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Examiners' Report
June 2017

IAL Chemistry WCH01 01

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June 2017

Publications Code WCH01_01_1706_ER

Introduction

The paper was accessible to the majority of candidates, though some parts of the last question were not attempted which may indicate that some candidates were short of time. The most challenging questions were the calculation on the Born-Haber cycle in Q21, and the calculation on enthalpy change in Q22. Giving clear explanations in several questions also proved to be demanding, candidates may have benefited from reading the question more thoroughly. In Q20(a)(iv), for example, many answers stated that isotopes had the same atomic number but different atomic mass. This did not answer the question as it did not explain why the chemical properties of the isotopes are the same.

Question 19 (a) (i)

Most candidates knew how to calculate the relative atomic mass of a mixture of isotopes. However answers given to four significant figures did not score both marks, as the question asked for three. Candidates should be encouraged to think whether their answers are in line with what the question requires. The calculated atomic mass cannot be outside the range 54-56 (the range of masses of the isotopes) so candidates would have benefited had they checked any answers outside this range.

(a) (i) Calculate the relative atomic mass of the element in this sample.

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

$$RAM = \frac{(54 \times 6.10) + (56 \times 92) + (57 \times 1.90)}{100}$$

$= 106.204$

$= 106 \text{ g mol}^{-1}$

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Examiner Comments

This example shows the correct procedure for calculating the relative atomic mass, but although their answer is to 3 significant figures they have made an error with their calculator, so only score 1 mark.
In this question, a candidate ought to expect the value to be around 56, so an answer of 106 should have perhaps caused the candidate to double check their answer.

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Examiner Tip

Look at numerical answers to see if they are logical and near the range of masses of the isotopes, and check calculations of any values that are out of this range.

Question 19 (a) (ii)

Many candidates were unable to identify that the species in a mass spectrometer are positive ions, so although iron was frequently identified, few correctly identified the number of electrons. This was despite the fact that later in the question, the vast majority went on to describe how the atom was ionised.

(ii) Identify **X** and hence give the numbers of subatomic particles present in the species at $m/e = 56$ in the mass spectrum.

(2)

X Ba / ~~Barium~~ Barium

Number of particles present in the species at $m/e = 56$		
protons	electrons	neutrons
56	56	81.3

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Examiner Comments

This was a surprisingly common incorrect answer, with candidates confusing relative atomic mass with atomic number.
It scored no marks.

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Examiner Tip

Make sure you apply the common skills from pre-16 courses, such as finding the number of protons, neutrons and electrons, throughout your A level studies.

Question 19 (a) (iii)

This question referred to element **X**, which had been extracted from a meteorite, not to a sample of the meteorite. Many candidates looked at the Periodic Table for an atom with mass or atomic number of 28. Some suggested ethane, which has molecular mass 28, or molecular nitrogen. As in part (a)(ii), it was rare to see candidates identify that the species is an ion.

(iii) A peak at $m/e = 28$ was also detected in the mass spectrum of **X**.

Identify the species which produced this peak.

(1)

Ethene - (alkene) or even silicon

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Examiner Comments

Many candidates simply looked for a species with a mass of 28, not considering the mass/charge ratio. This example shows two of the most common incorrect answers, gaining no marks.

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Examiner Tip

Remember that in a mass spectrometer, some particles may lose two electrons not just one. For atoms, this will give a peak at a mass/charge ratio of half that of the relative atomic mass.

Question 19 (a) (iv)

To be awarded the marks candidates had to make it clear that the number of electrons in the outer shell, or the electron configuration, is what determines chemical properties. Saying that the number of electrons is the same in isotopes is only part of the answer. A large number of responses were framed in the context of describing what is meant by the term isotope; however this was not what the question asked. Such answers often did not manage to score both marking points.

(iv) Explain why the three isotopes of **X** have the same chemical properties.

(2)

Because they all isotopes which has same atomic number and different mass number. And also they are extracted ~~dry~~ from a meteorite, and have same properties of solid.

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Examiner Comments

This example has just described what is meant by isotope, and has not really explained why they have the same chemical properties as there is no mention of electrons, so did not receive any credit.

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Examiner Tip

Read each question carefully to make sure you are clear what it is asking. Use the command words, such as describe and explain, to help you focus on the type of response required.

Question 19 (b) (i)

The majority of candidate knew that ionisation is carried out in the mass spectrometer by bombarding a sample with electrons. However, a significant number of candidates did not mention that the solid sample must first be vaporised.

(b) (i) Outline how a solid sample of element **X** is converted into ions in a mass spectrometer.

(2)

By Bombardment of the sample with high energy electrons.

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Examiner Comments

Here the candidate successfully describes how to ionise the sample, but as there is no reference to converting the solid to a gas, they only score 1 mark.

