the main group elements will be covered. Trend in chemical behaviour will be looked at for the oxides, halide and hydrides of period 3, before some specific groups will be studied. In particular you will learn to use oxidation state diagrams to help predict the chemistry of a particular element, as well as looking at the unique chemistry shown by both the lightest and heaviest element in any group.

Outcome 3

In this Outcome you will be encouraged to carry out some experiments to demonstrate some of the theory work you have been doing. This may well involve some redox chemistry to demonstrate the oxidation state diagrams you have looked at.

Assessment

Three pieces of work will be required to pass this Unit. Outcome 1 will be assessed using a single test. In Outcome 2 you will be given advanced notice of a question paper you will be expected to answer under closed-book conditions. You will have one week to prepare your answers, before being presented with the paper under exam conditions. For Outcome 3 you will be required to perform well in the laboratory exercises and to produce a full laboratory report on one of the practicals you completed.