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Examiners' Report
June 2018

GCE Chemistry 8CH0 01

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Introduction

This paper allowed students of all abilities to demonstrate what they knew. Many of the questions were accessible for all students whilst some were able to differentiate the knowledge and understanding of the most able. The paper began with a question about bonding and shapes of molecules, part of which was very familiar from GCSE, which appeared to give students some confidence. Subsequent questions were designed to keep most students engaged for the full time of the examination, and there seemed to be no issue with students running out of time with most students attempting the final question. Space did not appear to be an issue with most students able to answer the questions within the space provided.

Question 1 (a)

On this question, a number of students were able to respond with answers which mentioned sharing a pair of electrons, an idea which is common at GCSE level, but must be developed further for AS. To score, students need to recognise that the bond was an attraction between the nucleii of the two atoms bonded together and the shared pair of electrons.

This example clearly shows the refinement of the GCSE ideas required at AS level.

1 This question is about covalent bonds.

(a) State what is meant by the term covalent bond.

(2)

A covalent bond is the strong electrostatic forces of attraction between 2 nuclei and the shared pair of electrons between them.

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Examiner Comments

Clearly stating that the bond is the electrostatic attraction between nucleii and a shared pair of electrons, this example scored 2.

This question extends an idea encountered at GCSE where the bond between non-metal atoms involves the sharing of electrons.

1 This question is about covalent bonds.

(a) State what is meant by the term covalent bond.

(2)

A covalent bond is a shared pair of electrons

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Examiner Comments

At AS, ideas first encountered at GCSE are refined and improved. This student has remembered the basic idea, but has not included any of the refinement of knowledge which is required here. To score two marks, this student needed to mention the nucleii and the attraction between these and the shared pair of electrons, so this scores 0.

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Examiner Tip

A glossary of definitions is a valuable resource for revision. Careful consideration of definitions is important to ensure the key elements are present. A covalent bond requires an attraction between two nucleii and a shared pair of electrons.

Question 1 (b)

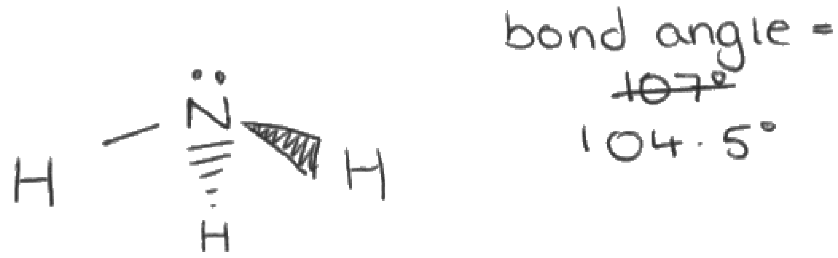
Drawing three dimensional diagrams to show the shape of molecules is an important chemical skill. Three dimensional shapes involve the use of 'dot' or 'hash' bonds and 'wedge' bonds. These show the direction of bonds going behind or in front of the plane of the paper respectively. A normal line shows a bond in the plane of the paper. Many students scored marks for good diagrams, but some simply did dot-and-cross bonding diagrams or diagrams using just lines which limited their ability to score marks.

Drawing 3 dimensional diagrams is an important skill needed to show the shape of molecules. A number of standard bond angles needs to be learnt and applied to both familiar and unfamiliar molecules.

(b) Draw a diagram of the ammonia molecule, clearly showing its shape. Include any lone pairs of electrons and the value of the bond angle.

(2)

NH_3



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Examiner Comments

This student has been taught to use a wedge to show an atom coming out of the plane of the paper toward the reader, and a hatched wedge that suggests the bond is going into the paper away from the reader. This is an excellent diagram and scored 1 mark. The bond angle of 107^0 which was correct has unfortunately been replaced by the incorrect angle of 104.5^O so this scores 1 mark.

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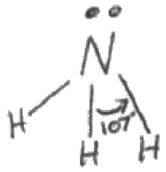
Examiner Tip

Learn the standard bond angles and practice applying them to unfamiliar molecules.

(b) Draw a diagram of the ammonia molecule, clearly showing its shape. Include any lone pairs of electrons and the value of the bond angle.

(2)



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Examiner Comments

This example has the correct bond angle labelled, but there has been no attempt at a 3 dimensional diagram so this scores 1 mark.

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Examiner Tip

Diagrams showing the shape of molecules involve three types of lines to represent the bonds, straight lines, wedges and hatched lines. Drawing diagrams is a difficult skill which comes with practice.

Question 1 (d) (i) - (ii)

In part 1 (d)(i), the question asked for the features of the molecules which allowed them to join via a dative covalent bond. The nitrogen in ammonia has a lone pair of electrons, and the boron in boron trifluoride is electron deficient, with 6 electrons in its outer shell. The nitrogen can therefore donate its' lone pair and hence form a dative bond. This question was well answered by many students. In (d)(ii) many students knew the correct bond angles, but a range of incorrect values were also seen.

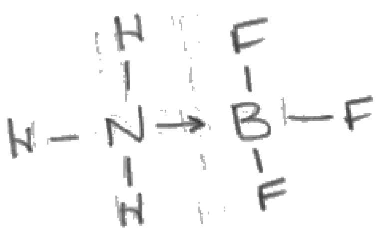
This question was well answered by many students, although some did not include all the necessary detail to achieve full marks. Dative covalent bond formation requires the use of a lone pair of electrons from one atom and a second atom which is able to accept these electrons. Nitrogen has the lone pair here and boron is electron deficient, it is two electrons short of a full outer shell, and so can accept these and share them with the Nitrogen to form the bond.

(d) (i) Ammonia and boron trifluoride react to form a compound NH_3BF_3 which contains a dative covalent bond. Each of the molecules, NH_3 and BF_3, has a different feature of its electronic structure that allows this to happen.
Use these two different features to explain how a dative covalent bond is formed.
(2)

- Ammonia contains a lone pair
- The lone pair is shared with the boron atom
- The ~~pair~~ pair of electrons comes from the same atom.

(ii) During this reaction, the bond angles about the nitrogen atom and the boron atom change.

State the new H—N—H and F—B—F bond angles.
(2)



H-N-H bond is

F-B-F bond

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Examiner Comments

This example recognises the lone pair on Nitrogen of the ammonai molecule but does not address the feature of the boron in boron trifluoride which allows the bond to form. The diagram of the product is correct, but no bond angles have been given so this collects 1 mark in (d)(i) and 0 in (d)(ii).

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Examiner Tip

The previous two parts of the question lead through to this final answer. Read the question carefully to identify what is required. This question asks for the two features of the molecules which allow the bond to form.

(d) (i) Ammonia and boron trifluoride react to form a compound NH_3BF_3 which contains a dative covalent bond. Each of the molecules, NH_3 and BF_3, has a different feature of its electronic structure that allows this to happen.
Use these two different features to explain how a dative covalent bond is formed.

(2)

The boron in BF_3 has an ~~the~~ outer electron shell which is two electrons from being full. ~~It has an empty~~ The N in NH_3 has a lone pair of unbonded electrons. The lone pair on Nitrogen can fill the outer shell of Boron. A dative covalent bond is a covalent bond in which both shared electrons are ~~f donated by or~~ from one atom.

(ii) During this reaction, the bond angles about the nitrogen atom and the boron atom change.

State the new H—N—H and F—B—F bond angles.

