Examiners' Report
June 2017

GCE Chemistry 8CH0 01

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk.

Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

ResultsPlus

Giving you insight to inform next steps

ResultsPlus is Pearson's free online service giving instant and detailed analysis of your students' exam results.

See students' scores for every exam question.

Understand how your students' performance compares with class and national averages.

Identify potential topics, skills and types of question where students may need to develop their learning further.

For more information on ResultsPlus, or to log in, visit www.edexcel.com/resultsplus. Your exams officer will be able to set up your ResultsPlus account in minutes via Edexcel Online.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk.

June 2017

Publications Code 8CH0_01_1706_ER

Introduction

This paper gave candidates an opportunity to show their knowledge and understanding with a range of questions covering the different topics. Several of the questions differentiated very well for the more able candidates, whilst less able candidates were also given plenty of opportunity to show what they knew. The following selection of examples from the paper with accompanying feedback and tips is a useful resource to help with highlighting areas of strength and opportunities for improvement.

Question 1 (a) (i)

This proved a good opening question for many candidates, who were able to demonstrate a very good understanding of how to carry out a flame test. Most knew to use hydrochloric acid, either to clear the nichrome wire loop to help the solid stick to the loop or to provide chloride ions for better flame colours. Some continue to use metal wires or innoculation loops or other methods of placing the sample in the flame which are not good enough for marks.

The following response was awarded 1 mark.

1 The presence of some ions in compounds can be identified using a Bunsen burner flame.

(a) (i) Some metal ions give characteristic colours in a flame test.

Describe how to carry out a flame test on an unknown solid.

(2)

A wire loop is firstly dipped into HCl to remove any other substances present. Then dipped into the unknown solid (powder) and then placed on a flame and a colour should apper.

ResultsPlus

Examiner Comments

This candidate was typical of those who used something other than the expected nichrome or platinum wire for the flame test. This did not score the first mark but was able to score the second.

ResultsPlus

Examiner Tip

Attention to detail in practical methods is required to get the full benefit in questions on these techniques in examinations.

Question 1 (b)

Many candidates interpreted their test results and identified the presence of potassium ions and the production of carbon dioxide. Many came up with the answer of K_2CO_3, whilst a few suggested $KHCO_3$. Incorrect answers included KCO3 which scored one mark and KCO2, which did not. Some wrote equations, but generally could still score the mark if it was clear what they were suggesting the substance was, but all candidates should be encouraged to read the questions very carefully.

This response scored both marks.

(b) A flame test on a white powder gave a lilac flame colour. Dilute hydrochloric acid was added to a second sample of the same powder in a boiling tube and the gas produced bubbled into limewater. The limewater turned cloudy.

Give a possible **formula** for the white powder.

(2)

lilac flame = K potassium

CO_3 = turns cloudy

$\boxed{K_2CO_3}$

ResultsPlus
Examiner Comments

This is a typical, fully correct answer. This candidate has done some working out but the answer is clearly identified.

ResultsPlus
Examiner Tip

Underlining or putting your answer in a box, as this candidate has done, makes it easy to find and mark and helps to organise your answers.

K = lilac flame CO_2 = gas produced

KCO_3

ResultsPlus
Examiner Comments

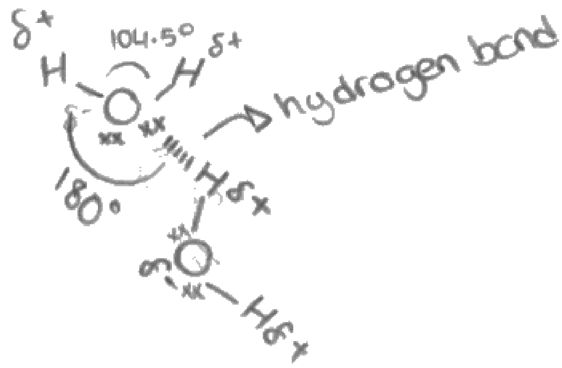
The correct ions, but not correctly balanced as far as charge is concerned, KCO_3 scores one mark out of the two available.

Question 2 (a) (ii)

Some of the diagrams here were extremely good. The bonding in water and intermolecular forces between water molecules had clearly been studied by many candidates, though they were not necessarily able to identify the angle of the bonds in the question. A particularly common mistake was to put the arc for the 180° hydrogen bond angle solely on the hydrogen bond.

(ii) Draw a diagram of a hydrogen bond between two water molecules in ice.

Show the value of the H—O—H angle within a molecule and the value of the O—H—O angle between the two molecules.

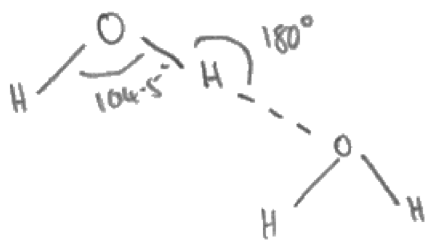


ResultsPlus
Examiner Comments

This diagram is full of useful information such as lone pairs of electrons and partial charges. Unfortunately the 180° angle is not the right one though the second angle required is correct. The diagram does not have the O-H-O angle of 180° drawn correctly and consequently this did not score any marks.

ResultsPlus
Examiner Tip

Read the question twice to make sure you know exactly what to do. It is particularly important in drawings of structures to make sure the distances and angles are appropriate.



ResultsPlus
Examiner Comments

This elegantly drawn example scored both marks.

Question 2 (a) (iii)

A number of candidates were able to explain how the hydrogen bonds resulted in a greater space between the molecules as they were arranged in a lattice arrangement. One or two thought that the spaces between the molecules, however, were filled with air and that it was this that made the ice less dense which prevented them from scoring this mark. A number of scripts referred to the hydrogen bonds taking up more space but made no reference to the molecules of water.

(iii) Explain why hydrogen bonding causes ice to be less dense than liquid water.

(2)

There is more Hydrogen bonding in Ice than in water. Hydrogen bonds increase the space between water molecules. There is more space between water molecules in ice than in liquid water therefore it is less dense.

ResultsPlus
Examiner Comments

This is an example where one mark was scored for the increased space between the water molecules.

ResultsPlus
Examiner Tip

This candidate has highlighted the question to try to help themselves to focus on what is required – a very useful technique.

