GCE

# Chemistry A

Advanced GCE **A2 H434**

Advanced Subsidiary GCE **AS H034**

# Report on the Units

# January 2009

**H034/H434/MS/R/09J**

Oxford Cambridge and RSA Examinations

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# Chief Examiner's report

**General Comments**

This session saw the first assessed unit (F321 – Atoms, Bonds and Groups) for OCR's revised Chemistry A specification.

The remaining AS units, F322 and F323, will be assessed for the first time in June 2009. A single theory unit, F322 (Chains, Energy and Resources), replaces two legacy shorter units (2812, Chains and Rings and 2813/01, How Far? How Fast?). F323 is a free-standing AS practical unit, assessing practical skills via Tasks taken under controlled conditions. This unit replaces both the legacy practical coursework (2813/02) and practical examination (2813/03). Initial feedback from centres using the Tasks has been very favourable. The Tasks are only available via OCR's secure Interchange site (see www.ocr.org.uk/interchange/). In addition, an e-mail update system enables centres to be updated of any changes. It is recommended that centres check Interchange before using a Task for assessment to ensure that no modifications have been posted; for this reason centres are strongly encouraged to subscribe for e-mail updates (To be notified by e-mail when changes are made to **GCE Subject** pages please e-mail GCEsciencetasks@ocr.org.uk including your centre number, centre name, a contact name and the subject line **GCE Chemistry A**). Additional information on the Practical Skills Assessment model can be found in the subject specific Practical Skills Handbook at www.ocr.org.uk/qualifications/asa_levelgceforfirstteachingin2008/chemistry_a/documents.html

# Principal Examiner's report

# F321 Atoms, Bond and Groups

**General Comments**

The high number of entries for this module would suggest that many new centres have decided to follow the OCR Chemistry A specification.

It is felt by OCR that the progress of students within Chemistry should be a gradual and steady increase of demand upon their skills as the individual develops, and AS chemistry is regarded as a natural progression from science at GCSE level.

The first unit of the new specification, F321 (Atoms, Bonds and Groups), was intended as a direct and equivalent replacement for the legacy unit 2811 (Foundation Chemistry). In order to show fairness to students, OCR has ensured comparability in demand between the old and the new styles of question paper.

The vast majority of the cohort had prepared well and responses indicated that the level of ability of the cohort was similar to previous years. Questions which have received a good airing in the past produced good responses. These include **5(d)**, about trends in reactivity down a group, and **4b**, about periodic trends in atomic radius.

However, as is always the case with the introduction of a new specification, some of the newly introduced material was less familiar to candidates. For example, Question **2(c)ii**, the explanation of the term *salt*, assessed one of the new sections of the specification, ***1.1.3 Acids***, yet was recognised by only a small minority of candidates. Question **3(b)ii** assessed part of ***1.3.3 Group 7***, where candidates are asked to contrast the benefits of using chlorine in water treatment with associated risks. This question did not elicit the response which the specification would have suggested.

A number of candidates omitted parts of the last question so time may have been a problem for some but there was an indication of poor planning/examination technique. Candidates are well advised not to spend an excessive amount of time on any particular part of the paper.

**Comments on Individual Questions**

**Question 1**

(a) (i) Almost every candidate took full advantage of this request for a straightforward definition and picked up this first mark. Only the very weakest candidates failed to score here, usually by muddling protons and neutrons in their statement.

Another reason for failing to score here was omitting to clarify that isotopes are atoms of the same element.

(ii) Again the majority of candidates gained this mark but for many it was not trivial and the answers, although worthy of credit, were not perhaps as secure as they might have been. Many included the irrelevant (in this case) comment that the same number of protons as well as the same number of electrons are responsible for identical chemical properties. Some students focussed solely on the ineffectual properties of a neutron in their answer and so were not awarded the mark.