(2)

F

N B

F

New H-N-H angles are 109.5°

New F-B-F angles are also 109.5°

ResultsPlus
Examiner Comments

This example clearly shows the two features and both the bond angles and so scores all 4 marks for these two parts.

Question 2 (a) (i) - (ii)

Students scored very well on this question. Most knew the answer to part 2(a)(i) and many were able to state that the number of protons was the same and the number of neutrons different in part (a)(ii).

2 This question is about hydrogen, the element with atomic number $Z = 1$.

(a) (i) Hydrogen has two stable isotopes, ${}^{1}_{1}H$ and ${}^{2}_{1}H$. Complete the table to show the number of subatomic particles present in the nuclei of these two isotopes of hydrogen.

(1)

Isotope	Number of protons	Number of neutrons
${}^{1}_{1}H$	1	0
${}^{2}_{1}H$	1	1

(ii) Use the data in the table to explain the term isotopes.

(2)

The ${}^{2}_{1}H$ atom is an isotope of the ${}^{1}_{1}H$ atom. This means that it has the same atomic number (~~p~~ number of ~~bo~~ protons both being 1) but different atomic mass number (number of neutrons being 0 in ${}^{1}_{1}H$ and 1 in ${}^{2}_{1}H$).

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Examiner Comments

This example has filled in the data correctly in the table, and then used the data in part (a)(ii) to explain the meaning of the term isotope. This is an excellent example scoring 1 mark in part (a)(i) and 2 in part (a)(ii).

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Examiner Tip

An 'Explain' question requires some justification. Remember that an 'Explain' will therefore need explanation or justification, and that if data is given you will usually need to use it in your answer.

Question 2 (b) (i)

Many students had a good try at answering this question, but some answers did not sufficiently explain why the value was bound to be greater than 1.0. The simplest way to answer the question was to suggest that lightest isotopes had an isotopic mass of greater than 1 and so the average value therefore, could not be less than this.

Estimation is an important skill in chemistry. It can be used to make sure answers to calculations are in the correct region and allows students to spot clearly incorrect answers and so rework their calculations. In this question, the idea of both isotopes having a mass greater than one means that the average must be greater than one was the expected answer. Some students did not express themselves with sufficient clarity to score the mark. Others did, but also explained why the answer would be just a little above one. This is a valuable skill, though not worth any marks on this occasion.

(b) The relative atomic mass of hydrogen in the Periodic Table is 1.0.
This is correct to two significant figures.

The table gives data for the relative isotopic mass and natural abundance of the two stable isotopes of hydrogen.

Isotope	Relative isotopic mass	Percentage abundance
$^{1}_{1}H$	1.007825	99.9885
$^{2}_{1}H$	2.014101	0.0115

(i) Using the data in the table, give a reason why it can be estimated that the relative atomic mass of hydrogen is greater than 1.0.

(1)

Both relative isotopic masses are slightly above 1, hence their weighted average must be (at least) slightly above 1 (but due to great abundance of $^{1}_{1}H$ it is 1.0 to 2sf)

ResultsPlus
Examiner Comments

This example mentions both isotopes having an isotopic mass greater than one so scores the mark.

ResultsPlus
Examiner Tip

Practice estimating answers in all calculations. It is a very valuable skill, which may save marks if calculators are used incorrectly.

Question 2 (b) (ii)

Most students were able to correctly calculate the relative atomic mass, but some were confused about 4 decimal places, and quoted the value to 4 significant figures instead.

Significant figures and decimal places have increasing importance in AS and A level chemistry. This calculation was well answered with many able to carry it out, but there was some confusion about giving the answer to 4 decimal places.

(ii) Calculate the relative atomic mass of hydrogen from these data, giving your answer to **four** decimal places.

(2)

$$\frac{(1.007825 \times 99.9885) + (2.014101 \times 0.0115)}{100}$$

$= 1.007940722$

$= 1.0080$

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Examiner Comments

This calculation is perfectly correct except for the final answer which does have 4 decimal places but has been incorrectly rounded. This scored 1.

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Examiner Tip

It is good practice to keep calculations in a calculator until the final answer, which should be rounded either to the number asked for or to the precision of the least precise numbers in the question. Practice makes perfect!

It is quite common to see answers which are close to the correct answer in calculations. This is normally where a mistake has been made in the use of the calculator. Sometimes, as mentioned previously, estimation can be used to spot these, but on other occasions, this is not possible.

(ii) Calculate the relative atomic mass of hydrogen from these data, giving your answer to **four** decimal places.

(2)

$$A_r = \frac{1}{100}\left((1.007825 \times 99.9885) + (2.014101 \times 0.0115)\right)$$

$$= \frac{1}{100}(100.6847\ldots)$$

$$= 1.0069 \text{ (4 d.p.)}$$

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Examiner Comments

In this example, the calculation quoted is perfectly correct, though not laid out in quite the same way as the mark scheme. The answer is not correct, however. We could not see what the mistake was here, but clearly there has been an error in the use of the calculator. As a result this scored 1.

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Examiner Tip

If you have sufficient time, restart calculations from the beginning to check your answers, or, if you can see a different method, use this as a check.

Question 2 (c) (i)

The definition and equation for ionisation energies is a very common question at AS level. This example requires an equation. Many were able to give the correct answer but a significant number were not, more than we had expected. This is probably due to hydrogen being a gaseous element which caused some confusion. Ionisation energy is always removal of electrons from single atoms or ions. In this case, a single hydrogen atom should have been used.

Another common mistake was to use the equation for ionisation in a mass spectrometer.

(c) (i) Write an equation to represent the first ionisation energy of hydrogen.
Include state symbols.

(2)

$H + e^- \rightarrow H^+ + e^-$

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Examiner Comments

This example is very similar to the ionisation in the mass spectrometer, but would require a second electron on the right hand side of the equation. This could have scored one mark without the electron on the left hand side or with the correct state symbols ((g) for both the H and the H^+) but unfortunately scored no marks.

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Examiner Tip

Ionisation energy definitions for both first and subsequent ionisation energies need to be learnt. The equations follow from the definitions if they are learnt properly. This is another example of where a glossary is a valuable tool.

The commonest incorrect response in this question was to write an equation involving the loss of electrons from hydrogen molecules, forgetting that the definition of ionisation energy is the loss of electrons from gaseous atoms, not molecules.

(c) (i) Write an equation to represent the first ionisation energy of hydrogen.
Include state symbols.

(2)

$$H_{2(g)} \longrightarrow 2H^{+}_{(aq)} + 2e^{-}$$

ResultsPlus
Examiner Comments

This example goes from hydrogen gas, which is a familiar diatomic molecule to candidates, to two hydrogen ions, which they most often encounter in aqueous acids. This explains the use here of H_2 and $H^+(aq)$. These were common mistakes and scored no marks.

Question 2 (c) (ii)

Students were able to score well here, though full marks was relatively rare. There are a number of factors which affect the value of ionisation energies, and it is important that students are aware of these and are able to select the most important depending on the comparison being made. They include the distance of the electron from the nucleus, the charge on the nucleus, the number of shielding electrons and the number of electrons in the orbital. This question required students to compare hydrogen with helium and then with lithium.

(ii) The sequence of the first three elements in the Periodic Table is hydrogen, helium and then lithium.

Explain why the first ionisation energy of hydrogen is less than that of helium, but greater than that of lithium.

(4)

Helium has two protons whereas hydrogen has ~~1~~ one, and so the nuclear charge of helium is much greater than that of hydrogen. This means there is greater attraction between the nucleus and valence electron, and so more energy is required to remove the electron in helium than hydrogen, so hydrogens first ionisation energy is lower. Lithium also has a greater nuclear charge however the effect is overridden, because the valence electron is from a new shell. This means the electron is further away from the nucleus, and there is electron shielding, lowering attraction between the nucleus and valence electron. Less energy is required to remove the electron from lithium therefore, and so hydrogen has a greater first ionisation energy than lithium.

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Examiner Comments

This is an example of a response that does not include a statement concerning the electronic structures of hydrogen and helium. Comparing the two by saying that the electrons were both in the first energy level scored one of the marks but was not included here. The comparison of hydrogen with lithium was good so this scored 3 marks.

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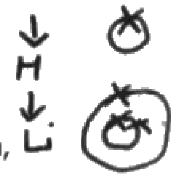
Examiner Tip

Always make sure that all factors are considered when answering questions on ionisation energy. It is a good idea to start by stating where the electrons are relative to each other in a comparison.

(ii) The sequence of the first three elements in the Periodic Table is hydrogen, helium and then lithium.

Explain why the first ionisation energy of hydrogen is less than that of helium, but greater than that of lithium.



(4)

Hydrogen and helium both have one shell, however helium has one more proton and electron compared to hydrogen. This causes the atomic radius of helium to be smaller due to more attraction. Due to this, heliums outer electron is closer to the nucleus ∴ more energy required to remove it ∴ higher first ionisation energy.
Lithium has a lower first ionisation energy because it has another shell, therefore its atomic radius is larger therefore its outer electron is further away and requires less energy to remove.

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Examiner Comments

This answer did compare hydrogen with helium successfully, and recognised that there was an extra shell of electrons for lithium, but did not mention the important factor of shielding, so this too scored 3 marks.

Question 2 (d)

Hydrogen's electronic structure leads to the position above lithium being sensible, whilst the difference in chemical reactivity and the fact that it is not metallic are obvious barriers to this position. Many students were able to score 2 marks here, but relatively few scored all 3.

(d) Hydrogen can be placed in several different positions in periodic tables. One is immediately above lithium in Group 1. Another is in the centre of the first row, as shown in the Periodic Table on the back cover.

Criticise the position of hydrogen immediately above lithium by giving one reason in favour and two against.

(3)

Hydrogen could be placed above lithium since it has one electron in its outer shell / energy level.
However, group one contains alkali metals, hydrogen is not an alkali metal and therefore its properties will be different to ~~those in the~~ the elements in group 1.

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Examiner Comments

This was a very common type of response. The student scores 2 marks for the comments regarding the similarity of the outer electron structure and the fact that hydrogen is not an alkali metal, but the final point about the different properties is too imprecise to score the third mark.

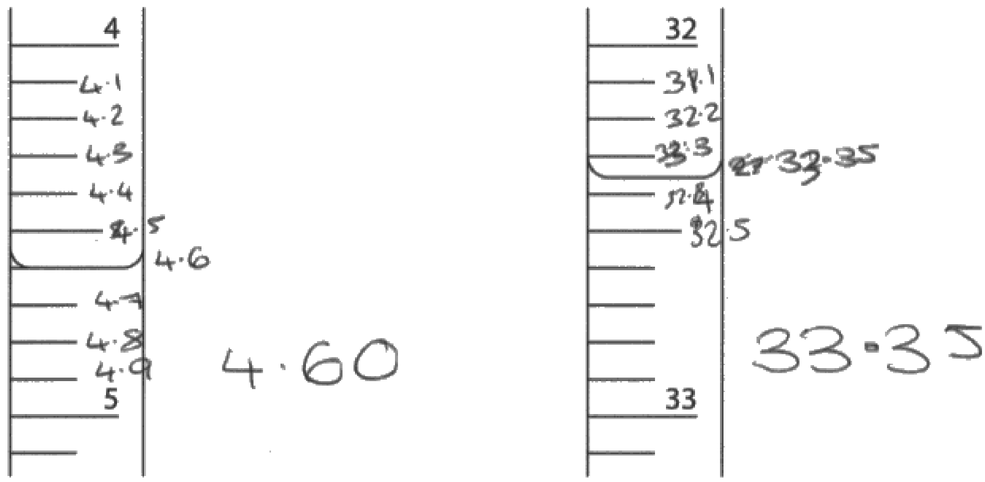
Question 3 (c) (i)

This question was very well answered, demonstrating the familiarity with the practical work in titrations required. Some students omitted trailing 0s on the value 4.60 and so lost one of the marks.

Some students read the numbers upside down, and so found volumes of 5.40 and 33.65.

(c) (i) Complete the table of results for titration number 1, using the diagrams to find the initial and final burette readings.

(2)



Initial reading   Final reading

Table of results

Titration number	Final reading / cm^3	Initial reading / cm^3	Titration volume / cm^3
1	33.35	4.60	28.75
2	28.05	1.10	26.95
3	37.65	10.20	27.45
4	32.05	5.00	27.05

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Examiner Comments

This student has read the scales the right way, but has made a slip with the final volume and has overwritten the correct answer and changed it to 33.35 instead of 32.35. The calculation is correct, however, so 1 mark is scored.

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Examiner Tip

Practical work is a very important component of an AS in chemistry. Examinations at this level will have a number of questions which test skills associated with practical work such as this one.

(c) (i) Complete the table of results for titration number 1, using the diagrams to find the initial and final burette readings.

(2)

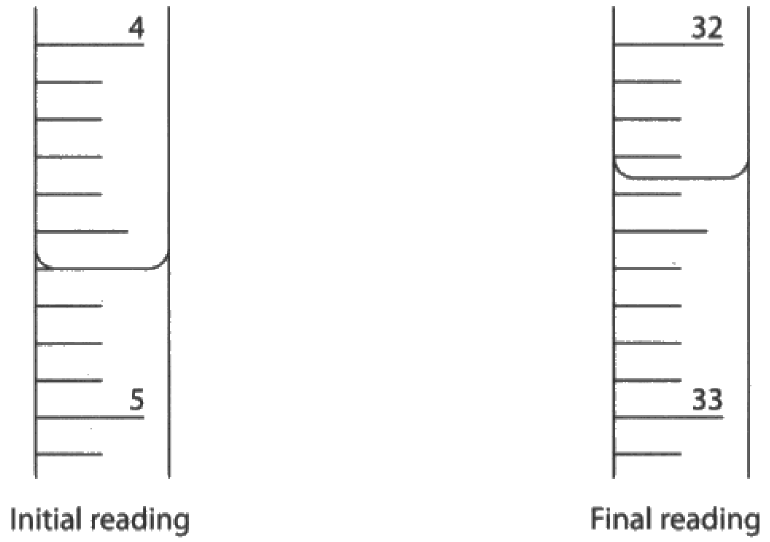

Table of results

Titration number	Final reading / cm^3	Initial reading / cm^3	Titration volume / cm^3
1	33.65	5.40	28.25
2	28.05	1.10	26.95
3	37.65	10.20	27.45
4	32.05	5.00	27.05

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Examiner Comments

This is an example of a candidate who has read the scale from the bottom up. This scores one mark for a correct subtraction from incorrect volumes.

Question 3 (c) (iii)

Students who could make a start on this calculation generally scored very well, with most quoting the answer to 3 significant figures. Marks could be scored no matter which of the values were selected in part (c)(ii).

(iii) Calculate the concentration, in mol dm^{-3}, of the potassium hydroxide solution, giving your answer to an appropriate number of significant figures.

(3)

$n = \frac{cv}{1000}$ $\quad c = \frac{n \times 1000}{V}$

$c = \frac{0.004 \times 1000}{27.3} = 0.1465$ mol/dm^3

≈ 0.15 moldm^{-3}

$H_2SO_4 + 2KOH$

$v = 25 cm^3$ $\quad n = 0.004$

$c = 0.08$ mol/dm^3

$n = 0.002$

$\uparrow \frac{0.08 \times 25}{1000}$

1 : 2

0.002 : 0.004

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Examiner Comments

This student has used the incorrect mean titre of 27.30 cm^3. This has already lost them one mark so is not penalised again. This calculation is entirely correct using this volume and so scores 3 marks.

(iii) Calculate the concentration, in mol dm^{-3}, of the potassium hydroxide solution, giving your answer to an appropriate number of significant figures.

(3)

M / C V

C = $\frac{M}{V}$

H_2SO_4 => 25 cm^3

0.0800 mol dm^{-3}

→ moles = $\frac{25}{1000}$ × 0.0800

= 0.002 mol

2 KOH

C = $\frac{0.002}{27 \div 1000}$

= 0.074074...

conc. of KOH = 0.07 mol dm^{-3}

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Examiner Comments

This example finds the number of moles of sulfuric acid correctly, but then does not multiply by 2 to give the moles of potassium hydroxide. Their concentration is half of that expected. They have then quoted the answer to only one significant figure so this response is worth one mark.

(iii) Calculate the concentration, in mol dm^{-3}, of the potassium hydroxide solution, giving your answer to an appropriate number of significant figures.

(3)

$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$

$0.025\ dm^3$ $0.027\ dm^3$

$0.08\ mol\ dm^{-3}$ $0.148\ mol\ dm^{-3}$

Mol : 2×10^{-3} mol (×2) Mol : 4×10^{-3} mol

$\frac{4 \times 10^{-3}}{0.027} = 0.1481\ mol\ dm^{-3}$

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Examiner Comments

This otherwise perfectly correct answer only scores 2 marks as the final value is given to 4 significant figures.

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Examiner Tip

The correct number of significant figures to use is the same as the smallest number of significant figures in the data in the question, or one less.

Question 4 (a) (i) - (ii)

This question was also well answered in general. The expected answers in part (i), sulfate(VI) and carbonate were often seen, with sulfate(IV), a perfectly correct answer which is less commonly covered in this specification, also seen regularly.

Incorrect answers tended to revolve around halide ions, particularly chloride ion which does give a white precipitate under the correct circumstances (with acidified silver nitrate solution).

4 An ionic compound contains a metal cation and a non-metal anion in a 1 : 1 ratio, and water of crystallisation. The compound can be represented as $MN.xH_2O$, where x is the number of moles of water of crystallisation per mole of MN.

A sample of $MN.xH_2O$ was dissolved in distilled water to produce a colourless solution, with a concentration of about 0.5 mol dm^{-3}. 2 cm^3 of the resulting solution was transferred to each of two test tubes.

The following tests were carried out to identify the ions present.

(a) **Test 1**

SO3⁻

(i) Addition of a few drops of a solution of barium chloride to one of the test tubes gave a white precipitate.

→ sulphate or carbonate

Identify, by name or formula, **two** possible anions that would give this result.

(1)

sulphate or carbonate

sodium ions or potassium ion

(ii) Addition of 1 cm^3 of dilute hydrochloric acid to the test tube in (a)(i) resulted in no further change.

Give the **formula** of the anion.

(1)

sulphate , SO3⁻

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Examiner Comments

This student clearly knows the identity of the possible ions and scores the mark in part (a)(i). Unfortunately they have the wrong formula for the ion. The correct answer for part (a)(ii) was the sulfate (VI) ion, SO_4^{2-}. This is the sulfate (IV) or sulfite ion, which would give a white precipitate initially, but would dissolve in the presence of the hydrochloric acid.

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Examiner Tip

Learn the formula of the complex anions such as sulfate (VI), sulfate (IV) and carbonate including their charges.

Question 4 (b) - (c)

The expected response here was the magnesium ion, though beryllium ions also give no flame test colour. Where students could make a start on the calculation in part (c) they scored well, with a fairly large proportion using the alternative values offered in brackets. The expected values of 7 (or 6 for the alternative) were commonly seen, although students scored a range of marks, with answers using a variety of methods.

Various methods were possible for the solution of this problem. Three methods were given in the mark scheme, but various combinations and alternatives were also possible.

(b) **Test 2**

A flame test on a sample of solid $MN.xH_2O$ gave no change in the flame colour.

Give a possible identity of the cation, M.

(1)

magnesium

(c) Heating the hydrated compound results in the formation of the anhydrous ionic solid MN by the following reaction:

$$MN.xH_2O(s) \rightarrow MN(s) + xH_2O(g)$$

Heating a sample of the hydrated compound reduced the mass to 48.9% of its original value.

Use this information and your answer to (a)(ii) and (b) to calculate the value of x.

[*Note: If you have been unable to identify MN, you may use this hydrated compound,* $CoCl_2.yH_2O$ *in which the sample reduced in mass to 54.6% of its original value. Use this information to calculate the value of y.*]

$MgSO_4$

(4)

$24.3 + 32.1 + 4(16)$

$= 120.4$

$120.4 + x(2+16)$

$120.4 + 18x$

$0.489(120.4 + 18x) = 120.4$

$120.4 + 18x = 246.216$

$18x = 125.8$

$x = 6.9$

$x = 7$

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Examiner Comments

This perfectly correct solution scores full marks. This answer would have benefitted from a little annotation to show what was being calculated. For example, labelling the first line as 'Relative formula mass of magnesium sulfate' would have been helpful.

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Examiner Tip

Clearly laid out calculations, preferably with some annotation to show what is being calculated, will lead to the best results. It helps to clarify the candidates thoughts as well as making seeing where marks can be awarded more straightforward.

(b) **Test 2**

A flame test on a sample of solid $MN.xH_2O$ gave no change in the flame colour.

Give a possible identity of the cation, M.

(1)

~~Ma~~ Mg^{2+}

(c) Heating the hydrated compound results in the formation of the anhydrous ionic solid MN by the following reaction:

$$MN.xH_2O(s) \rightarrow MN(s) + xH_2O(g)$$

Heating a sample of the hydrated compound reduced the mass to 48.9% of its original value.

Use this information and your answer to (a)(ii) and (b) to calculate the value of x.

[*Note: If you have been unable to identify MN, you may use this hydrated compound,* $CoCl_2.yH_2O$ *in which the sample reduced in mass to 54.6% of its original value. Use this information to calculate the value of y.*]

(4)

~~n(MN.xH2O) = cV~~ =

~~MN~~ ~~H2O~~

~~48.9~~

100 − 48.9 = 51.1

~~Co~~

$MgSO_4$

MN	H_2O
$\frac{51.1}{120.3}$	$\frac{48.9}{18}$
$\frac{0.424}{0.424}$	$\frac{2.71}{0.424}$
1 :	6

ResultsPlus
Examiner Comments

This example uses the expected method of finding the number of moles of anhydrous magnesium sulfate and of water and then finding the ratio of these moles to give the value of x. The formula mass of magnesium sulfate is not that expected using data from the periodic table, but many candidates are award the sulfur has a relative atomic mass of 32 to 2 significant figures rather than the 32.1 given in the periodic table. This is not penalised. Unfortunately this candidate has inverted the percentages so gets an answer of 6 instead of 7 and so scores 3 marks for the calculation. The identification of the ion in (b) is perfectly correct and so scores 1.