The hydrogen bonds between the water molecules cause the molecules to ~~separate~~ form a crystal structure, with gaps in between. In liquid water the molecules have enough energy to oppose the bonds and fill these gaps, so ice is less dense in water.

ResultsPlus
Examiner Comments

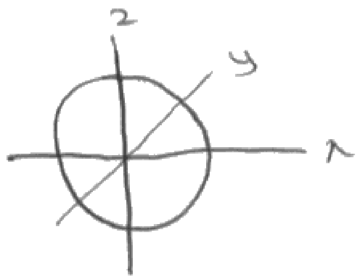
Here the candidate has described the crystal structure of the ice as well as describing gaps, in which liquid water can be filled, so this was an example where 2 marks were awarded.

Question 3 (a)

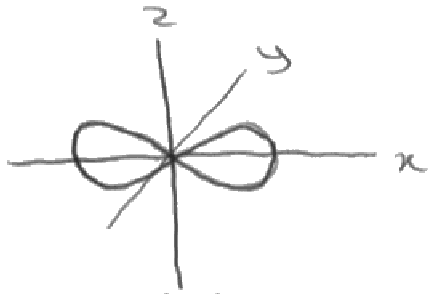
The question was extremely well answered. Most candidates gave the expected correct response, but a number gave an acceptable answer where they showed all three of the p-orbitals in the same diagram.

3 Electrons in atoms occupy orbitals.

(a) Draw in the boxes the shape of an s-orbital and a p-orbital.



s-orbital



p-orbital

ResultsPlus
Examiner Comments

A very nice example of an s-orbital and a p_x orbital worth 2 marks.

ResultsPlus
Examiner Tip

Diagrams are best kept simple, as this one is. Shading is generally not a particularly useful thing in chemistry diagrams and is often best avoided.

Question 3 (b)

The definition of the first ionisation enthalpy was tested regularly on the previous Advanced level specification, and candidates had clearly been made aware of the important parts of this definition. There were very many fully correct answers, with some including the use of an equation to help their explanation. Overall the question was well answered.

(b) State what is meant by the term **first ionisation energy**.

(3)

The enthalpy change required to remove one mole of electrons from one mole of gaseous atoms ~~in a~~ to form one mole of unipositive ions.

ResultsPlus

Examiner Comments

This is an excellent example including all the vital facets of the definition and is worthy of 3 marks.

ResultsPlus

Examiner Tip

A Glossary of the common definitions is a very useful revision aid. Use past paper mark schemes and examiners' reports to identify exactly what is required for each one.

This response gained 2 marks.

the energy needed to remove 1 electron*from 1 mol of a gaseous element to form 1 mol of positively charged gaseous ion

* from the outermost shell (greatest energy level)

ResultsPlus

Examiner Comments

Unfortunately, this otherwise very good definition has omitted the important word **atom** which it is vital to include.

ResultsPlus

Examiner Tip

Learn definitions with great care and attention to detail.

Question 3 (c) (i)

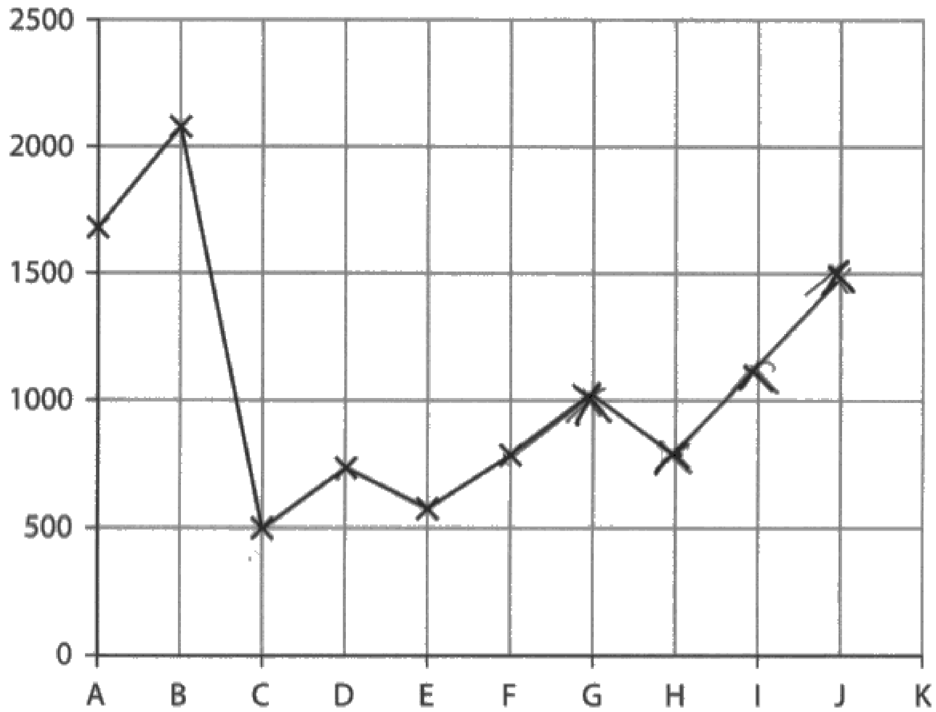
A surprisingly large number of candidates did not appear to realise that this was a question to be attempted. There were many blank diagrams, and even some with labelling on the points given. Candidates really should be encouraged to read carefully what they need to do rather than jumping to conclusions. Of those that attempted this question, some were obviously familiar with this diagram but there were a significant number who appeared not to have seen it before as they produced some unlikely suggestions for the remaining points, the most common of which was a zig-zag pattern.

This is a typical example of a good attempt at this question. The point for H is about at the same height as that of F. It should have been plotted between F and G. This point was given the benefit of the doubt, and this allowed a score of 2, with the points at I and J above H in the expected rising line, and below A and B the elements which would be in the same group. Unfortunately this candidate did not plot the final point for K so was unable to score full marks.

(c) (i) The graph shows the first ionisation energies for a series of six consecutive elements **A**–**F**. The letters are not their chemical symbols.

Complete the graph of the first ionisation energies for the next five elements.

(3)



ResultsPlus
Examiner Comments

It is important that candidates are familiar with, and can recall and explain, graphical relationships, including this between element and first ionisation energy.

