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Examiners' Report June 2023

Int GCSE Chemistry 4CH1 1C

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Introduction

In general, candidates performed well on this paper and displayed good knowledge across a range of topic areas.

Where mathematical skills were assessed eg in graph plotting, in moles calculations, or in calculating a relative atomic mass, many candidates were able to score full marks. Some candidates who were skilled in the chemistry behind calculations lost marks through rounding their answer too early, or by truncating the answer on their calculator screen eg by showing 0.36 as 0.3. Candidates should always work to at least the same number of significant figures as the data in the question.

As in previous series, candidates need to take care on the use of terminology. This was noted particularly in Q07(d), where there was confusion between halogens and halide ions. Some candidates also do not fully understand the difference between a bond between two atoms in a molecule, and an intermolecular force between molecules.

Questions on practical chemistry were variable, although most candidates found Q08 more straightforward than Q06, mostly because Q08 was similar to questions asked in the past on energetics, whereas Q06 was in a new and unfamiliar context. Good candidates were able to apply their knowledge of practical work on this question.

Question 1 (a)(i)

Question 1(a) provided a straightforward introduction to the paper, and many candidates scored all 3 marks.

Question 1(a)(iii) was more variable, with some candidates choosing fractional distillation, or evaporation.

Question 1 (b)

Q1(b) was a different way to assess the production of a soluble salt and most candidates were able to select appropriate words from the box.

Candidates need to read questions on separating mixtures carefully, so that they are clear whether or not the substance being separated is the solvent, the solute, or an insoluble solid.

(b) A sample of solid hydrated copper(II) sulfate can be obtained from a mixture of copper(II) oxide and copper(II) sulfate.

Complete the passage by using words from the box.

(4)

The mixture of copper(II) oxide and copper(II) sulfate can be separated by first

........dissolving........ the copper(II) sulfate in distilled water.

The copper(II) oxide is then removed by

........~~filtration~~ filtering........ .

Some of the water from the copper(II) sulfate solution is then removed by

........evaporating........ .

A pure sample of hydrated copper(II) sulfate is then obtained by

........crystallisation........ .

ResultsPlus
Examiner Comments

A good answer, scoring all 4 marks.

The candidate has crossed out 'filtration' and replaced it with 'filtering', which was the word in the box provided. However, 'filtration' would also have been accepted.

Question 2 (a)(i)

Although most candidates knew that rust was an oxide of iron in Question 2(a)(i), the oxidation state was frequently missing and so no mark was scored.

The remaining parts of Question 2(a) were better known by candidates.

Question 2 (b)(i)

Question 2(b)(i) gave the opportunity for candidates to construct a simple chemical equation that did not need balancing.

Although examiners are quite lenient with the use of chemical symbols, sub-scripts and super-scripts, it was pleasing to see fully correct equations from most candidates.

(i) Give a chemical equation for the reaction between iron and sulfuric acid.

(1)

$$2Fe + H_2SO_4 \longrightarrow Fe_2SO_4 + H_2$$

ResultsPlus Examiner Comments

As this equation is only worth 1 mark, any error loses the mark, so this equation scores 0.

ResultsPlus Examiner Tip

Candidates should be able to construct formulae of compounds from their ions, so knowing that sulfate ions have a – 2 charge would help to work out the correct formula of iron(II) sulfate.

Question 2 (b)(ii)

The test for hydrogen gas is frequently tested by the examiners. Candidates should note that all chemical tests should include both a method and a result.

(ii) Give a test for hydrogen.

(1)

burns with a squeaky pop sound

ResultsPlus
Examiner Comments

The answer here only mentions the result ie that hydrogen burns with a squeaky pop and so scores 0.

In order to score the mark, it needs to include the test that is carried out: the use of a burning splint, or bringing a test tube of the gas next to a Bunsen flame.

Question 2 (c)(i)

'Displacement' was frequently seen as the answer to Question 2(c)(i). As the question asked for a description of the whole reaction, it was not acceptable to write simply 'oxidation' or 'reduction', although giving both did score the mark.

When copper metal is fresh, as in the experiment in Question 2(c)(ii), it has a noticeable pink colour – although a range of other colours was accepted. This was more likely to be recalled by candidates who had carried out practical work in this topic.

Question 2 (d)

Question 2(d) was well answered by most candidates. A few candidates lost the mark by failing to make a comparison ie that iron was less reactive than magnesium. The statement 'iron is not very reactive' does not imply anything about the reactivity of magnesium.

Question 3 (a)

The types of bonding were well known in Question 3(a), but the description of the type of structure was not always as accurate.

Both structures are giant – and this was enough to score the mark for the covalent substance. However, ionic structures need to be described as giant lattices.

3 The table gives some information about three substances, X, Y and Z.

Substance	Melting point	Conducts electricity when solid	Conducts electricity when molten	Type of bonding	Type of structure
X	low	no	no	covalent	simple molecular
Y	high	no	no	covalent	Giant covalent
Z	high	no	yes	ionic	giant lattice

(a) Complete the table by giving the missing information.

(4)

ResultsPlus
Examiner Comments

This is a fully correct answer for 4 marks.

ResultsPlus
Examiner Tip

Substances with high melting points will be giant structures.

Giant ionic structures should always be described as 'giant lattices'.

Question 3 (b)

Question 3(b) is one of the areas of chemistry where candidates need to be very careful on the use of terminology. Although it is less common to read candidate answers that refer to the breaking of covalent bonds, not all answers correctly describe intermolecular forces. The phrase 'there are weak forces between the bonds' is being seen increasingly frequently – but it's not clear what this means, and so it scores 0.

Note that the second mark requires candidates to refer to **little** energy, or **a small amount** of energy. The use of 'less' energy could still be a large amount, but less that for a giant structure.

(b) Explain why substance X has a low melting point.

(2)

It has a low melting point because it's a simple molecullar substance so the intermolecular forces do not require much energy to break.