Mistakes in identitifying the metal ion in part (b) would obviously lead to incorrect answers to the calculation. Transfer errors were allowed and so calculations with incorrect metals could still score full marks.

(b) **Test 2**

A flame test on a sample of solid $MN.xH_2O$ gave no change in the flame colour.

Give a possible identity of the cation, M.

(1)

Ag , Silver

(c) Heating the hydrated compound results in the formation of the anhydrous ionic solid MN by the following reaction:

$$MN.xH_2O(s) \rightarrow MN(s) + xH_2O(g)$$

Heating a sample of the hydrated compound reduced the mass to 48.9% of its original value.

Use this information and your answer to (a)(ii) and (b) to calculate the value of x.

[*Note: If you have been unable to identify* MN, *you may use this hydrated compound,* $CoCl_2.yH_2O$ *in which the sample reduced in mass to 54.6% of its original value. Use this information to calculate the value of* y.]

(4)

$AgNO_3 . xH_2O(s) \rightarrow AgNO_3(s) + xH_2O(g)$

% 100 − 48.9 % = 51.1 % H_2O

Mr $AgNO_3$ = 169.9 (Assume one mole used)

∴ Mr $AgNO_3 . xH_2O$ = 347.444

∴ wt H_2O = 177.54

Mr H_2O = 18

$\frac{177.54}{18}$ = 9.86 ~ 10

∴ x = 10

ResultsPlus
Examiner Comments

This candidate has lost the mark in (b) for identifying the metal ion as silver and for identifying the anion as nitrate ion also. Their calculation for the formula of hydrated silver nitrate, from the data given, is perfectly correct and so scores full marks in (c).

ResultsPlus
Examiner Tip

Clearly laying out your calculation, as in this example, allows markers to understand how the question is being answered and makes the awarding of full marks easy for correct calculations.

Question 5 (a) (i)

This question was testing the ability of the students to understand practical instructions and interpret chemical equations. A familiarity with this type of synthetic practical work involving the reactions of acids would be a great advantage here.

5 A student made crystals of a metal chloride, $JCl_2.6H_2O$, by reacting the metal carbonate, JCO_3, with hydrochloric acid, HCl(aq). The product was purified.

Procedure

Step **1** 150 cm^3 of hydrochloric acid, concentration 0.80 mol dm^{-3}, was transferred to a 400 cm^3 conical flask. The flask was warmed gently using a Bunsen burner. A spatula measure (about 1.0 g) of metal carbonate was added to the acid.

Step **2** When the reaction in Step **1** was finished, more metal carbonate was added until the metal carbonate was in excess.

Step **3** The resulting mixture was filtered into an evaporating basin.

Step **4** The evaporating basin was heated using a Bunsen burner to concentrate the solution. The concentrated solution was allowed to cool and crystallise.

Step **5** Once crystal formation was complete, the resulting mixture was filtered for a second time.

Step **6** The resulting white crystals were rinsed with a small volume of ice-cold water.

The equation for the reaction between the metal carbonate and hydrochloric acid is

$$JCO_3(s) + 2HCl(aq) \rightarrow JCl_2(aq) + H_2O(l) + CO_2(g)$$

(a) (i) Describe **two** observations that the student might make which show that the reaction in Step **1** has finished.

(2)

would stop fizzing & reacting & CO_2

would stop being produced

ResultsPlus
Examiner Comments

This is an example where two points have been made, but both are covering the same idea - that of gas no longer being produced, so this example scores 1 mark.

ResultsPlus
Examiner Tip

Use the number of marks available for each item as a guide to how many points you need to make.

Many candidates recognised that the gas given off, carbon dioxide, could be tested for using limewater. This was not mentioned in the description of the experiment, however, and rarely scored a mark as a result.

5 A student made crystals of a metal chloride, $JCl_2.6H_2O$, by reacting the metal carbonate, JCO_3, with hydrochloric acid, HCl(aq). The product was purified.

Procedure

Step **1** 150 cm^3 of hydrochloric acid, concentration 0.80 mol dm^{-3}, was transferred to a 400 cm^3 conical flask. The flask was warmed gently using a Bunsen burner. A spatula measure (about 1.0 g) of metal carbonate was added to the acid.

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Step **5** Once crystal formation was complete, the resulting mixture was filtered for a second time.

Step **6** The resulting white crystals were rinsed with a small volume of ice-cold water.

The equation for the reaction between the metal carbonate and hydrochloric acid is

$$JCO_3(s) + 2HCl(aq) \rightarrow JCl_2(aq) + H_2O(l) + CO_2(g)$$

14.26

(a) (i) Describe **two** observations that the student might make which show that the reaction in Step **1** has finished.

(2)

HCl + metal carbonate gives off CO_2 so the liquid would fizz/bubble/effervesence and go cloudy (limewater).

ResultsPlus
Examiner Comments

This answer has recognised the carbon dioxide would be formed in the reaction, but not that it will cease being formed at the end of the step when all of the added metal carbonate has reacted and so scores no marks.

Question 5 (a) (ii)

This part of the practical technique was well understood and familiar to the majority of students, or they were able to interpret the instructions correctly.

Question 5 (a) (iii)

Again a question testing an understanding of why practical techniques might be used. This was much more challenging, and the use of ice cold water to wash off soluble impurities was not commonly understood. The instructions tell the students that it is being used to rinse the crystals, so simply washing the crystals was not sufficient to score the mark. Much more commonly recognised was the idea that the crystals would dissolve if the water was hot or in large volume.

(iii) Explain the use of a small volume of ice-cold water in Step **6**.

(2)

This is so the crystals don't dissolve in the water. Being cold stops the crystals from breaking down. Using a small amount minimise the amount of the crystal dissolving back.

ResultsPlus
Examiner Comments

This response covers the point about avoiding redissolving the crystals so scores 1 mark.

ResultsPlus
Examiner Tip

Familiarity with practical techniques and the ability to apply your knowledge and understanding to these is an important part of AS chemistry.

Question 5 (b)

This calculation provided very good differentiation with most students being able to score 1 or 2 marks and only the better students being able to score all 5 marks. There were two methods; one finding the molecular mass of JCl_2 and thus the atomic mass of J and the second finding the mass of J in the sample and hence the atomic mass. Both methods finished by students selecting the element which has the closest mass to their calculated value.

It was quite common for students to score the first three marks, but then to make an incorrect subtraction for the fourth mark. If this occured, the fifth mark could still be scored by looking up the atomic mass found on the Periodic Table.

(b) The student obtained a mass of 14.26 g of hydrated crystals. Assuming that the percentage yield is 100%, use the information in the procedure to give a possible identity of J.

(5)

$JCO_3 + 2HCl \rightarrow JCl_2 + H_2O + CO_2$

7gram 150cm 0.80 14.26

$\frac{Acc}{theo} \times 100 = 100$

$n\,2HCl = 0.8 \times \frac{150}{1000}$

$2n = \frac{3}{25}$

$n = 0.06$

$\frac{14.26}{theo} \times 100 = 100$

$\frac{14.26}{x} \times 100 = 100$

$14.26 = x$

$\frac{mass}{mol \mid Mr}$

$\frac{14.26}{0.06} = Mr$ $Mr = 237.66$

$Mr = 238$

$238 - (2 \times 35.5) = 167$

J Mr = 167

= Erbium

ResultsPlus
Examiner Comments

This example does not subtract the mass of water from calculated formula mass of the compound, giving a mass which is 108 g mol-1 too large. Erbium is the element which has this mass so the final mark could be scored, so this was awarded 4 marks.

Question 5 (c) (i)

This question was basically in two parts: one to explain the surprising lack of colour in the crystals and the second, the use of the flame test.

Some students attempted to do only one of these two tasks. The expected metal was Nickel, a transition metal, which would be expected to have coloured compounds as this is a property of transition metals. This mark was relatively rarely scored, but the second mark, for using the flame test to identify the cation present, was much more accessible.

(c) The student was surprised by the white colour of the crystals of $JCl_2.6H_2O$ in Step **6**.
This did not agree with the possible identity for J from the calculation in (b).
The student decided to perform a flame test on the crystals.

(i) Explain why the student was surprised and decided to carry out a flame test. **(2)**

to show which ~~ani~~ cation was present as each metal gives a distinct color when burnt so could be used to be sure exactly what J was.

ResultsPlus
Examiner Comments

This response scores the second of the available marking points by stating why the flame test would be carried out.

Question 5 (c) (iii)

Students who successfully made a start to this question could often find the percentage yield correctly. Most gave the answer to 2 significant figures.

1 mark would have been scored in part (c)(i) by this response for knowing that cobalt, a transition metal, should give coloured crystals.

(c) The student was surprised by the white colour of the crystals of $JCl_2.6H_2O$ in Step **6**.
This did not agree with the possible identity for J from the calculation in (b).
The student decided to perform a flame test on the crystals.

(i) Explain why the student was surprised and decided to carry out a flame test.

(2)

Cobalt is a transition metal and would not form white crystals

(ii) The flame test colour was crimson red. Identify J.

(1)

☒ **A** barium green

☒ **B** calcium brick

☒ **C** lithium

☒ **D** strontium red

(iii) Calculate the actual percentage yield of the reaction, which produced 14.26 g of crystals.

Give your answer to **two** significant figures.

(2)

$SrCl_2 . 6H_2O$

Mr = 266.6 = 15.996 g

moles = 0.06

$100 \times \frac{14.26}{15.996} = 89.1\%$

= 89.1% (3.s.f)

ResultsPlus
Examiner Comments

The identification of strontium in the multiple choice question is correct and the subsequent calculation fully correct up to the final answer, which is quoted to 3 significant figures, where the question clearly asks for 2. This therefore scored 1 of the two marks.

ResultsPlus
Examiner Tip

Read the question carefully, particularly for calculations which are often required to be given in particular numbers of significant figures, decimal places or to appropriate numbers of significant figures.

(c) The student was surprised by the white colour of the crystals of $JCl_2.6H_2O$ in Step **6**. This did not agree with the possible identity for J from the calculation in (b). The student decided to perform a flame test on the crystals.

(i) Explain why the student was surprised and decided to carry out a flame test. **(2)**

To Prove the identity Of S

(ii) The flame test colour was crimson red. Identify J. **(1)**

- ☒ **A** barium
- ■ **B** calcium
- ☒ **C** lithium
- ☒ **D** strontium

(iii) Calculate the actual percentage yield of the reaction, which produced 14.26 g of crystals.

Give your answer to **two** significant figures. **(2)**

mass = moles x mr
= 0.06 x ~~[crossed out]~~ 255.6
= 15.336g

$\frac{14.26}{15.336} \times 100 = 92.98$
or 93%

ResultsPlus
Examiner Comments

In this answer a mistake, perhaps in the reading of the number on the calculator, has been made in the calculation of the relative formula mass. It should be 266.6. The subsequent calculation using this incorrect value is correct and the answer quoted to 2 significant figures so this scores 1 mark.

(c) The student was surprised by the white colour of the crystals of $JCl_2.6H_2O$ in Step **6**. This did not agree with the possible identity for J from the calculation in (b). The student decided to perform a flame test on the crystals.

(i) Explain why the student was surprised and decided to carry out a flame test.

(2)

This is because the student ~~didn't~~ would have expected the crystals to be coloured.

(ii) The flame test colour was crimson red. Identify J.

(1)

☐ **A** barium

☐ **B** calcium

☒ **C** lithium

☐ **D** strontium

(iii) Calculate the actual percentage yield of the reaction, which produced 14.26 g of crystals.

Give your answer to **two** significant figures.

(2)

0·06 × Li $Cl_2.6H_2O$
= 11.154

yield = actual / theoretical

= 11.154 / 14.26 × 100

= 78.21879

= 78% (2 s.f)

ResultsPlus
Examiner Comments

In this example the metal chosen in the multiple choice question is lithium, which is incorrect. The subsequent calculation of the theoretical yield is correct but then, perhaps because it correctly calculates the answer is greater than 100%, the calculation of the percentage yield is inverted. This scores 1 mark for the calculation of the theoretical yield.

Question 6 (a) (i)

Very few did not score here. This aspect of AS chemistry has clearly been particularly well taught and well understood by almost all students.

Question 6 (a) (ii)

This question required students to recognise that the two elements had the same outer shell electron structure and that this lead to their similar chemical reactivity. Many were able to do this.

(ii) Explain why iodine and chlorine have many similar chemical reactions.

(2)

They are in the same group in the periodic table.
Both are non metals
Have the same number of electrons on outer shells, meaning reactions will be similar

ResultsPlus
Examiner Comments

This was a typical correct answer. As well as the third statement, which contains both the marks, two additional statements have been made. These are both factually correct so do not penalise the student. This scored both marks.

Question 6 (b) (i)

This was another item where many students scored both the available marks.

(b) Members of the same group sometimes react in different ways.

Iodine and chlorine react differently with thiosulfate ions, $S_2O_3^{2-}$.
Iodine gives $S_4O_6^{2-}$, whilst chlorine gives SO_4^{2-}.

(i) Complete the table by identifying the oxidation numbers of sulfur in the three sulfur-containing ions. **(2)**

$(x \times 4) + (-2 \times 6) = -2$
$(x \times 4) + (-12) = -2 \quad x \times 4 = 10$

-2×4

Ion	Oxidation number of sulfur
$S_2O_3^{2-}$	2
SO_4^{2-}	$-8 = -2$ 6 $S = 6$
$S_4O_6^{2-}$	~~10~~ 2.5

ResultsPlus
Examiner Comments

This student has unfortunately failed to include a sign with their oxidation numbers, and so only scored 1 of the 2 marks.

ResultsPlus
Examiner Tip

Signs should always be included with answers to calculations of oxidation number and in other situations such as energy changes.

(b) Members of the same group sometimes react in different ways.

Iodine and chlorine react differently with thiosulfate ions, $S_2O_3^{2-}$.
Iodine gives $S_4O_6^{2-}$, whilst chlorine gives SO_4^{2-}.

(i) Complete the table by identifying the oxidation numbers of sulfur in the three sulfur-containing ions.

(2)

Ion	Oxidation number of sulfur
$S_2O_3^{2-}$	+2
SO_4^{2-}	+4
$S_4O_6^{2-}$	+2.5

$-6 + 2x = -2$

$-8 + x = -2$

$-12 + 4x = -2$

ResultsPlus
Examiner Comments

In this example, the candidate has used an algebraic expression to calculate the answers. Unfortunately, they have not done this correctly in the second part. The expression is correct but the answer to it is not. This has 2 correct out of 3 so scores 1 mark.

Question 6 (b) (ii)

Recognition that iodine gained an electron was common.

(ii) The equation for the reaction of iodine with thiosulfate ions is

$$2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$$

State, in terms of electrons, why iodine is classified as an oxidising agent in this reaction.

(1)

$4x + -12 = +2$
$4x = +16$
$\frac{10}{4}$

Beuse it gains electrons

ResultsPlus
Examiner Comments

This was a typically correct response.

ResultsPlus
Examiner Tip

Again, reading the question carefully is vital. Explaining why a species acts as an oxidising agent can be done in terms of electrons or in terms of oxidation numbers.

(ii) The equation for the reaction of iodine with thiosulfate ions is

$$2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$$

State, in terms of electrons, why iodine is classified as an oxidising agent in this reaction.

(1)

it reduces ~~it's set~~ itself from 0 to −1 and oxidises other elements / molecules.

ResultsPlus
Examiner Comments

This answer is in terms of oxidation numbers so does not score a mark.

Question 6 (b) (iii)

Many students were able to deduce that chlorine was a stronger oxidising agent as the oxidation number of the sulfur went higher that it did with iodine as shown by these two typical examples.

(iii) Use your answer to b(i) to show that chlorine is a stronger oxidising agent than iodine.

(1)

Because Chlorine and thiosulphate forms SO_4^{2-} it means its oxidation state is +6 and thus more positive than iodines formation of $+2\frac{1}{2}$ therefore it is more oxidising.

ResultsPlus
Examiner Comments

This response received 1 mark

(iii) Use your answer to b(i) to show that chlorine is a stronger oxidising agent than iodine.

(1)

It ~~lowers the~~ increases the oxidation number of the Sulphur more than Iodine does.

ResultsPlus
Examiner Comments

This response received 1 mark

Question 6 (b) (iv)

This equation was quite well answered. Ionic half-equations are always challenging at this level except for the most straightforward examples. Many students were able to deduce the correct species from description of the experiment, but then some failed to correctly balance the equations, often having either 8 hydrogen ions or 10 electrons. Students need to remember to balance the charge on both sides of the equation after they have balanced the different types of atoms.

(iv) Chlorine reacts in aqueous solution with $S_2O_3^{2-}$ to give SO_4^{2-}.
The ionic half-equation for the reaction of chlorine is

$$Cl_2 + 2e^- \rightarrow 2Cl^-$$

Write the ionic half-equation for the reaction of aqueous $S_2O_3^{2-}$ to give SO_4^{2-}.
State symbols are not required.

(2)

~~$2H_2O + \overset{+2}{S_2O_3^{2-}} \rightarrow \overset{+6}{2SO_4^{2-}} + 4e^- + 4H^+$~~

$6H_2O + S_2O_3^{2-} \rightarrow 2SO_4^{2-} + 10e^- + 10H^+$

ResultsPlus
Examiner Comments

This response has 6 waters instead of 5 and 10 electrons instead of 8 so scores 1 mark for identifying the correct species.

(iv) Chlorine reacts in aqueous solution with $S_2O_3^{2-}$ to give SO_4^{2-}.
The ionic half-equation for the reaction of chlorine is

$$Cl_2 + 2e^- \rightarrow 2Cl^-$$

Write the ionic half-equation for the reaction of aqueous $S_2O_3^{2-}$ to give SO_4^{2-}.
State symbols are not required.

(2)

$S_2O_3^{2-} + 5H_2O \rightarrow 2SO_4^{2-} + 2e^- + 10H^+$

ResultsPlus
Examiner Comments

This one has only 2 electrons produced so also only scored one mark for the species identification.

Question 6 (b) (v)

Relatively few students were able to score this mark, although it was common for those who had scored both marks in part (b)(iv) to score this mark as well.

(iv) Chlorine reacts in aqueous solution with $S_2O_3^{2-}$ to give SO_4^{2-}.
The ionic half-equation for the reaction of chlorine is

$$Cl_2 + 2e^- \rightarrow 2Cl^-$$

Write the ionic half-equation for the reaction of aqueous $S_2O_3^{2-}$ to give SO_4^{2-}.
State symbols are not required.

(2)

$5H_2O + S_2O_3^{2-} \rightarrow 2SO_4^{2-} + 10H^+ + 8e^-$

L4

(v) Use your answer to (b)(iv) and the half-equation for chlorine, to write the overall ionic equation for the reaction between chlorine and thiosulfate ions.
State symbols are not required.

(1)

$Cl_2 + 2e^- + 5H_2O + S_2O_3 \rightarrow 2SO_4^{2-} + 10H + 8e^- + 2Cl^-$

ResultsPlus
Examiner Comments

This student has combined the two half-equations but has not multiplied the chlorine to chloride half-equation by 4 and then cancelled the electrons, so does not score the mark.

ResultsPlus
Examiner Tip

Full equations, and the half-equations which can be used to produce them, should be balanced. The equations should have the same number of atoms and the same charge on both sides. Full equations never have uncancelled electrons.

Question 7

This 6 mark question was accessible to most students, but resulted in a good range of marks being scored. The most common of the indicative points to be missed was the idea that the same number of electrons would result in a very similar contribution to the boiling temperature from London forces for all three molecules. As a result 5 indicative points was a quite common score for good students.

***7** The compounds hydrogen fluoride, water and methane, all have simple molecular structures, but they have significantly different boiling temperatures.

Discuss the reasons for the differences in the boiling temperatures of the three compounds, using the data in the table and the Pauling electronegativity values in the Data Booklet.

Compound	Boiling temperature /°C	Number of electrons
CH_4	−161.5	10
H_2O	100.0	10
HF	19.5	10

(6)

water and hydrogen flouride both have hydrogen bonds, despite ~~two~~ fluorine having a greater electronegativity, therefore forming a bigger difference in δ charge between the hydrogen and fluorine compared to water, and even having stronger hydrogen bonds than water, water forms 2 hydrogen bonds between each molecule, therefore requires more energy to break these bonds, hydrogen fluoride only forms 1 bond per molecule, requires less energy,

CH_4 does not form hydrogen bonds, it ~~forms~~ forming london forces between each molecule, and is therefore weaker and requires less energy ~~to~~ to break the bonds and overcome the forces of attraction,

Carbon is δ+, and hydrogen is δ-, therefore forms carbon forces between bonds, however has no overall polarity as the polar quantities vectors cancel each other out

Fluorine has an electronegativity of 4,
hydrogen has 2.1.
difference in electronegativity = ~~2~~ 1.9,
therefore form stronger hydrogen bonds,

~~OH~~ ~~Other~~ Oxygen has 3.5,
therefore difference is 1.4, forms
weaker ~~H bonds~~ hydrogen bonds,
however forms 2 bonds per molecule
in more bonds, requires more energy.

Carbon has an electronegativity of 2.5,
hydrogen has 2.1, so difference is
only 0.4, so it is not
strong enough to form hydrogen
bonds, it only forms London
forces.

ResultsPlus
Examiner Comments

This is a typical example of a student who missed just the first indicative point concerning the same number of electrons giving the same London forces. There is no additional incorrect reasoning and the logic linking the points together is good so this student scores 3 for the indicative points and 2 for logic and reasoning and so scores 5 marks.

*7 The compounds hydrogen fluoride, water and methane, all have simple molecular structures, but they have significantly different boiling temperatures.

Discuss the reasons for the differences in the boiling temperatures of the three compounds, using the data in the table and the Pauling electronegativity values in the Data Booklet.

Compound	Boiling temperature / °C	Number of electrons
CH_4	−161.5	10
H_2O	100.0	10
HF	19.5	10

(6)

For methane, the electronegativity difference is 0.4, in H_2O it's 1.4 and in HF it's ~~1~~ 1.8. Therefore, HF has the most polar bonds, with the most ionic character. ~~Additionally, HF is the only compound in wh~~

The London forces do not contribute to the difference as they all have the same number of electrons, so the same charge density fluctuation. But CH_4 has a much lower boiling temperature for several reasons. Firstly, it's the only non polar molecule (the polar bonds cancel out due to symmetry) and therefore has no permanent dipole-dipole interactions (which the others do).

CH_4 also, unlike the others, cannot Hydrogen bond. So yet again has less intermolecular interactions.

The high boiling point of water is actually an anomoly, as the Hydrogen bonds between HF molecules are actually stronger due to the greater electronegativity difference, so theoretically should take more energy to overcome. However, on vapourisation, not all the HF bonds actually need to be broken. Additionally to this, H_2O makes two hydrogen bonds per molecule. (HF only makes one) so the bonding is more extensive, requiring less energy to overcome.

ResultsPlus
Examiner Comments

This candidate made an excellent attempt at this question. All the 6 indicative points were scored but then, unfortunately, the final sentence contradicts the final indicative point concerning the amount of energy needed to separate the molecules. This meant the response could only score 5 out of 6 marks.

ResultsPlus
Examiner Tip

In a six mark question in chemistry, there are 6 indicative points which need to be made. You should aim to make six points and link them together to complete your argument.

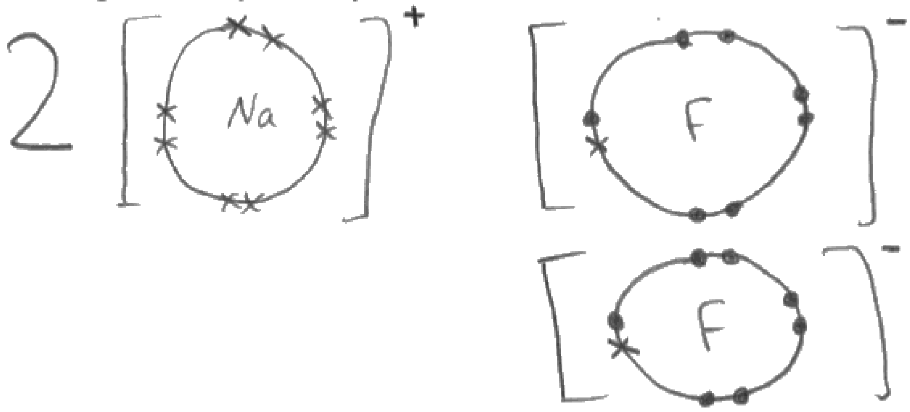
Question 8 (a) (ii)

Provided that they had read the question with care and gave diagrams showing all the electrons rather than just the outer shells, this question was well answered. Some students did not know, and could not work out, what isoelectronic meant and so only scored marks for the diagrams.

(ii) Draw dot-and-cross diagrams of the ions in sodium fluoride, showing all the electrons.

Use your diagram to explain why the ions are described as isoelectronic.

(3)



They are isoelectronic because they have the same number of electrons as the ions.

ResultsPlus
Examiner Comments

This student needed to read the question a little more carefully. All the electrons need to be shown, as the question links the structure to isoelectronic which is the same number of electrons.

ResultsPlus
Examiner Tip

Always read the question with care, and preferably twice, to make sure you are answering the correct question!

(ii) Draw dot-and-cross diagrams of the ions in sodium fluoride, showing all the electrons.

Use your diagram to explain why the ions are described as isoelectronic.

(3)

The outer electron in Na is lost to Fluorine, which needs 1 electron to gain noble gas configuration.

ResultsPlus
Examiner Comments

This candidate completed the electronic structures of the ions but could not link this to the idea of them being isoelectronic. Consequently 2 marks were scored.

Question 8 (a) (iv)

This question was well answered by those students who knew the correct trend. This should have also helped them if they were struggling with the idea of what isoelectronic meant in part (a)(ii).

(iv) Explain your answer to (a)(iii) in terms of the structure of the ions.

(2)

from N^{3-} to ~~the end of its period~~ Al^{3+} ionic radii decreases as you have the same number of electrons but with an increased proton number meaning there is a stronger positive nuclear charge pulling in the electron shells making the atomic radii smaller

ResultsPlus

Examiner Comments

This is an example of a student who was able to describe how and why the ionic radius of the isoelectronic ions changed. Both marks were awarded.

Question 8 (b)

The final question proved challenging as many students did not recognise there were two factors to consider, the charge on the ion and its radius, and did not read the question carefully enough and so did not use the examples they had been given of lithium, potassium and calcium fluoride to explain their answers. Some students clearly knew the factors involved but did not answer the question they had been set.

(b) The strength of ionic bonding in different compounds can be compared by using the amount of energy required to separate the ions. Some values for this energy are given in the table.

Compound	Amount of energy required to separate the ions / kJ mol^{-1}
LiF	1031
KF	817
CaF_2	2957

Using the data provided, explain how changes in the cation affect the bond strength in an ionic compound.

(2)

The larger the cation the weaker the bond as the attraction between the nuclear charge of the cation and the anion is decreased. Additionally, the charge of the cation affects strength as the higher the charge the greater the charge density, so there's stronger attraction between oppositley charged ions (eg Ca^{2+} not K^+).

ResultsPlus
Examiner Comments

This student clearly knows and understands the factors which will result in different amounts of energy being required to separate the ions. Unfortunately, the question requires the discussion to be in terms of the data provided for full marks to be awarded. This has not happened here so this scores 1 mark.

ResultsPlus
Examiner Tip

It cannot be said too often. Read the question carefully!

Paper Summary

Based on the performance on this paper, students are offered the following advice:

- It has been suggested many times before, but students should read questions with great care, particularly at the beginning of the exam when nerves will be apparent, and at the end when tiredness is playing a part. Marks can easily be lost by not identifying what is being asked

- Clarity on the unstructured calculations is important. Providing labels such as "The number of moles of ammonia is...." will demonstrate to the examiner exactly what is being calculated and will help them award method marks in the event of an incorrect final answer.

- Whilst a knowledge of GCSE chemistry is an important starting point, many questions will require some demonstration of a refinement of these ideas. The same question might appear in a GCSE or an A level paper but the answers, though similar, will not be the same.

- Further practice of the longer six mark questions which require the identification of 6 key indicative points should be a priority for all students.

- Multiple choice questions should never be left blank. Usually one or two answers can be eliminated as unlikely so try to narrow down your choice.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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