ResultsPlus
Examiner Tip

Read the question carefully, this one clearly says plot the next five elements and only four were plotted.

Question 3 (c) (ii)

This compared compound C, an element in group 1, with D in group 2. Candidates were required to recognise this from the graph, in particular the large group between B and C indicating the beginning of a new shell of electrons. The context of this question was slightly unusual making it a little challenging, but for many candidates it was relatively straightforward. Candidates finding this type of question more difficult should be encouraged to start with a basic idea, for example the number of protons in the nucleus of the atoms and the position of the electrons being lost. In this case both electrons were lost from the same s-orbital and the number of protons in D was one higher than in C. Further information, such as the number of shielding electrons and the distance of the electrons from the nucleus can then be included. In this question only basic information was required for the marks.

(ii) Explain why the value of the first ionisation energy for **D** is **greater** than for **C**.

(2)

D has 1 more proton per atom than C with the same amount of shielding so outer electrons experience a greater nuclear attraction, pulling them in more so more energy is required to remove them.

ResultsPlus
Examiner Comments

This example demonstrates an understanding that the number of neutrons attracting the electron being lost has increased from C to D, but the change in ionisation energy observed requires them to be in the same type of orbital, and this has not been clearly shown, so this answer scored 1 mark.

ResultsPlus
Examiner Tip

Be sure to think carefully about what information is needed to fully answer the question. Don't forget to include the most basic information as this is often the starting point on which the answer builds.

Question 3 (c) (iii)

Candidates found this question rather more challenging than the last. Many were convinced that the electron in the outer shell of E being removed was further from the nucleus than the outer electron in D, just because it was an electron in a new sub-shell. Recognising that the electron was in a new sub-shell and was shielded by more electrons between itself and the nucleus was the key here. Good candidates were able to answer accurately and scored well.

This response was awarded 2 marks. It was felt that the candidate was saying that the electron in the p-orbital which was being removed from Element E was further from the nucleus than its own s-electrons, which is true, rather than those of Element D which they are not. This answer was one which just scored full marks.

(iii) Explain why the value of the first ionisation energy of **E** is **less** than for **D**.

(2)

Moving from D to E, even though Nuclear charge increases, the new electron is added to a p-orbital, which is further away from the nucleus and it is also screened by the electrons in the s-subshell, thus the outer electrons are less strongly attracted to the nucleus.

ResultsPlus
Examiner Comments

Candidates should be very clear that not all s-orbitals, even those in the same shell, are the same distance from the nucleus in all elements.

ResultsPlus
Examiner Tip

Think very carefully about the position of the electrons being lost in the two elements. Whilst electrons in the same shell, or even sub-shell, will be a similar distance to the nucleus in different elements they will not be the same distance. The atom gets smaller as you go across the period so equivalent electrons get closer to the nucleus.

This candidate scored 1 mark for recognising that a new sub-shell of electrons had been started. Unfortunately stating that the atomic radius of E was greater than D prevented a second mark from being scored.

The value for the first ionisation energy of E is less than for D because in E one more electron is added to ~~the~~ a new sub-shell. This means that there is an increase in the atomic radius & the shielding making the force of attraction weaker so less energy is required to break off the electron in E than to remove electrons from a full sub-shell in D.

ResultsPlus
Examiner Comments

This example is typical of candidates who were muddled about atomic radius. This candidate may have an idea of fixed sub-shells which are always the same distance from the nucleus, so adding a sub-shell increases the radius, when in fact the radius is less due to the increase in protons in the nucleus.

Question 4 (a)

Candidates found the writing of the ionic equation in these questions extremely challenging, and it differentiated well for higher ability candidates. The first equation was a well-known one and required little prompting, with many candidates scoring here, though there were a number of errors, including not balancing the charge with the number of electrons and not putting the electrons on the correct side of the half-equation. Equation (ii) was probably the most challenging as candidates were required to work out what to include in the equation and needed to identify that water would be formed as a product. Equation (iii) was easier as the candidates are expected to know the full equation for this reaction so only needed to convert it into an ionic equation. Some used this equation to help to write their answers for equation (ii). Part (iv) allowed many candidates to score 1 mark for being able to describe disproportionation, with many able to identify what was happening to chlorine in the equation, even if their equation (iii) was not totally correct.

(a) (i) Write an ionic half-equation for the reduction of chlorine molecules to chloride ions.
State symbols are not required.

(1)

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

(ii) Write an ionic half-equation for the oxidation of chlorine molecules to chlorate(I) ions in the presence of cold, aqueous hydroxide ions.
State symbols are not required.

(1)

$OH^- + Cl_2 \cancel{H_2} \longrightarrow HClO^- +$

$ClO = -1$
$-1 + x = -1$
$x = 0$

(iii) Combine the two equations in (a)(i) and (ii) to give the ionic equation for the reaction of chlorine molecules with cold, aqueous hydroxide ions.

(1)

(iv) Use your answer to (a)(iii) to explain why the reaction is described as a **disproportionation** reaction.

(2)

Because chlorine ~~oxygen~~ is simultaneously being oxidised and reduced in the same reaction.

ResultsPlus
Examiner Comments
This is a typical example of a candidate struggling to write the ionic equations but knowing the definition of disproportionation.

ResultsPlus
Examiner Tip
Practice, practice, practice with ionic equations. Don't forget the electrons, and be sure that the charge is equal on both sides. If it is not, the equation is unbalanced.

(a) (i) Write an ionic half-equation for the reduction of chlorine molecules to chloride ions.
State symbols are not required.

(1)

~~$Cl_2 + 2e^- \rightarrow 2Cl^-$~~ $\frac{1}{2}Cl + e^- \rightarrow Cl^-$

(ii) Write an ionic half-equation for the oxidation of chlorine molecules to chlorate(I) ions in the presence of cold, aqueous hydroxide ions.
State symbols are not required.

(1)

$\frac{1}{2}Cl_2 + 2OH^- \rightarrow ClO^- + H_2O + e^-$

(iii) Combine the two equations in (a)(i) and (ii) to give the ionic equation for the reaction of chlorine molecules with cold, aqueous hydroxide ions.