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Examiner Tip

Remember that to form ions, the substance has to first be in the gaseous state. Read the stem carefully to help you frame your answer. The statement that X is a solid was a prompt that samples have to be vaporised.

Question 19 (b) (ii)

The steps in production of the mass spectrum were generally well known. A description of the terms “acceleration” and “deflection” was allowed, but when candidates used these terms there were some variations such as “deflation” and “defection”. Many candidates repeated a description of the vaporisation and ionisation stages,indicating that they had not read the question with care. On occasion this repetition had the undesired effect that candidates stopped after describing acceleration, thinking they had covered three steps.

(ii) Following the formation of ions, there are three steps in the production of a spectrum in the mass spectrometer.

Name the three steps **in order** and state how the first two are carried out.

(3)

First the atoms are vapouised. The ~~ions or~~ atoms are sent through the vapourising chamber. Then the atoms are ionised. The atoms are sent through the ionising chamber. Here positive ions are formed by bomberding with electrons. Then these positive ions are accelerated in the acceleration chamber by the use of 'electric field'. Then these ions enter the deflection chamber where a magnetic field is present. Ions deflect and detector take results

(Total for Question 19 = 12 marks)

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Examiner Comments

This answer covers all the three steps of the process after ionisation, and states how the ions are accelerated and deflected, so scores all 3 marks. However they repeated their answer to part (b)(ii). This did not lose any credit, but they could have used this time for other questions.

ResultsPlus
Examiner Tip

Be careful to answer only the question that is asked. Whilst extra correct but irrelevant information can be ignored, sometimes candidates can include additional statements which contradict their earlier work, and so lose credit as well as time.

Question 20 (a) (i)

Most types of bonding were suggested here as well as metallic, but if the type was incorrect no marks were allowed. The question asked for an explanation of how the bonding holds the structure together, so a description of the structure did not score both marks unless there was also a reference to the attraction of the delocalised electrons and the positively charged ions or positive nucleus.

(i) Name the type of bonding in sodium and explain how this bonding holds the structure together.

(2)

Sodium has a giant metallic structure with many layers of positive Na ions covered by a sea of free mobile delocalised electrons. The attraction between Na ions and surrounding sea of delocalised electrons holds the structure together and gives Na a high melting point.

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Examiner Comments

This example shows how the candidate has carefully considered the command words and hence both named the type of bond and explained how it holds the structure together, so scored both marks.

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Examiner Tip

Sometimes in this type of question, a clear diagram, provided it is annotated, can be an effective way for more visual learners to illustrate their understanding.

Question 20 (a) (ii)

Various types of bonding were suggested though ionic was most common; the question asked for an explanation of how the bonding holds the structure together. Candidates who described the formation of sodium and bromide ions could not score unless they referred to the attraction between oppositely charged ions.

(ii) Name the type of bonding in sodium bromide and explain how this bonding holds the structure together.

(1)

Sodium bromide has ~~covalent~~ ionic bonding ~~which has strong forces of attraction between the negative electrons and the positive nuclei~~ which has strong electrostatic forces of attractions between the positive and negative ions.

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Examiner Comments

Here the candidate scores the mark as both the bonding type and the attraction between positive and negative ions were evident.

ResultsPlus
Examiner Tip

Take care when referring to halide ions. In this question 'ionic bond which is an attraction between sodium and brom**ide** ions' was allowed, but 'ionic bond which is an attraction between sodium and brom**ine** ions' was not.

Question 20 (a) (iii)

The majority of candidates scored this mark. Some did not refer to bonding so did not score, tending to reframe the question as their answer.

(iii) The table shows the melting temperatures of sodium and of sodium bromide.

Substance	Sodium	Sodium bromide
Melting temperature / K	371	1020

What can you deduce from these data about the bonding in the two substances?

(1)

Ionic bonding is stronger than metallic.

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Examiner Comments

As the question asks what can be deduced about the bonding in the two substances, a comparison is needed to score the mark. This response does that succinctly so was awarded the mark.

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Examiner Tip

Use of comparative language can be an important skill to use in exam questions. Words like 'stronger' and 'weaker' often give more information about your understanding than just 'strong' or 'weak'.

Question 20 (a) (iv)

The vast majority of answers referred to electrical conductivity, and most had little or no problem with this question. When problems occurred it was generally because answers suggested that sodium bromide did not conduct under any circumstances, or it was unclear whether they were referring to electrical or thermal conductivity.

(iv) Name **one** physical property, other than melting or boiling temperature, in which sodium and sodium bromide differ due to the difference in their bonding.

Describe how this property differs for each of the two substances.