(iii) This part was well answered though a large proportion of the candidates did not make a distinction between relative isotopic mass and relative atomic mass. Consequently, many answers contained reference to the average or weighted mass of the atoms. This suggests that for many this stock answer has simply been learnt verbatim with little understanding. One also wonders how much is understood when a candidate quotes;

$$\frac{\text{mass of an isotope}}{\text{1/12th mass of 12C}}$$

Allocating atoms of $^{12}C$ a mass of 12 g was occasionally seen on some scripts.

Candidates need to be aware that the word relative applies to a comparison between atoms of elements and atoms of $^{12}C$.

(b) This question was one not really seen before in the legacy 2811 Foundation Chemistry unit and there was some evidence of candidates not reading the question carefully before responding.

The first bullet point was frequently not addressed. The specification uses graphite as one of its examples of a giant covalent lattice structure. The remaining marks (for explaining the properties of graphite) were more readily scored. Almost all referred to the layered nature and realised that mobile electrons were the reason for electrical conductivity. Few were able to relate the weakness of the interlayer bonding to softness, but most were able to secure this low level mark by stating that layers could easily slide over one another. The hardest mark related to the high melting point of graphite to strong covalent bonds within each layer that required considerable energy to break.

It is also noteworthy how many candidates gave impressively complete answers here, often explaining the properties clearly and in detail.

(c) (i) It was pleasing to see that the majority of candidates knew how to approach this question and many gave a fully correct answer. Some lost marks by forgetting to round their answer appropriately while a few made the mistake of taking the relative atomic mass of lead in place of carbon.

(ii) Candidates found this final part of the first question really rather challenging. Although available on the *Data Sheet*, a significant number of candidates failed to use the correct value for the Avogadro constant. Others divided their answer to **(c)i** by $N_A$ rather than multiplying. Candidates should be reminded to assess whether such a calculated answer is reasonable.

**Question 2**

(a) (i) It was pleasing to see that virtually every candidate knew that a covalent bond is associated with the sharing of electrons. Where a candidate did not collect the mark it was because they had failed to indicate that a pair of electrons is involved.

(ii) This was very well answered with the majority of diagrams being drawn extremely clearly.

(iii) A few students were unable to name the shape of the ammonia molecule correctly. The most common error was being misled by the arrangement of the electron pairs into suggesting it was tetrahedral in shape, but the occasional trigonal planar was seen. The explanation of the shape was much less well answered. Although some candidates did move towards suggesting that the lone pair repelled the bonding electrons more than they repelled each other, often the answers were very hurried and stopped short of gaining the mark. It was also common to see responses that the shape depended upon the lone pair repelling atoms. Relatively few candidates attempted to identify the key point of the number of bonding and lone pairs present around the nitrogen atom in the ammonia molecule. Candidates need to explain their answers clearly and in detail as in many cases the candidates probably knew the information they needed to gain these marks but did not express themselves in sufficient detail.

(b) (i) This was well answered. The number of students who gave the electron configuration of the chlorine atom was pleasingly small.

(ii) The majority of candidates were awarded this mark. If candidates did drop the mark it was because they used a dot and a cross for the dative covalent bond. It was slightly disappointing to see that few candidates used brackets and a positive sign when drawing their diagrams. Although these were not needed for the mark it would be better to draw the diagram in this manner.

(iii) This was well answered with many candidates correctly showing both the name of the shape and the bond angle.

(iv) Rather stubbornly, responses to this and similar questions have shown little improvement upon those seen in legacy 2811 papers. Candidates need to ensure they state that particles can move, and indeed which particles can move. The often seen phrase ‘particles are free’ does not necessarily describe mobility. Also it would be expected that the correct charge carrier is identified.

It is still all too common to find candidates attributing the conduction in ionic solutions to the movement of electrons. ‘No delocalised electrons’ (without further qualification) does not really portray why solid ionic compounds do not conduct electricity. Instead it suggests that candidates are simply stating that ammonium chloride is not a metal.

(c) (i) Candidates found this equation challenging. Many confused ammonia with ammonium despite the formula for both of these species being given in the question. Equations were then often balanced by producing hydrogen gas as one of the products. Other candidates gave equations which produced water as a product presumably since they expected water as the product of a neutralisation reaction. Attempts at ionic equations were not given credit here.