ResultsPlus
Examiner Comments

Although this answer reads very well and uses the correct terminology, it only scores 1 mark.

ResultsPlus
Examiner Tip

Make sure that you describe the strength of the intermolecular forces. It is a key idea that the forces between molecules are **weak**.

Question 4 (a)(i)

Most candidates were able to give two key features of a homologous series in Question 4(a)(i), although there was some confusion between whether properties were similar (chemical properties), or showed a trend (physical properties).

Candidates are reminded to read questions carefully. In this case, the question did not specifically ask about the alkene homologous series, but about homologous series in general. Answers specific to any individual series, therefore, did not score.

It is worth reminding candidates and centres that, if two answers are requested in the question, two answers should be given. Giving an additional incorrect answer will negate on the marks scored.

4 This question is about unsaturated hydrocarbons.

(a) Ethene (C_2H_4) is a member of the homologous series of alkenes.

(i) Give two characteristics of a homologous series.

(2)

1 They differ by the general formula CnH2n.

2 They have double bond between one pair of carbon.

ResultsPlus
Examiner Comments

This response scored 0 because the answers given are specific to the alkene homologous series, and are not characteristic for all homologous series.

ResultsPlus
Examiner Tip

Make sure that you read the question carefully. Most questions are placed in a context – in this case, the context for the whole question is alkenes.

However, the question itself asks for general characteristics of a homologous series and so needs to be true in all cases.

Question 4 (a)(ii)

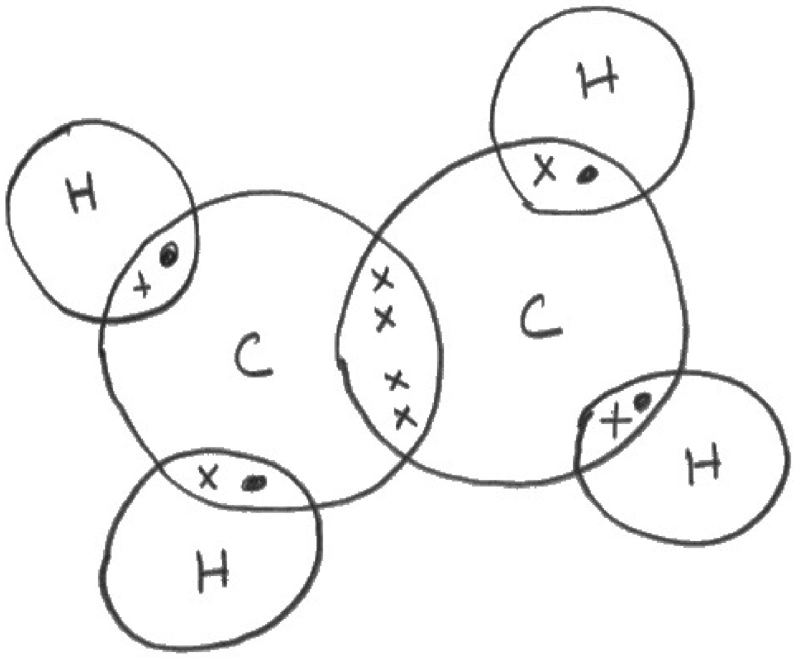
Question 4(a)(ii) was a more difficult dot-and-cross diagram than candidates were used to, as it included a double bond. Candidates who understood that the double bond contained four electrons – two from each carbon atom – almost always went on to score both marks.

When dot-and-cross diagrams include more than two atoms, candidates should try and use symbols that show clearly which atom the electrons belong to. This is partly to make the answer clearer to the examiner – but it also helps make the answer clear when you come back to check your work at the end of the exam.

(ii) Draw a dot-and-cross diagram to show the bonding in a molecule of ethene.

Show outer electrons only.

(2)

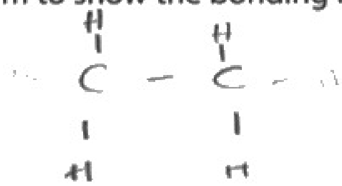


ResultsPlus
Examiner Comments

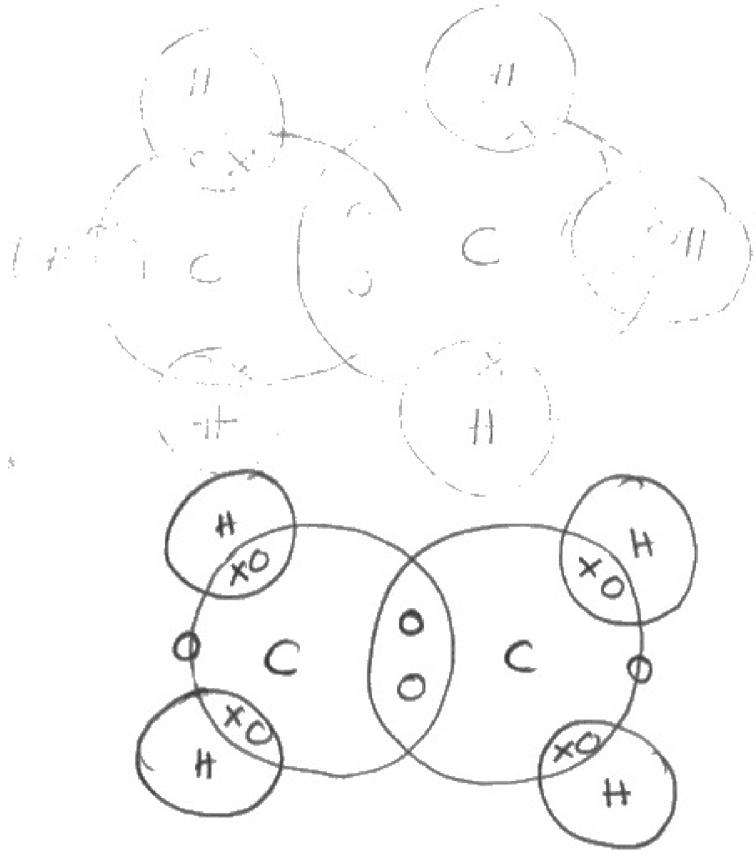
An excellent answer, scoring both marks.