(2)

Sodium can conduct electricity in solid state but sodium bromide can't conduct electricity in solid state only when molten or in aqueous state because the ions in sodium bromide are closely packed together in solid state but free to move in aqueous and molten whereas in sodium the delocalised electrons are free to carry current even in solid state

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Examiner Comments

This example scores 2 marks as it is clear that they have stated the property and described the difference, stating that sodium bromide does not conduct when solid. They then go on to explain this difference, which was not required in the question.

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Examiner Tip

Remember that 'describe' questions alone do not need you to explain your descriptions. In this case the explanation is correct but would have taken the candidate time that could have been spent on other questions.

Question 20 (b) (i)

Although there was evidence that candidates had some understanding of dative covalent bonding, they often found it difficult to put into words precisely how they differ from covalent bonds. The use of the word 'share' was prevalent but often difficult to judge whether answers were discussing electrons simply shared between atoms, which is the outcome for both bond types, or 'shared from' one atom to another, which may imply dative covalent.

(b) The ammonium ion, NH_4^+, contains covalent bonds and a dative covalent bond.

(i) Describe the difference between a covalent bond and a dative covalent bond.

(2)

Covalent bond is the sharing of electrons from both atoms.
dative bond is when an atom donate its lone pairs to another
atom.

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Examiner Comments

This example scored the first mark, as the idea of 'sharing electrons from both atoms' was enough evidence to show that the electron pair is derived from both atoms in the covalent bond.

Similarly, the source of the two electrons for the dative bond pair from one atom, scores the second mark.

ResultsPlus
Examiner Tip

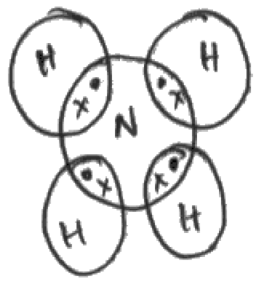
Candidates could practice their written answers when revising and ask friends to review them to see if they make sense. They could then compare them to text book descriptions to help develop less ambiguous language.

Question 20 (b) (ii)

The question included the formula of the ammonium ion, but despite this many answers showed the dot and cross diagram for ammonia. When the ammonium ion was drawn correctly the charge was often missing, or else none of the bonds was dative covalent i.e. with two dots for nitrogen electrons being shared by a hydrogen atom with no electrons. If candidates reversed the symbols, using a cross for nitrogen, this was not penalised.

(ii) Draw a dot and cross diagram for an ammonium ion. Use the symbol **x** for electrons from the hydrogen atoms and **•** for electrons from the outer shell of the nitrogen atom.

(2)



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Examiner Comments

This was a very common type of response and it scored 1 mark. The four bonds are clearly shown but it is not evident which one has both electrons derived from the nitrogen. The charge for the ion is also missing.

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Examiner Tip

In dot and cross diagrams use the dot and cross symbols to make it clear which atom provided which electrons.

Question 20 (b) (iii)

Very few candidates knew about the appearance of electron density maps and this question was answered very poorly. When some knowledge of electron density maps was evident it was often in the incorrect context of a covalent bond, or describing the polarisation of the anion, without any sense of the discrete nature of the maps for both ions.

(iii) Suggest how an electron density map of ammonium chloride would provide evidence for the presence of ions in the compound.

(1)

There is no overlap electron density between two atoms.

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Examiner Comments

This answer, although it does not refer to the 'lines' in the electron density map, at least realizes there will be no electron density between the atoms so was given 1 mark.

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Examiner Tip

Practise drawing and annotating electron density maps for both covalent and ionic compounds.

Question 21 (a) (i)

Most candidates appreciated the significant jump in ionization energy and were able to use the trend to predict a value within an acceptable range.

21 (a) The table below shows some of the ionisation energies of magnesium.

	First	Second	Third	Fourth	Fifth
Ionisation energy / kJ mol^{-1}	738	1451	3184	10541	13629

(i) Complete the table by predicting a value for the **third** ionisation energy of magnesium.

(1)

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Examiner Comments

Here the candidate followed an approximate trend from the first two ionization energies but did not realise they change in main energy level, so did not score.

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Examiner Tip

Collate data on ionization energies, and other periodic properties. Plot them on spreadsheets to visualize trends and then try to explain any patterns you see.

Question 21 (a) (ii)

There were many correct answers here, and pleasingly very few candidates quoted an equation that summarised the first 3 ionisation energies. If examiners could not decide whether the state symbol was (s) or (g) the first mark was not allowed.

(ii) Write the equation for the third ionisation of magnesium. Include state symbols.

(2)

$$Mg^{2+}(g) + e \rightarrow Mg^{3+}(g)$$

ResultsPlus
Examiner Comments

Unfortunately this equation has the electrons being gained on the right hand side, so is incorrect. The state symbols for the magnesium ions are clearly shown so 1 mark out of two was awarded.

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Examiner Tip

Practice writing equations for a range of ionization energies, including for non-metals, which follow the same format. Try to describe what the equation shows, so you can define ionization energies as well.