(ii) Very few candidates were able to explain the meaning of the term *salt*. It was designed to be a straightforward recall type response similar to that seen in the specification. Many attempted their own definitions either based on the idea that salts contain ions or on the fact that a salt is the product of a reaction between an acid and a base.

(iii) A pleasing number of candidates gave the stock definition for a base being a proton acceptor. A few stated that it was a base because it reacted with an acid.

(iv) Surprisingly, a significant number of candidates failed to gain this mark. This was either because of errors involving the brackets in the formula or because they used whole number values for the relative atomic mass of the elements. Sulfur was frequently seen as 32. Candidates need to be reminded that they are expected to use the relative atomic mass values provided on the *Data Sheet*. Candidates were asked to provide an answer to one decimal place and this was designed to alert them to use the *Data Sheet*.

**Question 3**

(a) (i) This was well answered by many, but weaker candidates missed the mark through either omission of the colour or the fact that a precipitate would be seen.

(ii) As is usually the case, students really struggle with these ionic equations and it was rare to award both marks for this part. It appeared as if the ability to answer this common question was somewhat diminished from earlier years. Many candidates could give the correct ionic equation for the first marking point but relatively few achieved both marks by including the correct state symbols, the common error being AgCl(aq). Rather alarmingly, this suggests that many candidates may not understand the meaning of precipitate.

(iii) The vast majority of candidates were able to recall that the silver chloride precipitate would dissolve [some without making reference to appearance of a solid in part **(i)**].

(b) (i) This was well answered with most candidates stating that chlorine would kill bacteria in the water.

(ii) Candidates found this part of the question more challenging and some struggled to come up with a sensible suggestion. The most common credited response referred to the toxicity of chlorine.

(c) (i) This type of question has become more and more accessible to candidates. Oxidation numbers and associated redox processes used to be mainly in the realm of A2 chemistry, but over the years it has become apparent that greater numbers of AS students can readily cope with this concept. As the equation directly related to a stated learning outcome from the specification it was felt that all three oxidation numbers should be required for the mark. The question was very well answered and it was rare for a candidate not to give all three oxidation numbers correctly.

(ii) Here most candidates knew that disproportionation involved the simultaneous increase and decrease of an element's oxidation number but few made clear which change was the oxidation and which was the reduction, and so only gained one of the two possible marks.

(iii) Candidates struggled here although this is a learning outcome in the specification. It was disappointing to see a large number of students trying to use $Na(OH)_2$ in equations (the newly introduced topic of ***1.1.3: Acids*** asks that candidates should be able to state the formulae of common sodium hydroxide). Many other incorrect responses involved reacting chlorine with sodium hydroxide in a 1:1 stoichiometric ratio to form NaCl and HOCl. Others added water as a product clearly remembering that this was part of the correct equation.

(d) (i) Although some candidates did put forward a correct equation many fell into the trap of suggesting that monatomic Cl was one of the products. Others omitted to balance their equations.

(ii) This was very well answered. Many candidates worked clearly and carefully through the calculation and obtained the correct answer of $HClO_3$. Errors often arose from a disorganised approach and mixing up the values given. Where an orderly approach had been used, those who had made a slip scored one mark by having their error carried forward. As ever, candidates are advised to show full working. Only very weak candidates failed to score at all in this part.

(iii) This question wrong-footed many candidates. Some suggested that the number was associated with the number of outer shell electrons on the chlorine, presumably being misled by the fact that this is the case for most of main group metals. Where knowledge of oxidation numbers was known, many failed to specify that (V) referred to the oxidation state of chlorine within the ion.

**Question 4**

(a) (i) This proved to be the most challenging question on the paper by some margin. Many candidates did not mention metallic bonding but proceeded to give an explanation about the change in ionisation energy on going from sodium to magnesium and then linked this to the melting point. It is clear that the connection between melting point and strength of metallic bonding is a very difficult concept for many candidates. For those who were in the right area with their responses, hardly any identified the greater charge on magnesium ion and hence the greater attraction between ions and delocalised electrons.