(1)

$Cl_2 + 2OH^- \rightarrow ClO^- + Cl^- + H_2O$

(iv) Use your answer to (a)(iii) to explain why the reaction is described as a **disproportionation** reaction.

(2)

The reaction is described as disproportionation because chlorine is getting oxidised and reduced simultaneously meaning it oxidation goes from 0 to +1 in ClO^- and 0 to −1 in Cl^-.

ResultsPlus
Examiner Comments
Such a small slip, on an otherwise excellent answer means this candidate dropped one of the marks which were available. In (a)(i) you will see the mistake, 1/2Cl not Cl_2. A simple mistake (it was correct in the crossed out version). The other parts were all very good.

ResultsPlus
Examiner Tip
As well as read the question twice, if you have time read the answers twice too!

Question 4 (b)

Here candidates scored very well, being able to recall the formula of the chlorate (V) ion. In this question we did accept the formula of a typical product, e.g. $NaClO_3$. Candidates were also able to correctly state the oxidation number of +5.

(b) A different ion containing chlorine is formed if the solution of aqueous hydroxide ions is hot.

Give the formula of the chlorine-containing ion **and** the oxidation number of chlorine in this ion.

(2)

→ OCl_3^- oxedation number = +5

ResultsPlus

Examiner Comments

This is a typical correct answer.

Question 4 (c) (i)

This equation was surprisingly hard for candidates to remember. There were many ways found for an incorrect answer, commonly including water, hydrogen ions or electrons in the final equation. Bromine as Br rather than Br_2 was quite common and so were missing charges on ions.

(c) (i) Bromine can be extracted from seawater containing bromide ions using chlorine.

Write the ionic equation for this reaction. State symbols are not required.

(1)

$Cl_2 + Br^- \rightarrow Br_2 + 2Cl^-$

ResultsPlus
Examiner Comments

This unbalanced equation with the correct species unfortunately did not score a mark.

ResultsPlus
Examiner Tip

Carefully count atoms and ions of an element on each side of the equation and charges on each side as both must balance. This one has one minus on the left and two on the right.

Write the ionic equation for this reaction. State symbols are not required.

(1)

$Cl_2 + 2HBr \longrightarrow 2HCl + Br_2$

ResultsPlus
Examiner Comments

This example included hydrogen in the answer, and so did not score.

Question 4 (c) (ii)

Candidates were able to answer this very well, with both chlorine and bromine available to choose a hazard that accompanies their use.

(ii) Identify **one** hazard associated with carrying out this reaction in a school laboratory and a safety precaution other than wearing a laboratory coat and eye protection.

(2)

Bromine gas is toxic and a face mask should be worn, to avoid inhaling the gas.

ResultsPlus
Examiner Comments

An example which gains the first mark but not the second as a face mask is insufficient for use with bromine here.

ResultsPlus
Examiner Tip

Always try to be precise about sources of a hazard and match the precaution to it as this candidate has tried to do.

Question 5 (a) (i)

This question was very well answered, with most candidates able to give the electronic configuration for magnesium atoms.

Question 5 (b)

This was well answered by many candidates, with most scoring at least one mark out of the two available.

(b) Magnesium exists as three stable isotopes. One isotope has a relative isotopic mass of 25.0.

State what is meant by the term **relative isotopic mass**.

(2)

Relative isotopic mass is the mass of an individual atom of a particular isotope relative to 1/12 th the mass of an atom of carbon 12 .

ResultsPlus
Examiner Comments

This is an excellent example of a response which scored both marks. Clearly the candidate recognises that it is the mass of an atom that is being defined and also the relevance of carbon-12.

ResultsPlus
Examiner Tip

This is another definition for the Glossary. It is important that the sense of the definition is correct as well as using the correct terminology.

The average mass of the same element of an isotope compare to the mass of $\frac{1}{12}$ of Carbon-12 atom.

ResultsPlus
Examiner Comments

This candidate has confidently demonstrated their understanding of the relative mass compared to carbon-12, but this is not clearly about an atom of an isotope, so only scored one mark.

Question 5 (d)

This calculation was extremely well done in general. Many were able to score full marks, laying out their work in an easily understandable way. Some assumed the isotopic mass of the missing isotope was 24 and calculated the relative atomic mass, which limited their marks as this was not what they were asked to do.

(d) The relative atomic mass of a sample of magnesium was found to be 24.3.
The percentage composition for two of the three isotopes is given in the table.
Use these data to calculate the percentage composition of the third isotope and hence its relative isotopic mass. Give your answer to an appropriate number of significant figures. You **must** show your working.

3 s.f.

Relative isotopic mass	Percentage abundance
25.0	10.00
26.0	11.01

(4)

$$\frac{(25.0 \times 10) + (26.0 \times 11.01) + (M \times 78.99)}{100} = 24.3$$

$$250 + 286.26 + (78.99 \cdot M) = 2430$$

$$78.99M = 1893.74$$

$$M = \frac{1893.74}{78.99}$$

$$= 23.97$$

$$\therefore \boxed{24.0 \quad 3\text{ s.f.}}$$

Relative isotopic mass = 24.0

Percentage abundance = 78.99

ResultsPlus
Examiner Comments

This clearly laid out example was a good answer scoring full marks.

ResultsPlus
Examiner Tip

Clearly laid out answers are both easier to read and mark but they also help to organise and direct your thoughts during a calculation when the route to the end may not always be obvious.

Some candidates decided to assume that the value was 24 and then calculate the value of the relative atomic mass. This was not what they were asked to do, however.

$$100 - 10 - 11.01 = 78.99$$

$$24 \times \frac{78.99}{100} + 25 \times \frac{10}{100} + 26 \times \frac{11.01}{100}$$

$$= 24.32$$

so relative isotopic mass is 24

ResultsPlus
Examiner Comments

This example of the approach outlined scores 1 mark for the percentage of the third isotope.

Question 6 (a) (i)

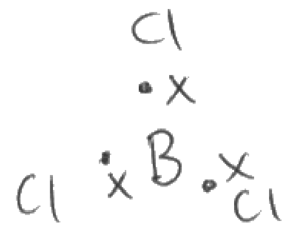
This equation proved more straightforward for candidates than the ionic equations in Question 4. Here, many demonstrated a good understanding of equation writing, with many correct answers in a number of formats. Incorrect answers commonly included Cl_3 or B_2.