Question 21 (b) (i)

Many answers did not give the atomisation of **both** magnesium and chlorine in ΔH_1, and some did not recognise ΔH_3 as being the electron affinity of chlorine atoms, or thought it was the sum of the first and second electron affinity. However ΔH_5, the enthalpy of formation of magnesium chloride was usually correct.

(i) Identify the enthalpy changes from the Born-Haber cycle by completing the table.

ΔH_1 is the sum of **two** enthalpy changes and you should give both.

(3)

Enthalpy change	Identity of enthalpy change
ΔH_1	En thalpy change of attomisation of ~~chloride~~ Cl Enthalpy change of changing state of Mg
ΔH_3	Enthalpy change of ionisation of Cl
ΔH_5	Enthalpy change of Formation of compound ($MgCl_{2(s)}$)

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Examiner Comments

The first answer refers to both Cl and Mg, but 'enthalpy of changing state of Mg' was insufficient to score. Describing formation of the chloride ion as ionization was a common misconception.

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Examiner Tip

Look at the equations in a Born-Haber cycle and make sure you can name the enthalpy changes that each equation represents.

Question 21 (b) (ii-iii)

Most able candidates could combine the values for the first and second ionisation energy correctly in part (ii), and these often went on to successfully calculate the lattice energy correctly. Not surprisingly a significant minority simply gave 1451 in part (ii); such candidates were allowed a transferred error in part (iii), but often made subsequent mistakes.

(ii) Use the data in (a) to calculate the value of ΔH_2.

(1)

$\Delta H_2 =$ 1451

(iii) Use your answer to (ii) and the following data to calculate the lattice energy of magnesium chloride, ΔH_4.

Enthalpy change	Value of enthalpy change / kJ mol^{-1}
ΔH_1	+391.1
ΔH_3	−697.6
ΔH_5	−641.3

(2)

$\Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4 \rightarrow \Delta H_5$

$(391.1) + (1451) + (-697.6) + \Delta H_4 \rightarrow -641.3$

$1144.5 + \Delta H_4 \rightarrow -641.3$

$\Delta H_4 \rightarrow -641.3 - 1144.5$

$\Delta H_4 \rightarrow -1785.8$

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Examiner Comments

In part (ii) the candidate has forgotten to add on the second ionisation energy, so loses the mark. However, in part (iii), the correct use of the value to find the lattice energy score two marks as a transferred error.

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Examiner Tip

Make sure your working out is clearly laid out in calculations so transferred errors can be followed. Take care to use brackets in this type of question, as it is easy to make a slip with a sign on the data, and so lose marks.

Question 21 (c) (i)

ΔH_2 is the sum of two ionisation energies, so this question was asking why formation of a calcium ion requires less energy than formation of a magnesium ion. This is because the attraction of the nucleus on the outer electrons in calcium is less than in magnesium, which can be explained in several different ways. It has nothing to do with the presence of the chloride ions or many other things which were suggested by some candidates. Some thought that the less positive ΔH_2 value meant it was more negative and produced arguments for ionisation being an exothermic process.

(c) A similar Born-Haber cycle can be drawn for calcium chloride.

*(i) In the calcium chloride cycle, the corresponding value for ΔH_2 is less positive. Explain why this is so.

(2)

Ca has more shells than Mg, this increases shielding, Ca has more shielding than Mg, so it is easier to remove $1e^-$ from it than it is for Mg. Positive nuclear ~~attraction~~ attraction is less in Ca than it is in Mg so less energy is required to remove $1e^-$. ΔH_2 is ionization energy.

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Examiner Comments

This answer has the idea that there is more shielding in calcium, which scored the first mark. This is then linked to the idea of less attraction to the (outer) electrons from the nucleus, so scored the second mark.

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Examiner Tip

Be careful not to confuse nuclear attraction and nuclear charge. The nuclear attraction felt by an electron in an atom can vary depending on its position relative to the nucleus; the nuclear charge of the atom is determined by the number of protons so is constant.

Question 21 (c) (ii)

The lattice enthalpy is a measure of the energy released when the positive and negative ions combine to form a lattice, so in this part of the question the force of attraction of calcium ions and magnesium ions with chloride ions had to be compared. Many candidates are not clear about the difference between the attraction of the nucleus for electrons which are orbiting it, and the attraction between two separate ions. In addition many answers became mired in a discussion of the relative ability of the two cations to polarise the anion, and did not compare the force of attraction between the ions.

*(ii) Explain why the value for the lattice energy, ΔH_4, is less negative for calcium chloride than for magnesium chloride.

(2)

This because magnesium ion is Smaller than Calcium ion meaning that it ~~is ab~~ has a ~~Sm~~ larger charge density. which allows it to form a Stronger ionic bond with chlorine than ~~m~~ Calcium ion.