(ii) Draw a dot-and-cross diagram to show the bonding in a molecule of ethene.

Show outer electrons only.



(2)



ResultsPlus
Examiner Comments

This scored 1 mark for the four carbon-hydrogen bonds being correct.

ResultsPlus
Examiner Tip

This candidate has used a good strategy – drawing a structural formula and converting it to a dot-and-cross diagram. However, the structural formula was not correct.

Candidates should remember that dot-and-cross diagrams invariably contain electron pairs, so a diagram with unpaired electrons is likely to be incorrect.

Question 4 (b)(i)

Candidates had different ways of expressing this – but most referred to the empirical formula of alkenes and used this to explain the ratio between carbon and hydrogen.

Question 4 (b)(ii)

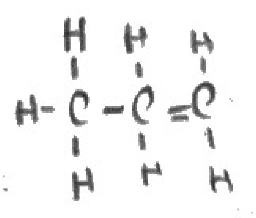
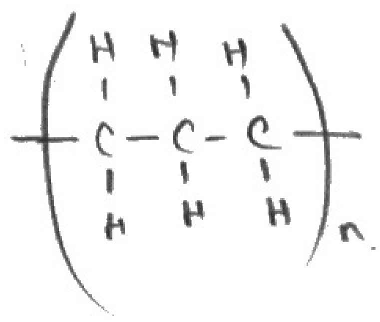
As always, candidates find poly(propene) the most difficult polymer structure to draw, because of the side chain.

However, there were some excellent answers here, which also showed a fully displayed structure, as requested in the question.

(ii) Propene can be polymerised to form poly(propene).

Draw the displayed formula of propene and the repeat unit of poly(propene).

(2)

propene	repeat unit of poly(propene)
	

ResultsPlus Examiner Comments

This was a common incorrect answer and scores 0.

The propene molecule has too many hydrogens – and the middle carbon has five bonds. The polymer doesn't have the characteristic side chain of poly(propene).

ResultsPlus Examiner Tip

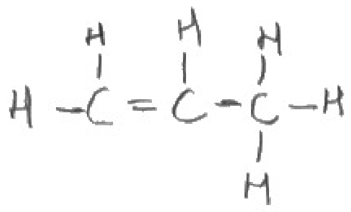
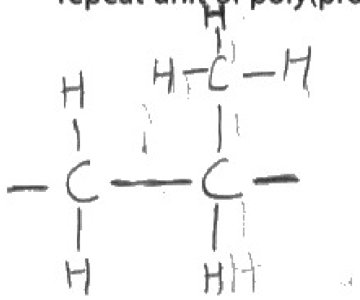
It might help to think of all polymers as having a repeat unit of two carbons, like poly(ethene).

Poly(chloroethene) then replaces one hydrogen with a chlorine atom; and poly(propene) replaces one hydrogen with a CH_3 – group.

(ii) Propene can be polymerised to form poly(propene).

Draw the displayed formula of propene and the repeat unit of poly(propene).

(2)

propene	repeat unit of poly(propene)
	

ResultsPlus
Examiner Comments

A very good answer for 2 marks.

Note that the structure is fully displayed.

ResultsPlus
Examiner Tip

The repeat unit doesn't have to be in brackets – but it must have "extension bonds" ie the bonds going to the left and right from the carbon atoms showing where it joins the neighbouring repeat units.

Question 4 (c)(i)

The difference between a molecular and empirical formula was well known, although some candidates misunderstood that the molecule has two double bonds, so could not be represented by the empirical formula for alkenes, CH_2.

Question 4 (c)(ii)

A similar question has been asked on an earlier paper and most candidates spotted that, as Question 4(c)(ii) was worth 3 marks, they had to explain both 'unsaturated' and 'hydrocarbon'.

Both definitions are well-known, so candidates who did not score all 3 marks usually omitted one definition.

(ii) Explain why this compound is an unsaturated hydrocarbon.

(3)

It is an alkene which follows general formula of C_nH_{2n}. Alkenes have carbon-carbon double bonds, thus the compound is unsaturated.

ResultsPlus
Examiner Comments

This answer explains unsaturated very well, but misses the explanation of hydrocarbon.

In this case, the candidate is fortunate and scores a mark for the empirical formula showing hydrogen and carbon atoms are present.

ResultsPlus
Examiner Tip

Look at the marks allocated to the question.

Here the question is worth 3 marks, so needs to go further than saying that unsaturated compounds contain double bonds.

Question 4 (c)(iii)

The test for an unsaturated hydrocarbon was well answered, with most candidates scoring both marks.

As in previous series, the mark scheme insists on having bromine water or a solution of bromine. There are still small numbers of candidates who describe the final solution as 'clear' rather than colourless.

(iii) Describe a test to show that this hydrocarbon is unsaturated.

(2)

You can test for unsaturated substances by adding bromine water. With unsaturated substances it will turn from orange to colourless even without UV light. Only unsaturated substances can turn it colourless. (without UV.)

ResultsPlus
Examiner Comments

Although this scores both marks, it is probably best to avoid reference to UV light except if reacting bromine water with an alkane.

Question 5 (a)(i)

Although examiners often ask for observations when an alkali metal reacts with water, candidates need to be aware that the observations are not identical for each metal.

Again, candidates need to read the question carefully. In this case, the idea that lithium floats on water was given in the question, and so did not score a mark.

5 This question is about lithium and some of its compounds.

(a) A small piece of lithium is added to a trough containing water.

The lithium floats on the surface of the water and a vigorous reaction occurs.

(i) Give two other observations when lithium reacts with water.