Question 6 (a) (ii) and (iii)

Recognition that boron could have an incomplete octet in its outer shell was necessary for this question. Most candidates were able to realise this, but some lost marks by not including the outer shell electrons in the boron. Some believed that boron had a lone pair, but still stated confidently that it did not in part (iii) so were still able to score both marks for the shape of the boron trichloride.

(ii) Draw a dot-and-cross diagram for BCl_3 showing only the outer shell electrons of the atoms.

(1)



(iii) Use your diagram to explain why BCl_3 has a trigonal planar shape with bond angles of 120°.

(2)

B ~~an Cl in BCl3 have no~~ has no lone pairs in BCl_3 and the B–Cl bonds have equal repulsion on one plane so they form a trigonal planar shape as there are 3 B–Cl bonds and because of equal repulsion the bond angle is $\frac{360}{3} = 120°$

ResultsPlus

Examiner Comments

This example is missing the outer electrons from the chlorine, so cannot score the mark in (i), but they have described the electrons in the outer shell of boron in (ii) so score the first of the two marks here. This candidate then describes the repulsion between the boron to chlorine bonds as equal. This does not say that the repulsion is a minimum or that the separation is a maximum, an understanding of which was required for the second mark.

Question 6 (b)

This calculation, which is of an unusual type compared to the previous specification, was very well answered by some. An approach calculating the empirical formula of aluminium chloride was expected, though not necessarily required. Some candidates used the ideal gas equation to find the number of moles and combined this with the mass of solid to find the molecular mass and hence the formula, which was an acceptable approach.

This is a nice example of the approach to the question of calculating the value for the molecular mass and then the molecular formula.

(b) Aluminium also reacts directly with chlorine to form a compound, aluminium chloride, containing only aluminium and chlorine.

A 0.500 g sample of aluminium chloride was analysed and found to contain 0.101 g of aluminium.

Another 0.500 g sample was heated to 473 K. The gas produced occupied a volume of 73.6 cm^3 at a pressure of 1.00×10^2 kPa.

Determine the molecular formula of the gas.

You will need to use the equation $pV = nRT$ and $R = 8.31\ \text{J mol}^{-1}\text{K}^{-1}$

(6)

m / n | Mr

$pV = nRT \longrightarrow \frac{pV}{RT} = n$

$\boxed{\cancel{1.00 \times 10^2 \times 1000 = 100{,}000\ \text{Pa}}}$

$\cancel{73.6\ \text{cm}^3 \times 10^6 = 73600000\ \text{m}^3}$

$\boxed{73.6\ \text{cm}^3 \div 10^6 = 7.36 \times 10^{-5}}$

$\cancel{\frac{100{,}000 \times 73600000}{8.31 \times 473}} =$

$100{,}000 \times (7.36 \times 10^{-5}) = 7.36$

$\cancel{\frac{1.00 \times 10^2 \times 73.6}{8.31 \times 473}} =$

$\frac{7.36}{8.31 \times 473} = 0.00187\ \text{mol}$

$\frac{0.500\text{g}}{0.00187} = $ Mr, 267.379.

Al = 3 outer electrons.

c

$27.0 + (35.5 \times 3) = (133.5 \times 2) = 267.$

$\underline{Al_2Cl_6}$

ResultsPlus

Examiner Comments

This candidate has demonstrated an understanding of the 1 to 3 ratio for the aluminium and chlorine, though this was not required for full marks to be given.

0.5 - 0.101 = 0.399g ← Cl⁻ in AlCl

1.00×10^2 Kpa = 1000000 pa.

$73.6 cm^3$ = 73600 dm^3

$$\frac{1000000 \times 73600}{8.31 \times 473} = 18724733.69 \text{ moles}$$

RMF = Cl_2.

ResultsPlus

Examiner Comments

This candidate has correctly converted the pressure value into pascals, but has gone wrong with the volume value, which should be divided by 1,000,000 not multiplied by 1,000. Consequently this scores one for correctly using the equation with incorrect values.

Question 6 (c)

Candidates were not expected to know that AlF_3 is a giant covalent structure; they were expected to deduce from the high sublimation temperature that it was a giant structure, perhaps ionic. They know the structure of Al_2Cl_6 and were expected to deduce that $AlCl_3$ was also covalent. They were also expected to know that the shape of BCl_3 is the same as that of $AlCl_3$, trigonal planar, so it would be non-polar. Instead a range of scenarios were presented for the bonding and structure of the two substances and hence the reason for their sublimation temperatures. Most candidates sensibly quoted and used the electronegativity data so gained some credit.

This is a very good answer scoring all 6 marks.

*(c) Aluminium fluoride and aluminium chloride are both crystalline solids at room temperature. Aluminium fluoride sublimes to form a gas at 1291 °C (1564 K), whilst aluminium chloride sublimes at 178 °C (451 K).

Use the Pauling electronegativity values in the Data Booklet to explain these differences in sublimation temperature.

(6)

Both Aluminium fluoride and aluminium chloride are polar ~~subst~~ molecules. They therefore form large crystalline solids because their strong permanent dipole-dipole forces hold the molecules together. Fluorine is the most electronegative element, this ~~means that it will cause~~ allows it to cause very strong dipoles. ~~The electrone~~ The electronegativity difference between Fluorine and aluminium is of 2.5 and the difference between chlorine and Aluminium is of 1.5. We can see how there is a larger electronegativity difference between Al + F ~~as~~ than Al + Cl. This ~~allow~~ makes the bond between F and ~~●~~ Al more polar, as F is the most electronegative element. This difference in electronegativity allows F to distort Aluminium's electron cloud more than Cl. ~~The~~ Fluorine causes a stronger dipole than Cl when bonded with Al. This means that there will be a stronger attraction between aluminium fluoride molecule than there will be between Aluminium chloride. Therefore more energy required to break the strong electrostatic attractions caused by the dipoles in Aluminium fluoride than in Aluminium chloride. More energy is required to break the bonds for Aluminium fluoride to sublime because its dipole-dipole-forces (caused by the strong dipole within the molecule, because F is very electronegative) are ~~very~~ stronger than those of Aluminium chloride - because Cl is less electronegativity and cannot make such a big dipole in the molecule and therefore the forces of attraction between molecules are weaker.