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Examiner Comments

Here the concept of the greater charge density of the magnesium ion is clear so the first mark is given. The answer then goes on to discuss the attraction, but refers to 'chlorine' rather than 'chloride' so does not score the second mark.

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Examiner Tip

In questions involving ions always check that the names you give to non-metal monoatomic ions ends in **-ide**.

Question 22 (a)

Comments such as “heat losses” or “it is very exothermic” showed that candidates were not visualising a situation in which they had to heat a solid and at the same time try to find a way of measuring how much heat was being absorbed. Many responses were comments about potential inaccuracies in experiments involving calorimeters, which were not relevant to the question.

22 Sodium hydrogencarbonate decomposes on heating to form sodium carbonate, carbon dioxide and water.

Reaction 1 $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g)$

(a) Suggest why it is difficult to measure the enthalpy change of this reaction directly.

(1)

Measuring the temperatures when heating is difficult.

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Examiner Comments

This was one of the few examples of a response where the candidate has realized that the heating of the thermal decomposition reaction makes it difficult to measure temperatures, which is a key feature of enthalpy change experiments.

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Examiner Tip

When doing experimental work, make sure you consider why a practical task is carried out in a particular way, not just how it is carried out.

Question 22 (b) (i)

Candidates would have benefited from visualising the reaction, which would happen quickly with a lot of effervescence and requires a container from which materials would not spray out but where the contents can be stirred and the temperature change measured.

(i) Explain why the beaker used in this experiment is large.

(1)

~~total~~ ~~Bebuls~~ Bubles form

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Examiner Comments

Although this answer correctly points out that bubbles form, it does not make the link between the bubble formation and the prevention of frothing over.

ResultsPlus
Examiner Tip

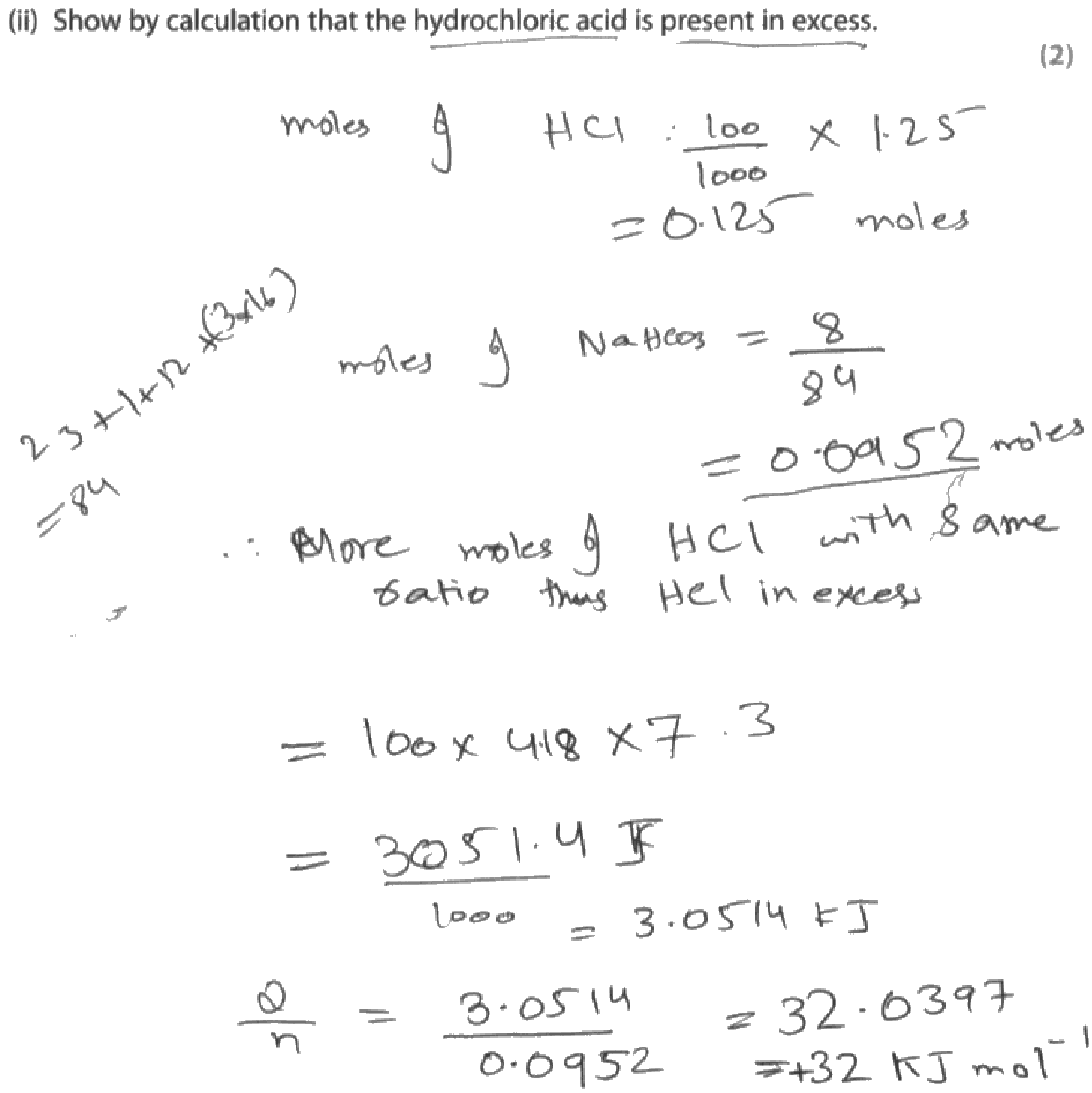
Read the stem of questions set in a practical context with care, and try to visualise each part of the experiment.

Question 22 (b) (ii-iv)

Several methods are possible in part (b)(ii). The simplest is to calculate the number of moles of each reactant. Some candidates calculated the number of moles of acid and hence the number of moles and mass of sodium hydrogencarbonate which react with it. However, the number of moles of sodium hydrogencarbonate must be known for the subsequent calculation.

In part (b)(iii) most candidates calculated the energy transferred correctly, but many did not realise that this was not the same as the enthalpy change of the reaction. When there was an attempt to calculate the enthalpy change it was often based on the number of moles of acid, not of sodium hydrogencarbonate, and errors in the sign of the enthalpy change were seen regularly.

In part (b)(iv) the marks for giving the chemical formulae needed in the Hess cycle were awarded infrequently. The bottom box often contained the symbols of the elements, as in a cycle based on enthalpies of formation. When the correct species were given the amounts were often not balanced and the hydrochloric acid was missing. Candidates forgot that the enthalpy change for **Reaction 2** had to be doubled. Applying Hess's Law to the cycle was too difficult for many, meaning that this was probably the most difficult part of the paper.


(ii) Show by calculation that the hydrochloric acid is present in excess.

(2)

moles of HCl : $\frac{100}{1000} \times 1.25$

$= 0.125$ moles

moles of $NaHCO_3$ = $\frac{8}{84}$

$= 0.0952$ moles

$23 + 1 + 12 + (3 \times 16) = 84$

∴ More moles of HCl with same ratio thus HCl in excess

$= 100 \times 4.18 \times 7.3$

$= \frac{3051.4 \text{ J}}{1000} = 3.0514 \text{ kJ}$

$\frac{Q}{n} = \frac{3.0514}{0.0952} = 32.0397$

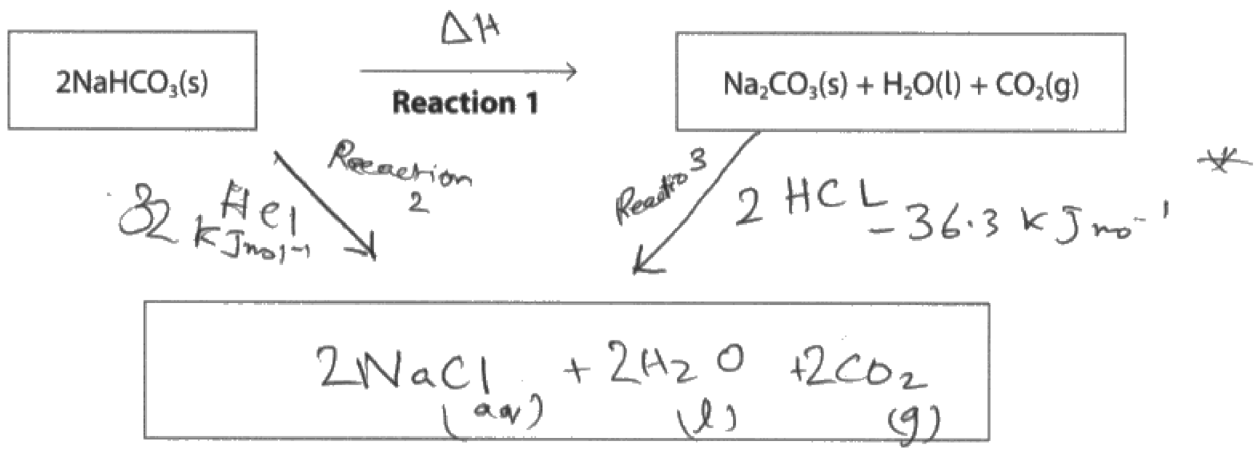
$= +32 \text{ kJ mol}^{-1}$

(iv) The enthalpy change for **Reaction 3** was found to be –36.3 kJ mol[−1].

Complete the Hess cycle by adding the appropriate arrows and formulae to the outline.

Use your completed cycle to calculate the enthalpy change for **Reaction 1**.

(4)



$\Delta H + R_3\Delta = R_2\,\Delta H$

$\Delta H = R_2\,\Delta H - R_3\Delta$

$= 32 - (-36.3)$

ΔH for **Reaction 1** = ...68.3........ kJ mol[−1]

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Examiner Comments

Simple calculation of the amounts of acid and sodium hydrogencarbonate was sufficient to score the marks in part (ii), and the correct limiting reactant was used in part (iii), to score all 3 marks.

In part (iv), the arrows were correctly added to the cycle, but the equations were not balanced. The value from part (iii) was not multiplied by 2, so the incorrect answer lost a mark

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Examiner Tip

Practice writing Hess Cycles for a range of enthalpy changes, making sure equations balance in all directions.

Question 23 (a) (i)

The question asks for a dot and cross diagram of the chlorine molecule. However some just drew Cl – Cl and showed the movement of the electrons in the covalent bond to form free radicals. Candidates would have benefited from reading the question carefully and scored more marks.

C_2H_6

23 (a) Ethane reacts with chlorine in the presence of ultraviolet light forming chloroethane, C_2H_5Cl and other products.

(i) Ultraviolet light causes **homolytic fission** of chlorine molecules.

Draw a dot and cross diagram of a chlorine molecule and use it to explain what happens to the molecule when homolytic fission occurs, naming the species produced.

(2)

The bond breaks equally and 1 electron is transfered to one chlorine and ~~one~~ the other electron is carried to the other chlorine. The result is the formation of 2 chlorine radicals.

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Examiner Comments

This candidate understands what happens during the formation of the chlorine free radical, so scores the second mark, although they have not attempted to draw the dot and cross diagram as requested. The candidate would have benefited had they read the question with care.

ResultsPlus
Examiner Tip

Read all questions with care, and follow the instructions given.

Question 23 (a) (ii-iii)

This was familiar chemistry and well done. A few candidates gave a termination step producing chlorine or a chloroalkane. Some candidates relied on recall and gave the equations for another alkane studied, often methane. Candidates would have benefited had they read the question with more care.

(ii) Write the equations for the **two** propagation steps which occur in the reaction producing chloroethane.

(2)

Equation 1:

$C_2H_6 + Cl\cdot \rightarrow C_2H_5\cdot + HCl$

Equation 2:

$C_2H_5\cdot + Cl_2 \rightarrow C_2H_5Cl + Cl\cdot$

$C_2H_5\cdot + HCl \rightarrow C_2H_5 + Cl\cdot$

ResultsPlus
Examiner Comments

Recall of the propagation steps is clearly evident in part (ii) and both marks were given. However in part (iii) the guidance is not followed as the reaction shown is not a termination step.

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Examiner Tip

Remember termination steps always have 2 free radicals on the left hand side of the equation and one product on the right hand side.

Question 23 (b) (i)

The answer required the information that the pi bond in ethene forms when p orbitals overlap, and that it breaks easily because overlap is poor. Many candidates knew the pi bond was weaker but were unable to express why. The idea that there is a region of high electron density, leading to electrophilic addition reactions, was also allowed. Some candidates wrote about the how the sigma bond forms, the shape of the double bond or its limited rotation. Candidates would have benefted had they read the question with more care.

(b) Ethene also reacts with chlorine but by a different mechanism.

*(i) Describe how the π bond in ethene forms and explain why this bond causes ethene to take part in addition reactions with halogens.

(2)

The π bond forms in the p-orbital ^side to side and it causes the double bond in ethene to break for addition reactions

ResultsPlus
Examiner Comments

This example shows how precision of language is a key skill in scientific communication. For instance, the answer recognises the involvement of the p-orbitals, but the 'side by side' comment is not enough to describe the overlap. They then realise that the double bond will break, but do not link the features of the pi bond to its relative weakness, so score 0 marks.

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Examiner Tip

Practice drawing diagrams to show both sigma and pi bond formation and use the diagrams to explain the relative strength of each bond.

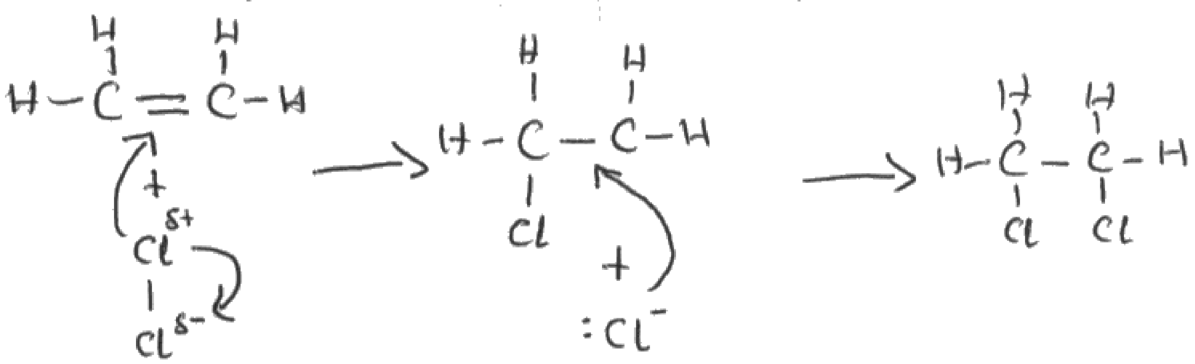
Question 23 (b) (ii)

The mechanism was generally well known. Marks were lost if the dipole on the chlorine molecule was not shown. Care is needed in positioning curly arrows, and in the first step one arrow had to clearly come from the double bond to the δ^+ chlorine, and another from the Cl-Cl bond to the δ^- chlorine. Answers showing $Cl^{\delta-}$ as the product of the first step were also common.

*(ii) Write the mechanism for the reaction of ethene with chlorine.

Use curly arrows to show movements of electron pairs.

(3)



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Examiner Comments

This example at first glance looks sensible, but a close inspection shows several mistakes. For instance in the first step, the electrons are moving from the chlorine to the pi bond, and the arrow showing movement of the chlorine bond pair starts on the Cl rather than the bond. The second step has a charge missing from the carbocation, so the second mark is not scored. The third mark is given for the attack of the chloride ion and correct product.

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Examiner Tip

Use 'draw, cover, redraw, check' to embed mechanisms. Draw out an example of the correct mechanism, cover it and attempt to redraw it, then check your answer. Repeat this several times then when you can do it successfully without errors, practice applying the mechanism to a range of different starting compounds.

Question 23 (b) (iii)

Many correct answers were given. The main errors were in numbering the position of the chlorine atoms correctly. If the name is not clearly based on dichloroeth**a**ne rather than dichloroeth**e**ne the mark was not awarded.

(iii) Name the product of the reaction of chlorine with ethene.

(1)

1,2 - dichloro ethene

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Examiner Comments

This answer did not score as it refers to 'ethene' not 'ethane'

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Examiner Tip

Take care when naming so what you have written cannot be confused with other functional groups.

Question 23 (c)

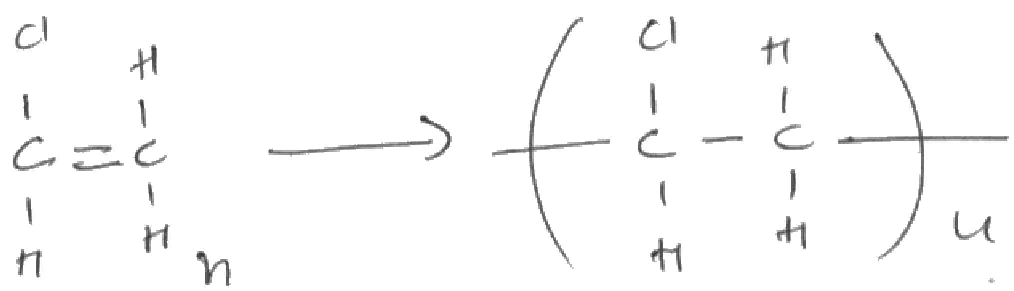
Many candidates succeeded in giving the formula of the monomer and the polymer, but they did not balance the equation by using 'n' to represent a large number of monomer molecules. Sometimes 'n' was used, but incorrectly placed after the formula of the monomer.

(c) The halogenoalkene, 1-chloroethene, is used to make a widely used polymer, poly(chloroethene), commonly known as PVC.

Write a balanced equation for the polymerisation of 1-chloroethene to PVC.

Use displayed formulae to show the bonds in both the monomer and the polymer.

(2)



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Examiner Comments

Although the correct monomer and repeat unit structures are shown, the 'n' is on the wrong side of the monomer, so only the first mark was awarded.

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Examiner Tip

Remember that the 'n' is used to balance polymer equations as the numbers of monomers involved are so large.

Paper Summary

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

- Read the stem of each question carefully to ensure you focus your response more precisely on what the question is asking.
- Take care when describing non-metal ions, such as halide ions. Ensure their names end in **-ide**
- Use command words to help guide you - for instance make sure you know the difference between describe and explain
- Practise drawing electron density diagrams for both ionic and covalent substances
- Practise writing a variety of different Hess cycles, based on the enthalpy changes studied in your course
- When revising, work together with peers to check for clarity in your written explanations.

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