(2)

1 Effervecsense is created

2 A vapour trail is given off when the lithium moves across the water

ResultsPlus
Examiner Comments

This answer scores both marks.

Reasonable spellings are accepted – so this version of effervescence is fine.

Note that the second answer line contains two ideas: a vapour trail, and lithium moving on the surface. The first of these is not on the mark scheme, but does not prevent the second mark being scored.

Question 5 (a)(ii)

Although candidates did seem to know that the solution formed was alkaline, they did not always remember the colours of methyl orange indicator. Orange and red were both seen as incorrect answers.

Good candidates gave a fuller explanation, in terms of the solution containing hydroxide ions, although this level of detail was not required on this occasion.

Question 5 (b)

Question 5(b) was the first question requiring extended writing on the paper.

In general, answers were very good, and the tests for the two ions were clearly described.

For the lithium ion, candidates could describe a flame test – or simply say 'Carry out a flame test'. However, it is not acceptable to describe a flame test as 'burning' – and, if the test is described, it should be clear that the sample is put **into** the flame, not above it. The colour was described correctly as red or crimson.

The carbonate test is well known, with most candidates using hydrochloric acid to react with the sample. A small number of candidates didn't make it clear that the limewater is in a separate test tube ie they added limewater to the sample along with hydrochloric acid.

(b) An unlabelled bottle containing a white powder is found in a laboratory.

Describe tests to show that the white powder in the bottle is lithium carbonate.

(5)

test for Lithium:
- do a flame test
- flame comes out yellow-orange.

test for carbonate:
- add dilute acid like HCl
- ~~add~~ gas given off
- bubble gas through limewater.
- lime water turns cloudy

ResultsPlus
Examiner Comments

A good answer which scored 4 marks.

The only mark not scored is for the flame colour.

ResultsPlus
Examiner Tip

Although this type of question is referred to as an "extended writing question", it is acceptable for candidates to structure their answer with clear bullet points.

Here, splitting the answer in two halves – one for each ion – adds a clear structure.

Question 5 (c)

The specification contains very clear definitions, so Question 5(c) required candidates to provide this definition.

Some candidates described how atoms gained and lost electrons to form ions, but this did not score marks as it doesn't describe the interactions which then take place between ions to form the ionic bond.

Question 6 (a)(i)

Most candidates could transfer the information about physical states from the question stem into state symbols in the equation.

The most common issue was candidates using (l) rather than (aq) for the solutions.

Question 6 (a)(ii)

The formula for lead(II) nitrate was given in the equation at the start of the equation, but candidates found it difficult to separate the formula into the constituent ions. The lead ion was more often correct, but the nitrate ion proved more challenging.

Question 6 (a)(iii)

Candidates did not always appreciate that the number outside the bracket applies to everything inside it ie lead(II) nitrate contains one Pb^{2+} ion and two NO_3^- ions.

It was common to see the 2 outside the bracket applied to the whole formula – including the lead ion, or just to the oxygen atoms.

Question 6 (b)

Question 6(b) discriminated well between candidates, as is usually the case with questions on practical work. In this case, the practical was not one in the specification, so candidates were expected to apply their knowledge in an unfamiliar situation. This did mean that answers varied, with candidates with more experience of practical work better able to apply their understanding.

Although the grid provided was rather small, candidates were able to plot points, identify the anomalous points, and draw the lines of best fit. Some candidates didn't follow the instructions in Question 6(b)(iii), and drew a curve rather than two straight lines.

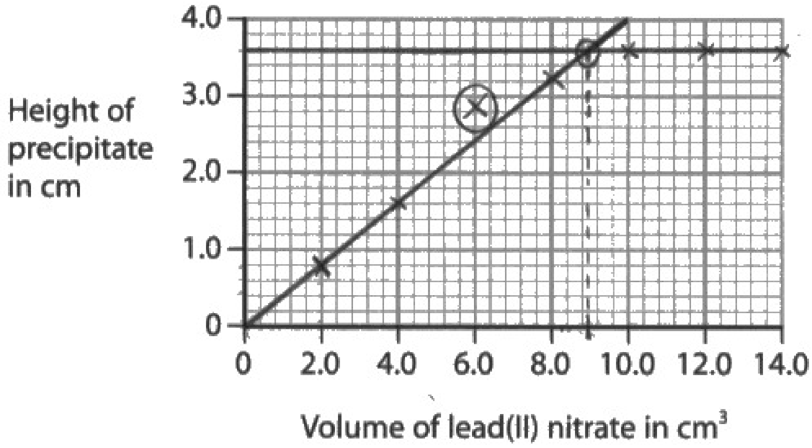
Candidates always find identifying reasons for an anomalous point difficult and many answers did not explain why the anomaly is larger than the expected value in Question 6(b)(iv).

In Question 6(b)(v), most candidates were able to express the idea that no precipitate could form if no lead(II) nitrate was added.

Although candidates had correctly interpreted the scales on the axes when plotting the graph, the reading of the intersect point in Question 6(b)(vi) caused more issues, with a surprising number of candidates having an answer with an incorrect reading from the x-axis.

(iii) Draw a line of best fit through the first four points and another line of best fit through the last three points. Make sure that the lines cross.

(2)



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Examiner Comments

This graph scored 2 marks.

The points are correctly plotted, and the use of clear crosses means that the examiners can see each plotted point clearly.

The anomalous point is clearly marked and the lines of best fit are clearly shown, with extrapolation.

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Examiner Tip

Make sure that lines of best fit are drawn with a ruler.

(iv) Give two possible mistakes the student could have made to cause the anomalous result.

(2)

1 Did not leave enough time for the precipitat to settle

2 Added the (were) wrong volume of lead nitrat and/or potassium chloride

(v) State why the first line of best fit should pass through the origin.