(Total for Question 6 = 16 marks)

ResultsPlus
Examiner Comments

Carefully consider which six points might be required on a six mark question. Then try to link these into a coherent argument. This candidate has done that and scores all six marks.

ResultsPlus
Examiner Tip

It is important to practice these longer answer questions. Try to identify the six key points (indicative points) which are identified in the mark scheme.

Fluorine in Aluminium fluoride is ~~the high~~ the most electronegative (4.1) due to the small radius and the large nuclear charge. Fluorine is also a very good oxidising agent. This is because fluorine is small so it can keep electrons very close to the nucleus which increases the attraction between the outermost electrons and the ~~A~~ nucleus.

Also, the boiling temperature ~~Chlorine As Also, boiling temperature~~ increases down group 7 as the atomic radius increases and there ~~are~~ is more shielding. It is easier for chlorine to let go of the electrons than it is for fluorine.

Also, the electronegativity difference is aluminium ~~ch~~ fluoride is 2.5, but for ~~chlorine it~~ aluminium chloride it is 1.5 so aluminium fluoride needs more heat to ~~turn into~~ form a gas.

(Total for Question 6 = 16 marks)

ResultsPlus

Examiner Comments

This candidate has tried to explain electronegativity differences in fluorine and chlorine rather than use the values to consider structure and bonding. Though much of what is written in paragraphs one and two is true, it is not worth any marks. Paragraph three scores two indicative points, and so the final score is two as not enough has been covered to demonstrate good linking of information.

Question 7 (a)

This question produced a range of scores for candidates. Some found the calculation too difficult to attempt, but could still score either one or two marks for filling in the data correctly and calculating a mean titre. The calculation itself required candidates to calculate the moles of sodium carbonate in the 10cm3 portions; realise that twice as many moles of HCl would be present in the titre volume and hence calculate the concentration of the hydrochloric acid.

This candidate has made a very good attempt. The table is completed correctly with all ticks and values to 2 decimal places. The initial step of the calculation to find the mean titre is correct, but then there are a number of steps leading to a value of 1.02 mol dm^{-3}, suggesting the candidate has not divided by 10 to find the moles of sodium carbonate in the volume of solution used in the titration. This scored 4 marks out of the 5 available.

Titration	1	2	3	4	5
Final burette reading / cm^3	26.00	34.00	36.10	24.15	48.20
Initial burette reading / cm^3	0.00	10.00	11.00	0.05	24.15
Titre / cm^3	26.00	24.00	25.10	24.10	24.05
Concordant results (✓)		✓		✓	✓

(a) Complete the table and determine the concentration, in mol dm^{-3}, of the hydrochloric acid solution, giving the answer to an appropriate number of significant figures.

(5)

$\frac{24+24.1+24.05}{3} = 24.05\ cm^3$

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

$V = \frac{10}{1000} = 0.01$

$n = c \times v$

Na_2CO_3 1.3g = m $\quad$ $v = \frac{100}{1000} = 0.1$ $\quad$ $n = \frac{m}{mr} = \frac{1.3}{12+48+46} = 0.012264$ moles $\quad$ $\frac{n}{v} = c$ $\quad$ $\frac{0.012264...}{0.1} = 1.2264$ moldm^{-3}

C of Na_2CO_3

$Na_2CO_3 : HCl$

1:2 ratio

~~cxv~~ ~~0.1~~ $c \times v$

0.01×1.2264

$= 0.012264$ moles $\quad \times 2 = 0.024528$ moles HCl

$n = c \times v$

$\frac{n}{v} = c$

$\frac{24.05}{1000} = 0.02405 \qquad \frac{0.024528}{0.02405} = 1.02$ moldm^{-3}

ResultsPlus
Examiner Comments

The calculation here is rather unstructured and would benefit greatly for some comments as to what is being calculated. This would make the answer clear for both the candidate and the examiner marking the work.

ResultsPlus
Examiner Tip

Structure your calculations to show clearly what is being calculated.

Titration	1	2	3	4	5
Final burette reading / cm^3	26.00	34.00	36.10	24.15	48.20
Initial burette reading / cm^3	0.00	10.00	11.00	0.05	24.15
Titre / cm^3	26.00	24.00	25.10	24.10	24.05
Concordant results (✓)				✓	✓

(a) Complete the table and determine the concentration, in mol dm^{-3}, of the hydrochloric acid solution, giving the answer to an appropriate number of significant figures.

(5)

mean titre $= \frac{(24.1 + 24.05)}{2} = 24.075$

	HCl	Na_2CO_3
conc	?	
volume	24.075 cm^3	100 cm^3
moles	0.0123 x 2 = 0.0246 moles	$n = m/M_r = \frac{1.3}{106} = 0.0123$ moles.

$n = c \times V$

$c = \frac{n}{V} = \frac{0.0246}{(24.075 \div 1000)} = 1.022$ $moldm^{-3}$ of HCl

ResultsPlus
Examiner Comments

This is another good attempt, but scores only 2 of the 5 marks. The initial data is completed correctly, but only 2 of the 3 concordant titres are ticked. The candidate has not divided the number of moles of sodium carbonate by ten to find the number in 10 cm^3 so loses a mark here. The rest of the calculation is correct, but the answer is given to 4 significant figures which shows greater precision than is possible with the data.

Question 7 (c)

Candidates have clearly attempted a considerable amount of titration in their courses. There were many good answers with many candidates scoring full marks. Some candidates needed to read the question more carefully as they were discussing perfectly valid approaches the technician could take to obtain a good result, but not at the point just before and at the neutralisation point as the question required. This question began with the command 'Explain' so the candidates needed to say what could be done and why it would make the result more accurate. We were looking for two major things which should happen in the titration at around the end point which were drop by drop addition to ensure the end point was not overshot and swirling of the mixture to ensure it was homogenous so all the acid and alkali could react. In addition, one of the remaining ideas could be used to secure the third mark, with most candidates using a white background to more clearly see the colour change.

This candidate scored 2 marks for the first two very sensible suggestions. The third suggestion is rather unusual and did not score.

(c) Explain **three** actions the technician might take in the procedure, just before the end-point of the titration, to ensure that the volume of acid added at the end-point is accurate.