Weaker candidates resorted to various inter-particle attractions ranging from van der Waals' forces to ionic bonding. Rather disappointingly, many chose to leave this question blank.

(ii) There were many good attempts to this question but there was clear confusion over the breaking of covalent bonds being responsible for the difference in melting points. This was more often seen when discussing the melting point of $S_8$ than for $Cl_2$. It was pleasing to see that many weaker candidates scored marks for realising that it was the relative strengths of van der Waals' forces that are responsible for the difference in melting points.

(b) This question was on material familiar to most candidates. It was very well answered by candidates who had prepared for the exam and many gained all three marks.
Less well-prepared candidates scored 2 marks often missing the relevance of similar shielding resulting from the outer electrons being in the same shell. Weaker candidates assumed that as it was the same outer shell involved then the atomic radius would remain constant – a case of not being aware of what the question is asking.

Some confusion exists over the difference between nuclear charge and nuclear attraction. Increasing nuclear attraction on the electrons is the result of increasing nuclear charge.

**Question 5**

(a) The formula of barium oxide was nearly always given correctly. In the case of barium nitride the candidates struggled a little more but there were still many correct answers. There were many attempts to write the formula for the nitrate (usually incorrectly).

(b) This part was similar to questions often seen in legacy 2811 Foundation Chemistry papers. They tend to tax the weaker candidates, often through poor manipulation of calculators rather than poor chemistry. The question was designed to test the candidate's ability to carry out calculations, using the amount of substance in mol; involving mass in part **(ii)**, involving gas volume in part **(ii)** and involving concentration in part **(iii)**.

(i) This was generally well answered. The only common error was to use 137 rather than 137.3 for the relative atomic mass of barium. Once again, the need to use the *Data Sheet* is key.

(ii) Many candidates found this calculation difficult and a wide range of answers were seen. Only a few made a slip with the units and left their answers in $dm^3$. Some candidates omitted this question. The information that one mole of gas molecules occupies 24.0 $dm^3$ at room temperature and pressure is now provided on the *Data Sheet*.

(iii) Here again candidates really struggled. Many divided the number of moles by the volume calculated in answer to part **(ii)**. Others divided by 100 instead of 0.1.

(iv) Most candidates achieved this mark giving pH values in the correct range. Incorrect answers included pH ranges including 7 or, more disappointingly, less than 7.

(c) Many candidates struggled with this question which should have been relatively straightforward. Perhaps some were put off by the fact that so much of the answer was already in the question. Credit was often jeopardised by poor explanation. At times it was difficult to determine whether the response referred to barium or to hydrogen. Many candidates realised that barium had already reacted with oxygen (some also stated nitrogen). Very able candidates were able to explain that the oxide would react with water to form hydroxide not hydrogen. Weaker candidates thought that hydrogen had escaped during the reaction.

(d) This was extremely well answered and many candidates had clearly taken the time to learn the explanation to this trend in reactivity. Weaker candidates scored well on this question but responses were often repetitive. Some candidates interpreted this as describing reactions rather than the trend.

A large proportion of candidates were able to score 4 or 5 marks. Common errors included omission of the word ‘more’ in front of shells/shielding, or ‘less’ for nuclear attraction. Candidates do need to realise description of trends will invariably involve use of the comparative. It was not uncommon to see candidates stating that nuclear charge decreases down a group, once again a case of confusing nuclear charge with nuclear attraction.

# Grade Thresholds

**Advanced GCE Chemistry A (H034)**
**January 2009 Examination Series**

**Unit Threshold Marks**

| Unit | | Maximum Mark | a | b | c | d | e | u |
|---|---|---|---|---|---|---|---|---|
| **F321** | Raw | 60 | 46 | 40 | 34 | 28 | 23 | 0 |
| | UMS | 90 | 72 | 63 | 54 | 45 | 36 | 0 |

**Specification Aggregation Results**

The specification will be aggregated for the first time in June 2009.

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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