(1)

because at 0cm³ of lead nitrate, potassium chlorid would not have anything to react with

(vi) Use your graph to determine the volume of lead(II) nitrate solution needed to react completely with 15.0 cm^3 of potassium chloride solution.

(1)

volume = 9 cm³ cm^3

(Total for Question 6 = 12 marks)

y = 3.6

3.6 = 0.4x

x = 3.6 / 0.4 = 9

0.8

y = 0.4x + c

y = 0.4x

0.8 = 0.8 + c

c = 0

ResultsPlus
Examiner Comments

Part (iv) scores 1 mark for the idea that the precipitate was not left to settle and so is taller than expected. The second answer does not account for the anomaly because "the wrong volume" could be larger or smaller than the correct volume.

Candidates had a variety of ways of expressing the idea in part (v) – and this answer was clear enough to score the mark.

Question 7 (a)

Question 7(a) was an accessible start to the question, with most candidates able to look up the atomic number of iodine from the Periodic Table, and therefore calculate the number of protons and neutrons.

Some candidates did an incorrect subtraction and ended up with the wrong number of neutrons.

Question 7 (b)

Calculations of relative atomic mass have been asked in previous years, and so most candidates knew what to do here and were able to access the question.

One common error was for candidates to divide by the sum of the mass numbers (79 + 81) rather than the sum of the abundances (52.8 + 47.2).

The Periodic Table provided with the question paper gives a relative atomic mass of 80 for bromine, and many candidates therefore rounded their final answer to 80 (or 80.0) rather than giving it correctly to 3 SF as 79.9

(b) A sample of bromine contains two isotopes.

- Br–79 with relative abundance 52.8 %
- Br–81 with relative abundance 47.2 %

Calculate the relative atomic mass (A_r) of this sample of bromine.

Give your answer to three significant figures.

(3)

$$\frac{79 \times 52.8 + 81 \times 47.2}{100} = 79.944$$

A_r = 79.9

ResultsPlus Examiner Comments

A fully correct answer, scoring 3 marks.

(b) A sample of bromine contains two isotopes.

- Br–79 with relative abundance 52.8 %
- Br–81 with relative abundance 47.2 %

Calculate the relative atomic mass (A_r) of this sample of bromine.

Give your answer to three significant figures.

(3)

79 × 52.8 = 4171.2
+
81 × 47.2 = 3823.2
= 7994.4

79 + 81
= 160
= 49.965

A_r = 50.0

ResultsPlus
Examiner Comments

This scores 2 marks.

The first mark is scored for calculating the total mass of a sample of bromine. Although the division is incorrect, the final answer is converted from 49.965 to 50.0, so is to 3 SF.

ResultsPlus
Examiner Tip

Remember that relative atomic mass calculations need to be divided by the total abundance, not the sum of the mass numbers.

Question 7 (c)

Candidates have different ways of approaching calculations – and so full credit was given for answers that used moles, and those that used simple ratios in Question 7(c). The method using moles was the most common – although some candidates confused the two methods. This usually meant that the 3:2 ratio was incorporated twice in the calculation – once as part of the Mr and then again in a separate ratio step. Candidates should stick with one method and not confuse the two.

Some answers seemed to be a jumble of numbers, with no clear method. This made it difficult for examiners to follow the method used. Candidates are recommended to structure their answers clearly – ideally with a brief description of each step. This also helps when checking answers.

(c) Aluminium reacts with chlorine to form aluminium chloride.

This is the equation for the reaction.

$$2Al + 3Cl_2 \rightarrow 2AlCl_3$$

Calculate the minimum mass of chlorine needed to form 26.7 g of aluminium chloride.

[for Cl_2, $M_r = 71$ for $AlCl_3$, $M_r = 133.5$]

(3)

$n(AlCl_3) = \frac{m}{M_r} = \frac{26.7}{133.5} = 0.2\,mol$

$n(Cl_2) = (0.2 \div 2) \times 3 = 0.3\,mol$

$m(Cl_2) = n \times M_r$

$= 0.3 \times 71$

$= 21.3$

minimum mass of chlorine = 21.3 g

ResultsPlus Examiner Comments

An excellent answer, worth all 3 marks.

As well as being mathematically correct, this answer is very clearly laid out, with a short description of each step.

Question 7 (d)

This was a challenging question for many candidates – partly because it was worth 6 marks, but also because it required precise use of terminology.

Several candidates gave answers that gave two options for each reaction eg "If Pair 1 react, then bromine is more reactive than chlorine, but if they do not react, then bromine is less reactive than chlorine". This type of answer did not score highly, because it didn't relate to the reactions that actually take place.

Questions about displacement reactions between halogens always cause issues with the use of terminology. When chemists use the word 'displacement', it refers to the element that it is produce in the reaction. For example, in Pair 2, bromine reacts with iodide ions to form iodine – or bromine displaces iodine from iodide ions.

There was also some confusion about colours. Iodine is a shiny grey solid, which is purple as a vapour, or when dissolved in organic solvents. However, aqueous solutions of iodine tend to be a red-brown colour.

The best answers here gave an observation, then explained this in terms of reactivity and any displacement reactions, then summarised to give an overall reactivity for elements in the group.

(d) A student mixes the following pairs of solutions.

Pair 1 bromine solution and potassium chloride solution

Pair 2 bromine solution and potassium iodide solution

Explain how the student can use the results of these experiments to show the order of reactivity of the three halogens, bromine, chlorine and iodine.

Include observations in your answer.

(6)

First, if the student uses the first pair 1, of adding bromine solution and potassium chloride solution which the student can write chemical equation it will be: $Br_{2(aq)} + KCl_{(aq)} \longrightarrow$?? , there will no reaction at all because Chlorine is more reactive than bromine. And the observation will remain the same, a colourless solution for KCl and an orange solution for bromine. And if the student uses the second pair, of bromine solution and potassium iodide solution which can also be ~~wirr~~ written in a chemical equation like: $Br_{(aq)} + KI_{(aq)} \Rightarrow KBr_{(aq)} + I_{(s)}$ there will be reaction because bromine is more reactive than iodine, so observation will be from an orange solution (Br_{aq}) to a colourless solution (KBr_{aq}). So the student concludes it will that chroline is the reactive than the three, followed by bromine and lastly ~~idoine~~ iodine.

ResultsPlus
Examiner Comments

The description of Pair 1 is good – and scores 2 marks.

For Pair 2, the equation given is not balanced so does not score. The only mark scored is for bromine being more reactive than iodine.

The overall statement of reactivity across the whole of Group 7 is correct.

The response therefore scores 4 marks.

Question 8 (a)(i)

Question 8 was on a more familiar experiment than Question 6 – and one which forms part of the Core Practicals. Candidates seemed more comfortable answering questions in this area, therefore.

Question 8(a)(i) gave candidates an accessible start to the question, with most candidates understanding that stirring distributed heat across the water evenly.

Question 8 (a)(ii)

Question 8(a)(ii) proved to be more challenging. It is important, when doing practical work during the course, that candidates are challenged on the reasons for the different steps in the method.

Few candidates therefore appreciated that alcohols are volatile – especially from a hot spirit burner. Most candidates simply said that finding the mass enabled the mass burned to be calculated. Although this is true, it does not explain why the mass is found **immediately** at the end of the experiment.

(ii) Suggest why it is important that the student immediately finds the final mass of the spirit burner and pentanol.

(1)

To see ~~how much~~ the mass of the pentanol which was burned or used up, in order to raise the temperature of the water by 35°C

ResultsPlus
Examiner Comments

This was a common answer, but scores 0.

Although it is important to find the mass of alcohol burned, it is not the reason why the reading needs to be taken immediately that the experiment is over.

ResultsPlus
Examiner Tip

Make sure that you understand the different steps in a practical method and why they are important to the accuracy of the experiment being carried out.

Question 8 (b)

When setting questions like this, the examiners try to make the diagrams as clear as possible.

Here, the level of liquid in the thermometer is clearly between the divisions on the scale, and so the expected answer was 15.9 ^{o}C.

Question 8 (c)

As Question 8(c)(i) was a "Show that..." question, most candidates were able to use the data given to give an answer of 14 700 J.

Some candidates approach these calculations by considering a mass of 1 g, evaluating an energy, and then multiplying by the mass used. Although this is not incorrect, it's not the simplest method – and there is a risk that candidates forget the second step.

Question 8(c)(ii) was answered well by many. Candidates are reminded that intermediate steps in a calculation should preserve at least the same number of significant figures as the data in the question. Many answers rounded the moles of pentanol, and therefore lost a mark.

The final instruction in the question was "Include a sign in your answer", but the negative sign was omitted by significant numbers of candidates.

(c) (i) Show by calculation that the heat energy (Q) supplied by the pentanol is approximately 15 000 J.

[for water, c = 4.2 J / g / °C]

[for 1.0 cm^3 of water, mass = 1.0 g]

(2)

$Q = 4.2 \times V \times \Delta t$

$Q = 4.2 \times 100 \times 35 = 14700J \approx 15\,000J$

ResultsPlus
Examiner Comments

A fully correct answer for 2 marks.

The candidate uses v, rather than m, in the equation used, but the numbers chosen are correct.

(ii) The table gives the initial and final mass readings.

Initial mass of spirit burner and pentanol in g	90.11
Final mass of spirit burner and pentanol in g	89.75

Use your answer to part (c)(i) and the information in the table to calculate the molar enthalpy change (ΔH) of combustion, in kJ / mol, for pentanol.

[for pentanol, M_r = 88]

Include a sign in your answer.

(5)

$$\text{moles} = \frac{\text{mass}}{Mr}$$

~~90.11~~ 90.11 − 89.75 = 0.36

$$\text{moles} = \frac{0.36}{88} = 0.004$$

$$\Delta H = \frac{14\,700}{0.004} = 3\,675\,000 \text{ J/mol}$$

$$= 3675 \text{ kJ/mol}$$

ΔH for pentanol = + 3675 kJ / mc

ResultsPlus
Examiner Comments

This scores 3 marks.

The number of moles of ethanol is rounded to only 1 SF (0.004, rather than 0.00409 or 0.0041).

The reaction is clearly exothermic, so should have a negative sign, rather than a positive sign, in the final answer.

ResultsPlus
Examiner Tip

You never lose marks by keeping all the figures on your calculator display in all the steps of the calculation until the final answer.

Question 8 (d)

It was surprising that many candidates didn't know the products of this complete combustion, with a variety of incorrect products being suggested, such as carbon, carbon monoxide or even hydrocarbons. Candidates are presumably more familiar with combustion of alkanes than alcohols.

The balancing mark was scored by few candidates as this was a challenging equation.

Note that it is acceptable to have fractions in chemical equations, as the co-efficients simply show a ratio between reacting species.

(d) The formula of pentanol is $C_5H_{11}OH$

Write a chemical equation for the complete combustion of pentanol.

(2)

$C_5H_{11}OH + O_2 \rightarrow CO_2 + H_2O$

ResultsPlus
Examiner Comments

Some equations are hard to balance – but you will always score one mark for knowing the correct chemical species.

This answer scores 1 mark for the correct products of complete combustion.

Question 9 (b)(i)

Some candidates misunderstood the question and thought that this question was about preparing sodium sulfate as a salt. These candidates therefore talked about making crystals and drying them with filter paper or in a drying oven.

However, many good answers were seen. Usually these referred to 'heating to constant mass', but others described this principle in their own words.

(i) Describe what the student should do next to make sure that all the water is removed from the hydrated sodium sulfate.

(2)

~~Kep Heat it again until the mass stops changing.~~

Repeat heating it. Continue to do this until the mass stops changing

ResultsPlus
Examiner Comments

A good description which scores both marks.

ResultsPlus
Examiner Tip

If there is a phrase that you cannot recall in the exam – such as 'heat to constant mass' – then you should describe the idea in your own words.

Question 9 (b)(ii)

This question proved challenging for many candidates.

Similar questions have been asked in previous exam series, and the diagram given should have helped candidates to see that the ice bath was collecting water.

A number of answers were too vague – simply referring to 'keeping the test tube cold'. Others were closer to the correct answer, but made reference to cooling the water. It therefore wasn't clear if these answers were just referring to the water in the test tube, or if they understood that water vapour needed to be cooled to allow it to condense.

A reference to condensing was important here as water vapour could be cooled but stay in the vapour phase.

(ii) Explain the role of the ice in the beaker.

(2)

cools down the water and gas produced which will go into the water. cools tube.

ResultsPlus
Examiner Comments

Although it is a good attempt, this answer scored no marks.

There needed to be a clear reference to water **vapour**. Although this may be what the candidate refers to with the word 'gas', it's not clear.

It was also important to use the idea of condensation within the answer.

Question 9 (b)(iii)

The specification contains two tests for water, and candidates do tend to get confused between them.

One of those tests is a chemical test to see if water is present – and this test will detect any trace of water eg in a solution, or if there is water present as an impurity in a liquid like ethanol.

However, this question asked for a test for **pure** water, and this requires a physical test ie that the melting or boiling point is at the correct temperature (and is sharp, rather than over a range of temperature values).

As with all tests in chemistry, there must be a description of the test, as well as its result. Therefore the statement "it has a boiling point of 100 °C" only scores (1) mark as there is no indication of the test being carried out. The description could be quite simple eg 'heat it', 'measure its boiling point'.

Most candidates chose boiling point – although freezing point would have been acceptable.

(iii) Describe how the student could prove that the liquid collected is pure water.

(2)

- they could see if the liquid boils at 100° c

- or if it freezes at 0°c

ResultsPlus
Examiner Comments

This response was given 1 mark.

Although the implication is that the liquid is being boiled, there isn't a clear description of the test, such as "Heat the liquid..."

Ideally, candidates should give a definite result. The test should prove that the liquid is pure water – so the result should definitely be that it boils at 100 °C.

ResultsPlus
Examiner Tip

Make sure that any test is described, as well as the result being given.

Question 9 (c)

Many candidates handled the data with confidence here, and scored full marks for a correct calculation.

In some cases, candidates subtracted the wrong values at the start – but they were still able to gain method marks for calculating numbers of moles and, therefore, a ratio.

The ratio of 0.025 : 0.25 was mis-read by some candidates, either because they thought that 10 moles of water of crystallisation was too big, or because they were confused by two similar numbers. Either way, a final answer of x = 1 was seen sometimes at the end of an otherwise correct calculation.

Understandably, not all candidates cope with moles calculations and ratios very well. However, there were two accessible marks available for subtracting the correct numbers at the start of the question, so candidates should always be encouraged to start questions and get as far as they can.

(c) The table gives the student's results.

Mass of empty tube in g	15.83
Mass of tube and $Na_2SO_4.xH_2O$ in g	23.88
Mass of tube and Na_2SO_4 in g	19.38

Use the student's results to calculate the value of x.

[for Na_2SO_4, M_r = 142 for H_2O, M_r = 18]

(5)

mass of water = 23.88 − 19.38 = 4.5

mass of Na2SO4 = 23.88 − 15.83 = 8.05

water

$\frac{4.5}{18} = 0.25$

Na2SO4

$\frac{8.05}{142} = 0.056$

$\frac{0.25}{0.05} : \frac{0.05}{0.05}$

= 5 : 1

x = 5

x = 5

ResultsPlus
Examiner Comments

Unfortunately, this response starts off with an incorrect subtraction, finding the original mass of hydrated sodium sulfate rather than the mass of anhydrous sodium sulfate at the end of the experiment.

However, the correct method is then followed – but the answer of 0.056 for the moles of sodium sulfate is then truncated to 1SF to give 0.05.

This means that the final ratio is given as 1 : 5, whereas the mole ratio based on their calculation is 1 : 4.46, which is closer to x = 4.

This answer scored 3 marks.

ResultsPlus
Examiner Tip

In most calculation questions, there are easier marks at the start – in this case for subtracting to find the mass of water and the mass of sodium sulfate.

Only round when you get to your final answer – and make sure that it is a proper rounding, not just removing the last digits from the answer.

Question 10 (a)(i)

Most candidates approached this question in the same way: calculating the number of moles of zinc in 1.3g and comparing to the moles of hydrochloric acid. In most cases, however, the working did not take any account of the 2:1 ratio in the reaction, so only scored 1 mark.

Smaller numbers of candidates used the alternative methods: either to work out the mass of zinc that would react with 0.0036 moles of hydrochloric acid; or to work out the moles of acid needed to fully react with 1.3g of zinc. Those that did pick one of these methods nearly always spotted the 2:1 ratio, however.

10 Zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen gas.

This is the equation for the reaction.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

(a) In an experiment, 20 cm^3 of hydrochloric acid containing 0.0036 mol are reacted with 1.3 g of zinc granules at a temperature of 30 °C.

(i) Show by calculation that the zinc is in excess.

(2)

$$\frac{mass}{mr} = mol$$

$$\frac{1.3}{65} = 0.02$$

$$0.02 > 0.0036$$

ResultsPlus
Examiner Comments

This was the most common method chosen, and the moles of zinc present has been calculated correctly.

However, the comparison should then be half this number of moles to 0.0036 moles of hydrochloric acid because of the ratio in which they react.

ResultsPlus
Examiner Tip

Always look at the reacting ratio in a chemical equation.

Question 10 (a)(ii)

As the gradient of the initial graph was quite steep, some candidates assumed that the new graph to be plotted would be less steep. However, there was room to fit in a steeper curve to answer the question correctly.

Even answers with the wrong gradient levelled off, correctly, at the same volume of hydrogen.

Question 10 (b)(i)

This was one of the more demanding questions on the paper and full marks were rarely seen.

Oddly, it was the first marking point – the idea that the curve had to be less steep than curve A – which was rarely seen. Most candidates did make the point that the reaction was slower at a lower temperature. Although using a reverse argument – in this case explaining why curve A represents a reaction at a higher temperature – is usually a valid response, it was difficult here because both curves B and C represented slower reactions.

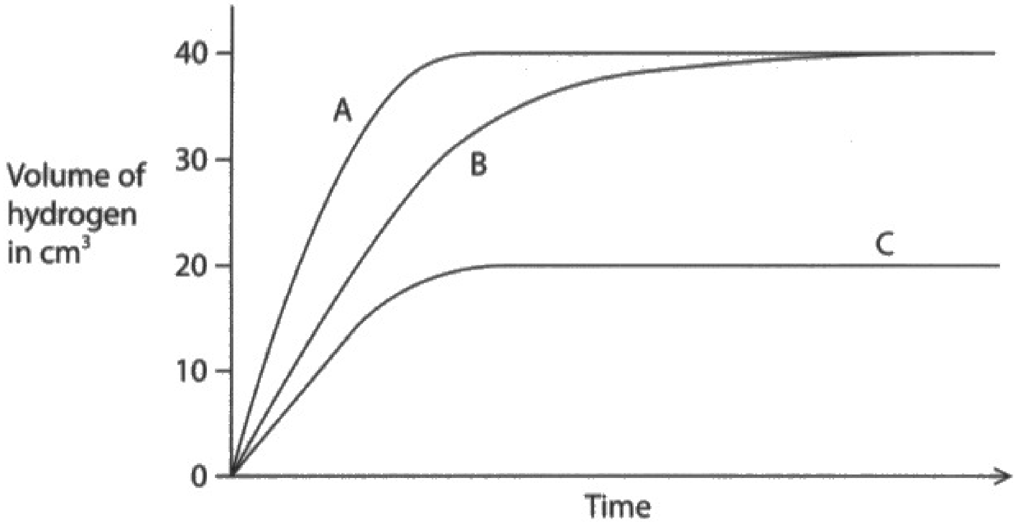
The key word 'kinetic' was missing from many answers when describing how the change in temperature affects the energy of the particles.

Although increasing the temperature will lead to a faster rate of collisions, the increase of rate is driven to a larger extent by the increased energy of the collisions, so candidates did need to refer to an increased frequency of **successful** collisions ie those that exceed activation. Note that mark schemes continue to accept only reference to collision frequency, and candidate answers should not refer to the probability or chance of a collision.

Some very good answers referred to the fact that curve B reaches the same final volume as curve A and explained this in terms on the same reacting quantities producing the same amount of hydrogen. This idea also gained credit.

(b) In the original experiment, 20 cm^3 of hydrochloric acid containing 0.0036 mol were reacted with 1.3 g of zinc granules at a temperature of 30 °C and curve A was obtained.

The student does two more experiments and obtains curves B and C.



(i) In one of these experiments the student repeats the original method but at a temperature of 20 °C.

Explain in terms of particle collision theory why the curve obtained could be curve B.

(4)

When the temperature is dropped from 30°c to 20°c the particles have less kinetic energy. This means they are slower. This means that there are less frequent successful collisions. Which means that the experiment takes longer to achieve the same volume of hydrogen. This is demonstrated from curve B which takes longer to achieve the same volume.

ResultsPlus
Examiner Comments

A good answer which scores 3 marks.

It correctly refers to the lower kinetic energy and the decreased frequency of successful collisions. Note that "This means they are slower" refers to the particles, not the overall rate and so is a repetition of M2.

M4 is scored by the reference to the taking longer to achieve the same volume. However, the final statement about achieving the same volume does not refer to the gradient (so no M1) or to why the final volume is the same (so no M5).

Question 10 (b)(ii)

Most candidates spotted the amount of hydrochloric acid had been halved, and related this correctly to the halving of the final volume of gas produced.

This quantitative explanation was sufficient to gain both marks.

As in the previous question, very few answers referred to the slope of the reaction.

(ii) In the other experiment the student repeats the original method but uses 20 cm^3 of hydrochloric acid containing 0.0018 mol.

Explain why curve C shows the results the student obtained.

(2)

In this other experiment, the same volume, but half the concentration of hydrochloric acid is used. As a result, the volume of hydrogen obtained is exactly half of that obtained in the original experiment.

ResultsPlus
Examiner Comments

An excellent answer, scoring both marks for making a quantitative link between halving the amount of acid and halving the volume of gas.

Question 10 (c)

Many answers here were answers to a slightly different question ie "Describe what a catalyst does". These answers focused on a catalyst speeding up a reaction but not being used up.

However, the question asked how a catalyst **works** – so the expected answer was one that referred to providing an alternative pathway with a lower activation energy.

(c) Catalysts can be used to speed up reactions.

Describe how a catalyst works.

(2)

A catalyst provides an alternate reaction pathway, for the reaction, and is not used up in the process.

ResultsPlus
Examiner Comments

This answer mixes a correct description of how a catalyst works with a more general definition of a catalyst, so only scores 1 mark.

ResultsPlus
Examiner Tip

Make sure you read the question carefully, so that your answer meets the expectation of the examiners.

Paper Summary

Based on their performance on this paper, candidates should:

- Take care on the use of terminology around covalent bonds and intermolecular forces.
- Make sure that explanations for anomalous results are in line with whether the anomalous results is too high or too low.
- Practise dot and cross diagrams for molecules with double bonds.
- Link collision theory to their answers when discussing rates of reaction.

Grade boundaries

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