(3)

Swirl the mixture to ensure that solution is uniform. Place a white tile under the solution to ensure that he stops exactly when solution turns orange. Use a teat pippette for the final drops of HCl, to ensure that he didn4 overshoot the end-point. Pippete has a lower % uncertainty.

ResultsPlus
Examiner Comments

Remember in 'Explain' questions that some justification of the point being made is required. This is done here in the first two sentences.

ResultsPlus
Examiner Tip

Justify your points in an 'Explain' question.

Question 8 (a)

Although some candidates were unsure of the state of calcium chloride in the product of this reaction, most scored well. In (ii) a relatively straightforward relative formula mass calculation was handled well by most candidates. Many candidates know how to approach part (iii) but were not sufficiently precise in their demonstration that the hydrochloric acid was in excess for the second point so quite a few scored only 1 mark.

(a) (i) Write the equation for the reaction between calcium carbonate and hydrochloric acid. Include state symbols.

(2)

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CO_{2(g)} + H_2O_{(l)} + CaCl_{2(s)}$$

(ii) Calculate the molar mass of calcium carbonate.

(1)

$40.1 + 12 + (16 \times 3)$

$= 100.1$

~~t~~ 100.1 g mol^{-1}

(iii) Show that, in each experiment, the hydrochloric acid is in excess.

(2)

$n = \frac{m}{Mr}$ $\qquad n = \frac{0.50}{100.1} = 4.995 \times 10^{-3}$ mol

$= 0.004995$ mol

→ most amount of $CaCO_3$ used

$n = C \times V$

$n = 2.00 \times 20$

$= 40$ mol

→ amount of HCl used.

→ always in excess

ResultsPlus

Examiner Comments

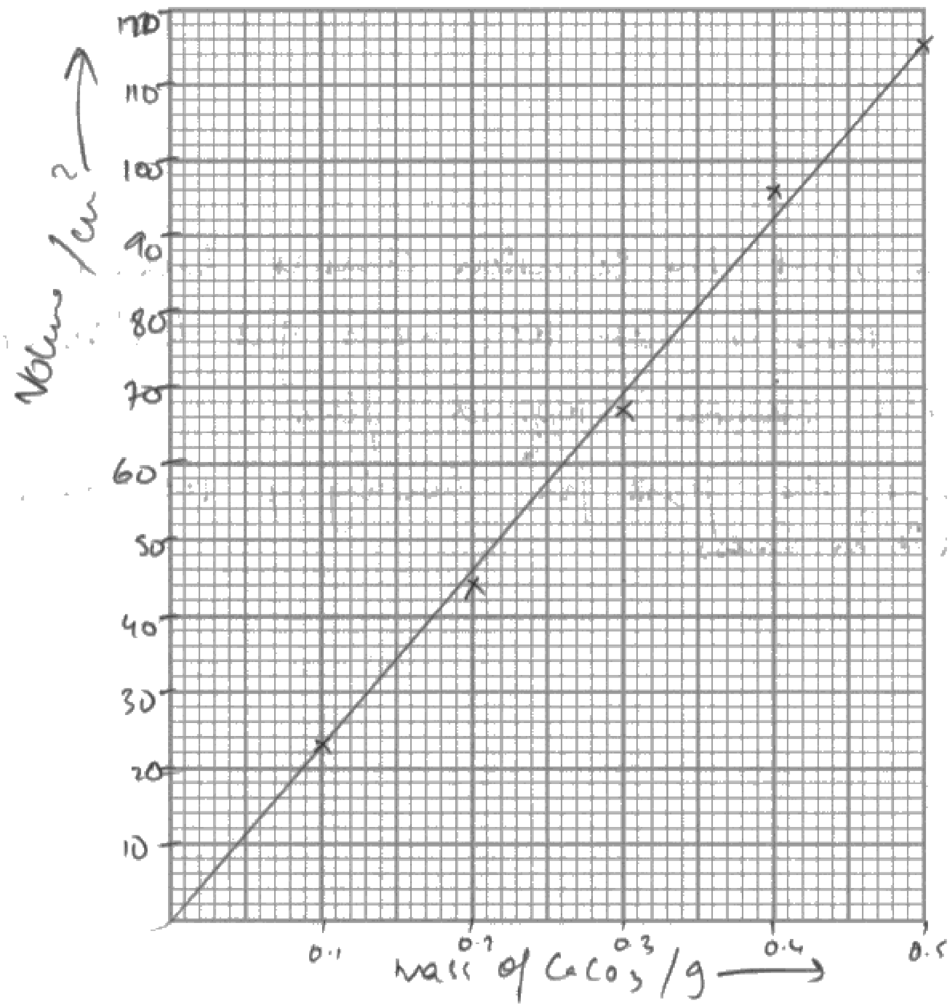
This example has an incorrect state symbol for calcium chloride in an otherwise correct equation. The molar mass is correctly calculated and used in (iii) to calculate the moles of calcium carbonate, but the moles of acid is not correct. This scored 1 mark for each of the three part questions so a total of 3 marks for part (a).

Question 8 (b) - (c)

These questions were quite challenging. The graph drawing and explanation of the plot were generally of a reasonable standard, though there is some scope for practice here. In general axes were labelled and lines of best fit were appropriate, with most points plotted correctly. The point most likely to be plotted incorrectly was the one for mass 0.5g and volume 115 cm^3 which was often plotted at 105 cm^3. The data points on a graph should cover at least half the graph paper. Graphs can normally be plotted which conveniently cover all or most of the available graph paper.

(b) (i) Plot a graph of volume of carbon dioxide produced against mass of calcium carbonate on the grid. Include a line of best fit.

(2)



(ii) State how your graph supports the idea that the volume of gas produced depends directly on the mass of calcium carbonate added.

(1)

constant gradient, Straight line through the origin.

(c) Calculate the volume, under these conditions, of one mole of carbon dioxide gas from these data. Give your answer in dm^3 to **two** significant figures.

(2)

moles of CO_2 = $\frac{0.04}{2}$ = 0.02 moles

volume of CO_2 = 0.02×24

= $0.48\ dm^3$

ResultsPlus
Examiner Comments

This example has a very good graph, scoring both of the available marks, and the description of the relationship between the mass and volume as a straight line through the origin is exactly what was expected. The final calculation of molar volume however is confused so did not score.

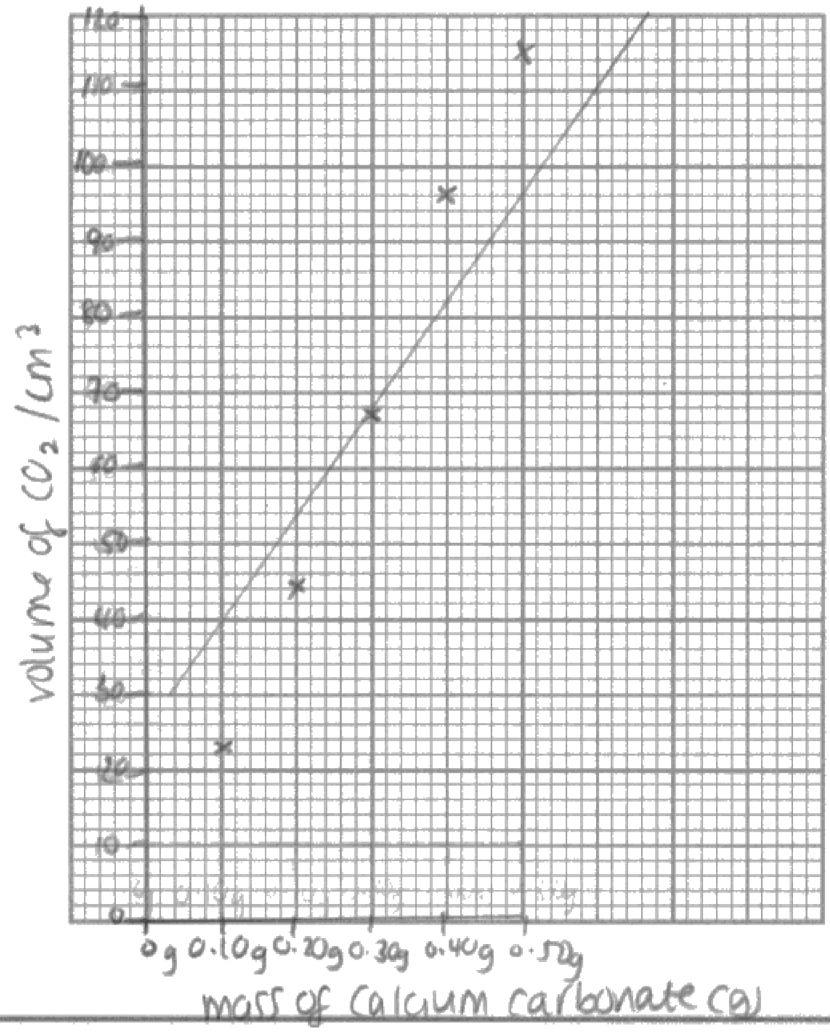
ResultsPlus
Examiner Tip

You should aim to fill the available graph paper with your graphs.

This example has a graph which only fills half the paper, so the points do not cover sufficient of the graph paper to allow for full marks in (i). The description of the line is not enough in (ii) to score that mark. In part (iii) the answer is a factor of 1,000 out. Unfortunately it is not clear where the value of 0.8695652174 comes from so it is not clear where the answer comes from. It did not score any marks.

(b) (i) Plot a graph of volume of carbon dioxide produced against mass of calcium carbonate on the grid. Include a line of best fit.

(2)



(ii) State how your graph supports the idea that the volume of gas produced depends directly on the mass of calcium carbonate added.

(1)

As the mass of calcium carbonate increases the volume of gas produced also increases which shows a direct relationship.

(c) Calculate the volume, under these conditions, of one mole of carbon dioxide gas from these data. Give your answer in dm³ to **two** significant figures.

(2)

c m v moles of HCl = 0·02 × 2·00

= 0·04

conc

↓

moles of CO_2 = 0·04 ÷ 2 = 0·02 0·8695652174

$$\text{vol} = \frac{0·02}{0·8695652174} = \underline{0·023}\ \text{dm}^3$$

~~mol~~ ~~dm~~$^{-3}$

B

ResultsPlus
Examiner Comments

A commentary on the source of the value given in the answer might have allowed marks to be scored as this answer is a factor of 1,000 out so may be worthy of credit.

ResultsPlus
Examiner Tip

Label your calculations to say what is being found and where the numbers come from. Plotted graphs should have axis which fill most of the paper and points which cover over half.

Question 8 (d)

This question was a very challenging end to the paper. A few candidates knew that carbon dioxide was soluble in the reaction mixture and were able to deduce that the initial pinch of carbonate would saturate the solution. There were some very interesting attempts to answer the question which had some credit, for example suggesting that the whole apparatus would be filled with carbon dioxide rather than air, but these were not sufficient and with only one mark available, did not score.

(d) Give a reason why the student added a small pinch of calcium carbonate to the acid before starting the reaction.

(1)

to saturate the solution with CO_2, so that CO_2 produced by the experiment did not dissolve in the water.

ResultsPlus

Examiner Comments

This is an example of one of the relatively few good answers to this question.

Paper Summary

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

- Candidates should aim to read the questions with great care in order to establish exactly what is being asked. It is easy to begin reading a question and leap to a conclusion as to where a question is leading which may be the wrong one. If time allows, reading through the answers twice is also an excellent way of picking up slips and mistakes.
- In common with all papers in this specification, the majority of calculations are now unstructured and require thought as to how to work through the information. There may well be more than one route so it is important to explain to the examiner what you are trying to do. This will help with the marking of your work, but it will also help to organise your thoughts and ensure that your calculation is travelling in the right direction!
- Within these calculations the phrase 'to an appropriate number of significant figures' will be seen. This should prompt a search for the data with the lowest precision as it is this which will determine the appropriate number of figures.
- Sloppy use of terms such as charge density, effective nuclear charge, shell, sub-shell and orbital is a place where marks can be lost. Make sure you know exactly what each one means so you use them in the appropriate context.
- The longer 6 mark questions require practice. Try to identify what the six key 'indicative points' might be and then construct your argument around these.

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

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Rewarding Learning

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL.