Pearson
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Examiners' Report
June 2022

International GCSE Chemistry 4CH1 2C

ResultsPlus

Introduction

This paper discriminated well and gave a range of marks for all grades. The additional guidance helped the candidates to focus on their revision. The paper was well balanced with some accessible marks on all seven questions. The first question was the highest scoring question which was understandable as it targeted the 1-3 grade candidates. The rest of the questions had some more challenging parts and some more accessible parts and were probably more or less of equal difficulty.

On the whole, candidates performed better on the calculations than was expected with a fair number scoring full marks on some of the calculations. Other candidates often picked up error carried forward marks on the three and four mark calculations. Equations and formulae proved difficult for many candidates and they did not perform as well as expected. Explanations and descriptions were variable with some very good answers however many candidates lost unnecessary marks as they were often too vague when writing their answers.

Question 1 (b)

This question was well answered with global warming being the most popular answer. Note that reference to the ozone layer would negate the mark.

Question 1 (c)

The test for carbon dioxide was well known, but some candidates only gained 1 mark for not describing the test and just giving the result.

(c) Describe a test for carbon dioxide.

(2)

A test for carbon dioxide would be to bubble the unknown gas through limewater and if it turns cloudy then the gas is carbon dioxide.

ResultsPlus
Examiner Comments

This is a clear answer as they have bubbled the gas into limewater and given the result of the test.

ResultsPlus
Examiner Tip

To gain both marks you need to describe the test and give the result.

(c) Describe a test for carbon dioxide.

(2)

~~Carbon~~ With limewater, Carbon dioxide turns limewater milky.

ResultsPlus
Examiner Comments

There is no indication of adding the gas to limewater so the first mark cannot be awarded. The result of the test is correct so the second mark can be awarded.

ResultsPlus
Examiner Tip

Make sure you describe how to perform the test, by adding the carbon dioxide to the limewater in some way.

Question 2 (a)(ii)

Most candidates realised that a pipette was more precise or more accurate than a measuring cylinder. Incorrect answers included being able to add a little at a time, perhaps confusing this with a burette or stating that you were less likely to spill any of the solution.

Question 2 (b)(ii)

Most candidates scored the mark for this question. The most popular answer was to say that there was a range of colours or that the colour change was gradual. Only the minority of candidates mentioned that there was no clear end point. Some incorrect answers involved saying that it showed no colour or that it reacted with the reaction mixture.

Question 2 (c)

Many candidates scored at least two marks for this calculation. A common error was to fail to divide by two, which lost them the second marking point.

(c) The student adds some dilute nitric acid to a burette and does the titration.

The equation for the reaction is

$$Ba(OH)_2 + 2HNO_3 \rightarrow Ba(NO_3)_2 + 2H_2O$$

The student finds that 21.50 cm^3 of nitric acid of concentration 0.600 mol/dm^3 neutralises 25.0 cm^3 of barium hydroxide solution.

Calculate the concentration, in mol/dm^3, of the barium hydroxide solution.

(3)

moles of nitric acid = conc. × volume

$= 0.600 \times \frac{21.50}{1000}$

$= 0.0129$ moles

$HNO_3 : Ba(OH)_2$

2 : 1

moles of $Ba(OH)_2 = 0.0129 / 2$

$= 6.45 \times 10^{-3}$ moles

concentration = $\frac{6.45 \times 10^{-3}}{25/1000}$

$= 0.258$ mol/dm^3

$n = v \times c$

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

concentration = 0.258 mol/dm^3

ResultsPlus
Examiner Comments

This is a well-constructed answer which showed clear working and gave the correct answer on the answer line gaining all 3 marks.

ResultsPlus
Examiner Tip

Always show your working in calculations because if you make a mistake, you may be awarded marks for error carried forward.

(c) The student adds some dilute nitric acid to a burette and does the titration.

The equation for the reaction is

$$Ba(OH)_2 + 2HNO_3 \rightarrow Ba(NO_3)_2 + 2H_2O$$

The student finds that 21.50 cm^3 of nitric acid of concentration 0.600 mol/dm^3 neutralises 25.0 cm^3 of barium hydroxide solution.

Calculate the concentration, in mol/dm^3, of the barium hydroxide solution.

(3)

0.0215 dm^3 = 21.50 cm^3

0.6 × 0.0215 = 0.0129

0.0129 mol

25 ÷ 1000 = 0.025

0.0129 / 0.025 = 0.516

concentration = 0.516 mol/dm^3

ResultsPlus
Examiner Comments

This answer scored 2 marks as the candidate failed to divide the moles of nitric acid by 2. However they were awarded the third marking point as an error carried forward.

ResultsPlus
Examiner Tip

If you show your working clearly and make a mistake in the middle of the calculation you may be able to gain error carried forward marks.

(c) The student adds some dilute nitric acid to a burette and does the titration.

The equation for the reaction is

$$Ba(OH)_2 + 2HNO_3 \rightarrow Ba(NO_3)_2 + 2H_2O$$

The student finds that 21.50 cm^3 of nitric acid of concentration 0.600 mol/dm^3 neutralises 25.0 cm^3 of barium hydroxide solution.

Calculate the concentration, in mol/dm^3, of the barium hydroxide solution.

(3)

$$\frac{21.50 \times 0.600}{\cancel{1000}}$$

$$= \cancel{0.0129\ mol}\ 12.9\ mol/dm^3$$

concentration = 12.9 mol/dm^3

ResultsPlus
Examiner Comments

Unfortunately this answer did not score any marks as the candidate decided not to divide by 1000 and crossed it out. The candidate did not divide their answer by 2 or attempt to complete the question.

ResultsPlus
Examiner Tip

Remember when finding the moles in a concentration calculation to convert the cm^3 into dm^3 by dividing by 1000.

Question 2 (d)

This question was poorly answered on the whole, with only the minority of candidates realising that barium sulfate was insoluble. Incorrect answers often focussed on the sulfuric acid, saying it was too strong, too weak or did not react with barium hydroxide.

Question 3 (c)

This question discriminated well and gave a range of marks. Many candidates gained 3 or 4 marks for this question, often missing the third or fourth marking point.

This is a good answer which scores all 4 marks.

(c) The table shows the electronic configurations of a fluorine atom and a chlorine atom.

	Electronic configuration
fluorine	2.7
chlorine	2.8.7

Explain the relative reactivities of fluorine and chlorine using the information in the table.

(4)

Flourine is more reactive than chlorine because its outer electron shell is closer to the nucleus, so the electrostatic attraction between negatively charged electrons & the positively charged nucleus is stronger, so it is easier to attract an electron to fill the outer shell, so flourine is more reactive

ResultsPlus
Examiner Comments

The candidate has stated that fluorine is more reactive than chlorine as its outer electron shell is closer to the nucleus, which scores the first two marking points. They have stated that there is a stronger attraction to the nucleus for the outer electrons and so it is easier to attract an electron, which scores the third and fourth marking points.

ResultsPlus
Examiner Tip

When you are comparing the reactivity of two elements use comparative words such as 'closer', 'stronger' and 'easier' when explaining why which element is the more reactive.

This question has scored the first two marking points.

(c) The table shows the electronic configurations of a fluorine atom and a chlorine atom.

	Electronic configuration
fluorine	2.7
chlorine	2.8.7

Explain the relative reactivities of fluorine and chlorine using the information in the table.

(4)

Fluorine is more reactive than chlorine as the outer shell electrons are closer to the nucleus of the atom. This means that there are less shells and so less energy is required ~~the~~ to break them. This means that less energy is needed to break the shells of fluorine than chlorine making fluorine more reactive.

ResultsPlus
Examiner Comments

The candidate has stated that fluorine is more reactive than chlorine and that the outer shell is closer to the nucleus. The rest of the answer is not creditworthy as they have talked about energy breaking the shells rather than the ease of attracting an electron.

ResultsPlus
Examiner Tip

Use the information given in the table to explain why fluorine is more reactive. The fact that it has 7 electrons in the outer shell implies that it needs to accept an electron to become stable.

Question 3 (d)(i)

Many candidates were unable to give a fully correct balanced equation. Common errors included writing the correct formulae but failing to balance the equation, writing Cl instead of Cl_2 or giving an incorrect formula of lithium chloride, usually $LiCl_2$ or putting charges on lithium and chlorine, $Li^+ + Cl^-$.

Question 3 (d)(ii)

This question discriminated well giving a range of marks. Many candidates scored all five marks. The flame test for lithium ions was well known. A common error was to give the test for chlorine rather than chloride ions.

(ii) **Describe tests to show that the product of the reaction is lithium chloride.**

(5)

One test could be a flame test where an aluminium loop is dipped in HCl (to be cleaned) and then the loop is covered in the product. If the flame burns red then we know that there are lithium ions present. We can also test for the chlorine by using damp blue litmus paper which is bleached white if chlorine is present

ResultsPlus
Examiner Comments

This candidate described how to do a flame test and gave the correct result and so scored the first two marks. Unfortunately they gave the test for chlorine rather than for chloride ions so no further marks could be awarded.

ResultsPlus
Examiner Tip

Lithium chloride contains chloride ions not chlorine gas and chloride ions would not bleach damp litmus paper.

(ii) Describe tests to show that the product of the reaction is lithium chloride. **(5)**

To test for lithium, do a flame test, the ~~colour~~ colour of the flame turns yellow. red.

To test for chloride ions, add dilute ~~hydroch~~ nitric acid to ~~react~~ remove impurities, then add silver nitrate solution, a white precipitate of silver chloride is formed

ResultsPlus
Examiner Comments

This is a clear concise answer which scores all 5 marks.

ResultsPlus
Examiner Tip

There is no need to go into detail as to how to perform a flame test, as just stating 'do a flame test' is sufficient to score the first mark.

Question 4 (a)

Most candidates scored at least one mark, usually for mentioning bright white light.

4 This question is about magnesium and magnesium compounds.

(a) Magnesium burns in oxygen to form magnesium oxide.

State two observations that would be seen during the reaction.

(2)

1 bright white light

2 white powder left over

ResultsPlus
Examiner Comments

A clear answer giving two correct observations.

ResultsPlus
Examiner Tip

Make sure you give two observations. Just stating that magnesium oxide is formed would not score a mark as this is not an observation.

4 This question is about magnesium and magnesium compounds.

(a) Magnesium burns in oxygen to form magnesium oxide.

State two observations that would be seen during the reaction.

(2)

1 A bright white light / flame

2 A white precipitate formed

ResultsPlus
Examiner Comments

Just one mark gained here as 'white precipitate' does not score the second marking point.

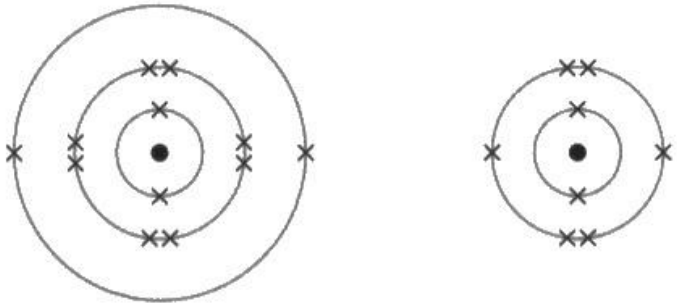
ResultsPlus
Examiner Tip

A precipitate only forms in a liquid or in a solution and there is no liquid or solution involved in this reaction. You need to mention white powder, white solid or white ash to score the mark.

Question 4 (b)

The majority of candidates scored both marks for this question.

(b) The diagram shows the electron configurations of a magnesium atom and an oxygen atom.



magnesium atom oxygen atom

Describe the changes in the electronic configurations when magnesium reacts with oxygen to form the ionic compound magnesium oxide, MgO

(2)

magnesium loses 2 electrons from its outer shell and oxygen gains the 2 electrons to its outer shell, meaning both end up with the electron configuration 2,8

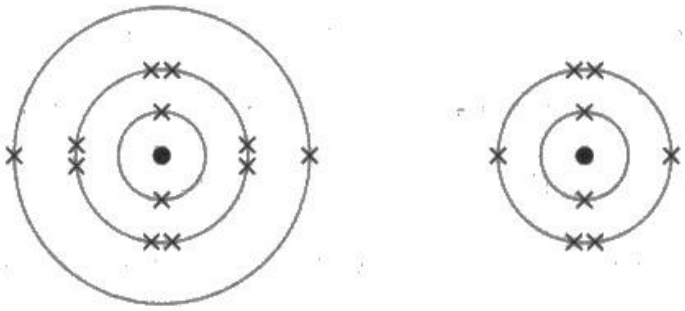
ResultsPlus
Examiner Comments

A clear concise answer that gains both marks.

ResultsPlus
Examiner Tip

Use the diagram of the atoms to help you describe the changes that occur when magnesium reacts with oxygen.

(b) The diagram shows the electron configurations of a magnesium atom and an oxygen atom.



magnesium atom oxygen atom

Describe the changes in the electronic configurations when magnesium reacts with oxygen to form the ionic compound magnesium oxide, MgO

(2)

Magnesium would have a full outer shell of electrons as Mg has shares its two electrons with oxygen six, creating a full outer shell

ResultsPlus
Examiner Comments

This candidate has mentioned sharing of electrons which means they lose both marks as magnesium and oxygen do not bond covalently.

ResultsPlus
Examiner Tip

Oxygen would not share six electrons with magnesium. A metal reacts with a non-metal by transferring electrons to form an ionic bond.

Question 4 (c)(i)

Most candidates knew that magnesium was more reactive than carbon and scored the mark.

Question 4 (c)(ii)

This question discriminated well and gave a range of marks. The majority of candidates knew that metals conduct electricity because they have delocalised electrons and that ionic compounds only conduct when molten or in solution, but many candidates thought that electrons were also responsible for the conduction of electricity in ionic compounds.

(ii) Explain the different ways that magnesium and magnesium chloride conduct electricity.

(4)

magnesium

There is a sea of delocalised electrons that surround the magnesium ion lattice, that are able to move around and ~~carry~~ carry an electric ~~charge~~. charge

magnesium chloride

Magnesium chloride can only conduct electricity when molten - when molten, the ions are able to freely move and flow past each other, so they are able to carry an electric ~~ion~~ charge.

ResultsPlus
Examiner Comments

This candidate gave a clear and concise answer and scored all four marks.

ResultsPlus
Examiner Tip

Make sure when you explain the different ways a metal and an ionic compound conduct electricity that you mention the movement of electrons and ions. Marks are often lost by just stating that electrons are free or carry charge rather than saying electrons move.

(ii) Explain the different ways that magnesium and magnesium chloride conduct electricity.

(4)

magnesium

Magnesium is a metal. Metals ~~are layers of ions~~ atoms and have ~~delocati~~ delocalised electrons that can carry ~~electro~~ electricity around.

magnesium chloride

Magnesium chloride is a ionic compound that has ~~have~~ delocalised ions that can carry electricity.

ResultsPlus
Examiner Comments

This candidate gained 1 mark for mentioning delocalised electrons in a metal. Unfortunately they said that electrons carry electricity around rather than electrons move. They also knew that ions were responsible for conducting electricity in an ionic compound but unfortunately, they failed to mention that the substance must be molten or aqueous to conduct and again they did not say that the ions were free to move.

ResultsPlus
Examiner Tip

The question asks for the different ways the two substances conduct electricity. This should help you to realise that they conduct in different states and that different particles are involved in the conduction.

Question 4 (d)(i)

The majority of candidates knew that reduction involved gain of electrons but unfortunately many candidates lost the mark here by saying that magnesium gains electrons. When you answer a question of this nature you need to refer to the correct species involved. Magnesium atoms do not gain electrons so this statement is incorrect. It is the magnesium ions that are gaining electrons.

Question 4 (d)(ii)

Only the minority of candidates gained the mark here for a correct half equation. Errors included failing to recognise that chlorine is a diatomic molecule, adding electrons to the wrong side of the equation, not balancing the equation, giving no charge or the incorrect charge on the chloride ion. Candidates need to practice writing half equations and making sure the formulae and charges balance.

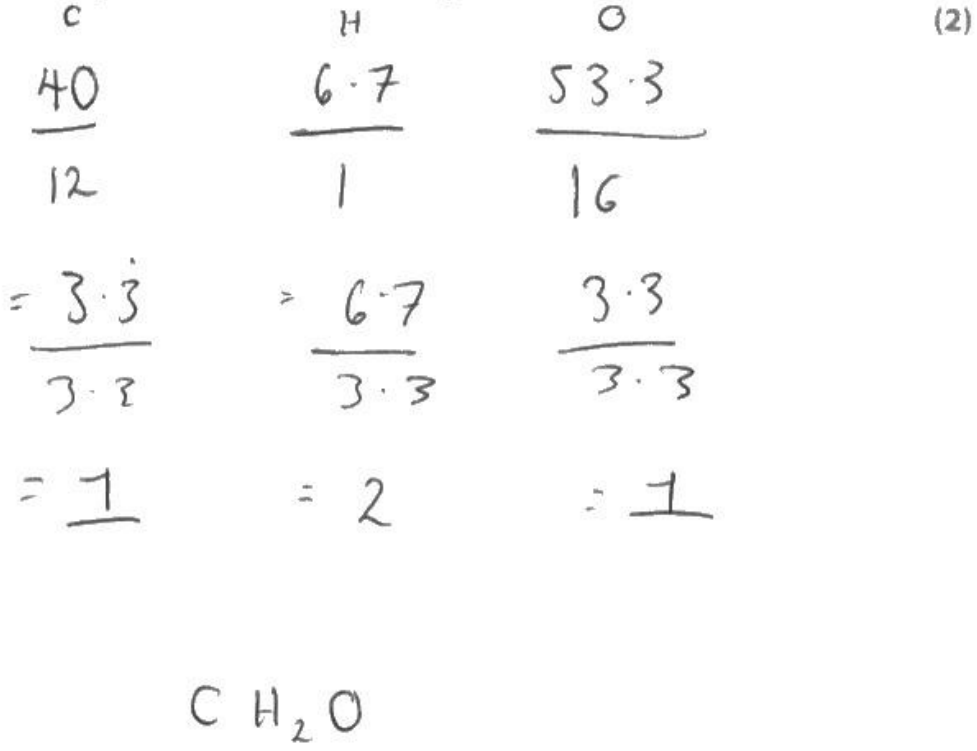
Question 5 (a)(i)

This question was well answered by the majority of candidates who showed their working clearly, which is necessary to gain the marks in a 'show that' question.

5 (a) An organic compound has this percentage composition by mass.

C = 40% H = 6.7% O = 53.3%

(i) Show that the empirical formula of the compound is CH_2O **(2)**



ResultsPlus
Examiner Comments

A well set out answer showing all the necessary steps and giving all values to an appropriate number of significant figures.

ResultsPlus
Examiner Tip

Make sure you show all the steps in the calculation in a 'show that' question.

5 (a) An organic compound has this percentage composition by mass.

C = 40% H = 6.7% O = 53.3%

(i) Show that the empirical formula of the compound is CH_2O

(2)

12 1 16

÷

40 6·7 53·3

0·3 6·15 0·3

× × ×1

1 2

CH_2O

ResultsPlus
Examiner Comments

Unfortunately this answer did not score any marks as the candidate divided the relative atomic masses by the percentages.

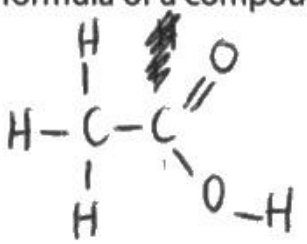
ResultsPlus
Examiner Tip

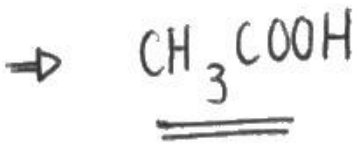
If you do an upside down calculation you will not obtain the correct ratio and you have therefore not shown that the ratio is 1:2:1. Dividing by atomic numbers would also be incorrect and both marks would be lost.

Question 5 (a)(ii)

This question was poorly answered on the whole, with many candidates drawing an incorrect structure.

(ii) Draw the structural formula of a compound with the molecular formula $C_2H_4O_2$ **(1)**





ResultsPlus
Examiner Comments

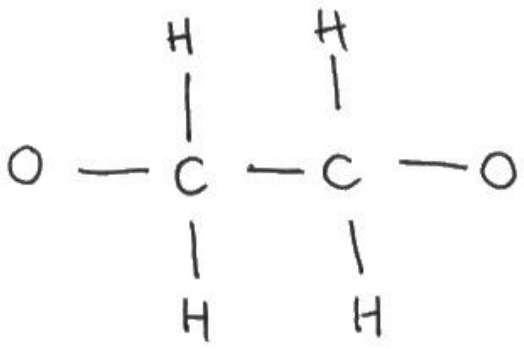
This candidate has drawn a correctly displayed formula of ethanoic acid. They have also given the structural formula which is an acceptable answer so the mark can be awarded.

ResultsPlus
Examiner Tip

It is not necessary to give both structures. In this example they are both correct so no harm done, but if one was right and the other wrong then this would be a list principle and the mark would be lost.

(ii) Draw the structural formula of a compound with the molecular formula $C_2H_4O_2$

(1)



ResultsPlus
Examiner Comments

This was a common incorrect answer which was seen fairly often. This is not a viable structure as there needs to be two bonds to each oxygen atom.

ResultsPlus
Examiner Tip

Note that each carbon atom needs to have four bonds to it, each oxygen atom needs to have two bonds to it and each hydrogen atom needs to have one bond to it. Note also that a double bond is equivalent to two single bonds to an atom.

Question 5 (b)(i)

Most candidates scored the first marking point for realising that two of the products were carbon dioxide and water. Only the minority of candidates scored both marks as the formula of the salt was not well known.

(b) Methanoic acid (HCOOH) reacts with sodium carbonate solution to give three products.

(i) Complete the equation for this reaction.

(2)

$2HCOOH + Na_2CO_3 \rightarrow$ 2HCOONa + H_2O + CO_2

ResultsPlus
Examiner Comments

This was a fully correct equation scoring both marks.

ResultsPlus
Examiner Tip

Make sure you give the correct formulae and that the equation is balanced to gain both marks.

(b) Methanoic acid (HCOOH) reacts with sodium carbonate solution to give three products.

(i) Complete the equation for this reaction.

(2)

$2HCOOH + Na_2CO_3 \rightarrow$ 2NaCOOH + CO_2 + H_2O

ResultsPlus
Examiner Comments

This candidate scored the first marking point for CO_2 and H_2O but unfortunately the third product was not the correct salt, so the second marking point was lost.

ResultsPlus
Examiner Tip

NaCOOH is not the formula of the salt sodium methanoate as this product has a carboxylic acid group present, so the acid has not been neutralised by reacting the acid with sodium carbonate. The H needs to be in front of the carbon and ideally the Na after the second oxygen atom.

Question 5 (b)(ii)

This question was well answered with most candidates realising that carbon dioxide was given off so effervescence or bubbling or fizzing occurred. Note that stating gas or carbon dioxide is given off does not score the mark as this is not an observation.

Question 5 (c)(i)

There was quite a bit of guesswork here with a variety of unusual names for the ester. The most common incorrect answer was to write methyl propanoate. Note that the propyl comes from the alcohol and the methanoate comes from the carboxylic acid. The formula is written in such a way that the derivative of the acid group comes first and the derivative of the alcohol comes second.

Question 5 (c)(ii)

This question was very well answered with a large majority of candidates recognising that this was a reversible reaction. A few candidates lost the mark for writing equilibrium but these answers were quite rare.

Question 5 (c)(iii)

Some candidates gave clear mark scheme answers for this question but there were a fair number who were not specific enough and lost the mark.

(iii) When this reaction occurs in a sealed container, the reaction can reach dynamic equilibrium.

Give one characteristic of a reaction at dynamic equilibrium.

(1)

the rate of the forward reaction is equal to the rate of the backwards reaction.
concentration of reactants and products stay constant.

ResultsPlus
Examiner Comments

This candidate gave both characteristics of a reaction at dynamic equilibrium and both were correct mark scheme answers so the mark could be awarded.

ResultsPlus
Examiner Tip

If you are asked for one characteristic choose the one you are most confident about. It is not necessary to give two answers, as if one happened to be an incorrect statement you would lose the mark. For example, if the candidate had stated that the concentrations of reactants and products were the same, this would have been incorrect and the mark would have been lost.

(iii) When this reaction occurs in a sealed container, the reaction can reach dynamic equilibrium.

Give one characteristic of a reaction at dynamic equilibrium.

(1)

the reaction is balanced

ResultsPlus
Examiner Comments

This answer is too vague and does not score the mark.

ResultsPlus
Examiner Tip

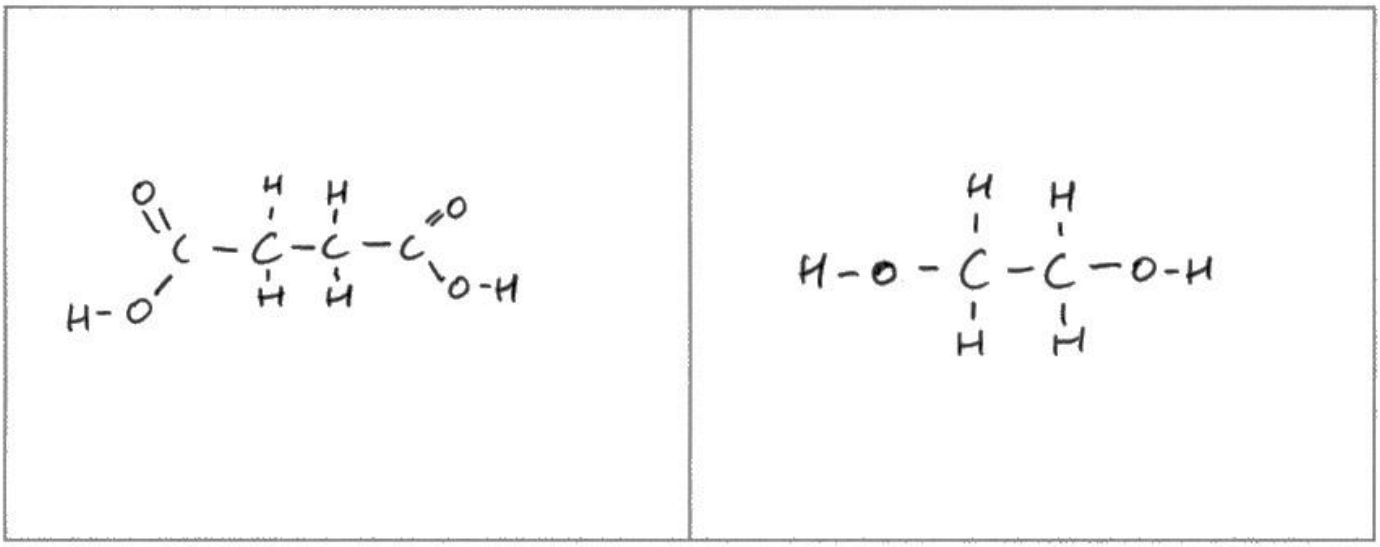
Learn the characteristics of a reaction at dynamic equilibrium from the specification, as vague answers such as this or stating that the forward reaction equals the backward reaction with no mention of rate would not score the mark.

Question 5 (d)(ii)

Only the minority of candidates scored both marks for this question.

(ii) Draw the structural formulae of the two monomers used to make this polyester.

(2)



ResultsPlus
Examiner Comments

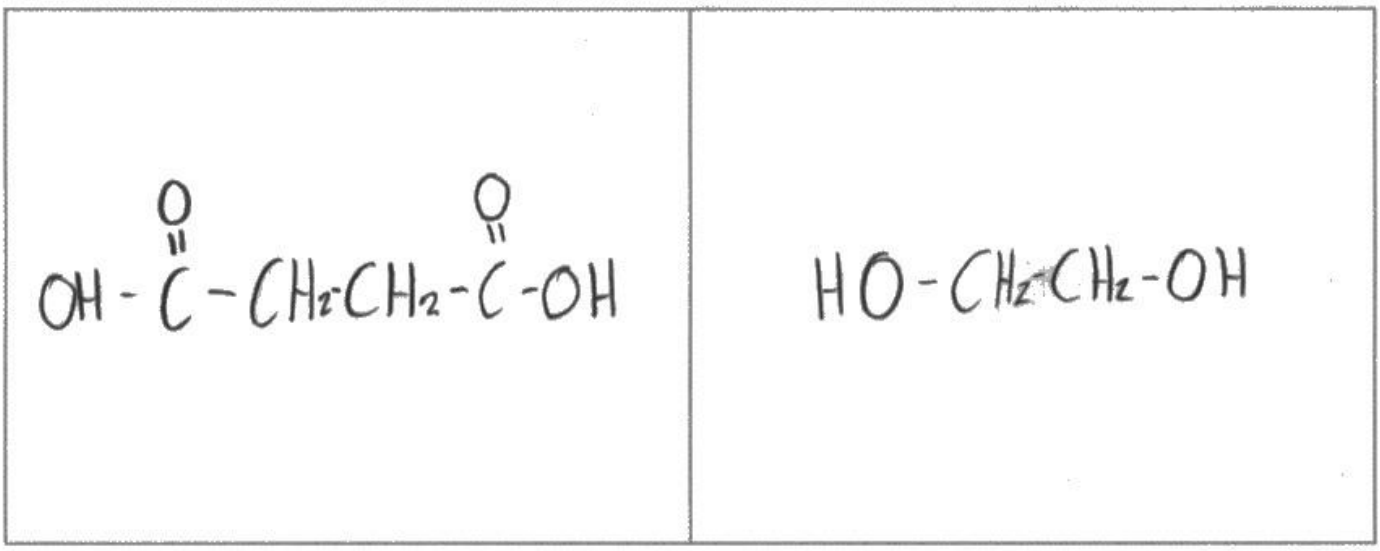
This candidate has clearly drawn both structures correctly showing all the bonds.

ResultsPlus
Examiner Tip

When drawing the structures of the monomers add the OH groups on to both ends of the dicarboxylic acid and the Hs on to both ends of the diol. Do not leave any spare bonds at the ends of the molecules.

(ii) Draw the structural formulae of the two monomers used to make this polyester.

(2)



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Examiner Comments

This candidate has drawn the diol correctly so has gained the second marking point. Unfortunately they have joined the H of the OH group to the carbon on the dicarboxylic acid which has lost them the first marking point.

ResultsPlus
Examiner Tip

Make sure you draw the structures so that the right atoms are connected correctly. There should be two bonds to the oxygen of the OH group and just one bond to the hydrogen.

Question 6 (a)

This question discriminated well and gave a good range of marks, with many candidates scoring 3 or 4 marks.

6 Titanium is an important metal in industry.

Titanium dioxide (TiO_2) can be converted into titanium metal in two stages.

Stage 1 titanium dioxide is converted into titanium(IV) chloride ($TiCl_4$)

Stage 2 titanium(IV) chloride is converted into titanium

(a) This is the equation for the reaction in stage 1.

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

Calculate the volume, in dm^3, of chlorine gas at rtp needed to react completely with 20 tonnes of titanium dioxide.

Give your answer in standard form.

[1 tonne = 10^6 g M_r of TiO_2 = 80]

[molar volume of chlorine gas at rtp = 24 dm^3]

(4)

g of TiO_2 = 20,000,000

mr g Cl = 35.5

moles of TiO_2 = $\frac{20,000,000}{80}$

= 250,000

moles of Cl_2 = 500,000

$V = 24 \times m$

$24 \times 500,000$

= 12000000

volume of chlorine gas = 1.2×10^7 dm^3

ResultsPlus
Examiner Comments

This candidate gained full marks for this question. They set out the working clearly and gave the correct answer in standard form.

ResultsPlus
Examiner Tip

Read the question carefully and use the data provided in the question and use the equation to deduce the mole ratio. Many candidates lost the fourth marking point for not giving the answer in standard form as they were told to do so.

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(a) This is the equation for the reaction in stage 1.

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Calculate the volume, in dm^3, of chlorine gas at rtp needed to react completely with 20 tonnes of titanium dioxide.

Give your answer in standard form.

[1 tonne = 10^6 g M_r of TiO_2 = 80]

[molar volume of chlorine gas at rtp = 24 dm^3]

(4)

volume = moles / 24 (dm^3)

moles = mass / mr

moles of TiO_2 = $\frac{20 \times 10^6}{80}$

= 250000

moles of Cl_2 = 250000 × 2

= 500000

Volume of chlorine = $\frac{500000}{24}$ = 20833.3̇

volume of chlorine gas = 20833.3̇ dm^3

ResultsPlus
Examiner Comments

This candidate gained the first two marking points for finding the moles of TiO_2 and then multiplying by 2 to find the moles of chlorine. Unfortunately they divided by 24 instead of multiplying and they did not convert their answer to standard form.

ResultsPlus
Examiner Tip

If this candidate had converted their answer into standard form correctly they would have been awarded an error carried forward mark. Always show all the steps in your working so that if you make a mistake, you can still gain error carried forward marks.

Question 6 (b)

Many candidates gained the first marking point for stating that argon was inert or unreactive but many lost the second marking point as their answers were often too vague and did not specify that the oxygen in the air would react with the magnesium or titanium.

(b) In stage 2, titanium(IV) chloride vapour is passed through molten magnesium in a container filled with argon.

This is the equation for the reaction in stage 2.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

Explain why the container is filled with argon rather than air.

(2)

Argon is unreactive, where if air is used, the magnesium will react with the oxygen to form magnesium oxide

ResultsPlus Examiner Comments

This question clearly stated that argon was unreactive and that oxygen would react with magnesium, so both marks could be awarded.

ResultsPlus Examiner Tip

The question asks for an explanation so candidates must state that argon is inert/unreactive and therefore either argon will not react with magnesium/titanium or the oxygen in air will react with magnesium/titanium.

(b) In stage 2, titanium(IV) chloride vapour is passed through molten magnesium in a container filled with argon.

This is the equation for the reaction in stage 2.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

Explain why the container is filled with argon rather than air.

(2)

Argon is less reactive than air, meaning that the reactants will not react with the Argon

ResultsPlus
Examiner Comments

Stating that argon is less reactive than air is not sufficient for the first marking point and just stating that the reactants will not react with the argon is too vague a statement, as candidates must specify the lack of reaction with either magnesium or titanium.

ResultsPlus
Examiner Tip

Saying that argon is less reactive than air does not necessarily mean that argon is unreactive as it still may react with the magnesium or titanium.

Question 6 (c)

Many candidates gained at least two marks for this question. The first marking point was often lost as they just discussed the alloy and did not compare it with the pure metal.

produced is pure

(c) Aeroplanes are made of an alloy containing aluminium and titanium.

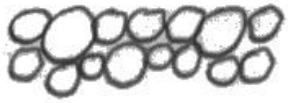
Explain why the alloy is stronger than pure titanium metal.

You may include diagrams in your answer.

(3)

METAL

ALLOY



- Pure titanium metal has regular layers ~~rows and columns~~ which can slide over each other
- The alloy has metal ions of different sizes which disrupts the lattice
- So in the alloy, the layers can't slide over each other which makes the alloy stronger

ResultsPlus
Examiner Comments

The candidate clearly states that titanium has regular layers that can slide over each other and in the alloy the ions are of different sizes and the layers cannot slide over each other so all 3 marks can be awarded.

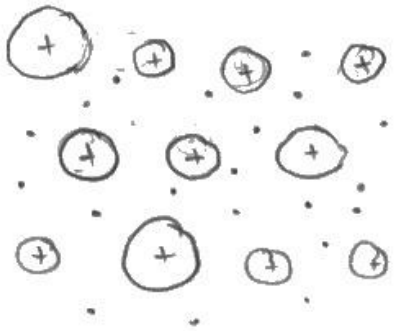
Make sure you explain why the alloy is stronger than the pure metal. You need to discuss both the pure metal and the alloy to gain all three marks. Note that the diagrams could score the first two marking points for showing the sizes of the atoms/ions.

(c) Aeroplanes are made of an alloy containing aluminium and titanium.

Explain why the alloy is stronger than pure titanium metal.

You may include diagrams in your answer.

(3)



• the aluminium and titanium nuclei are different sizes so the aluminium nuclei disrupt the arrangement of the pure titanium lattice structure, making it harder for the layers of cations to slide over each other and making the alloy harder than pure titanium metal

ResultsPlus
Examiner Comments

This candidate has stated that the nuclei are of different sizes. This is not sufficient for the second marking point as they must refer to the atoms or ions not the nuclei. They have only talked about the alloy and not the pure metal so the first marking point has not been awarded, however they have scored the third marking point for saying that it is harder for the layers to slide over each other.

Make sure you refer to the correct particles in your answer and also compare the pure metal with the alloy.

Question 7 (a)

The majority of candidates scored the mark here either for carbon or soot which was the preferred answer. The allowable answer of copper oxide was also seen quite often.

Question 7 (b)

This question was well answered by the majority of candidates.

(b) In one experiment, the student burns 0.92 g of ethanol.

The student calculates that the heat energy absorbed by the water is 18.2 kJ.

Show that the results of this experiment give an approximate value for the enthalpy of combustion of ethanol of $\Delta H = -900$ kJ/mol.

[M_r of ethanol = 46]

(2)

$\Delta H = \frac{Q}{n}$

$= \frac{-18.2\text{ kJ}}{0.02\text{ mol}}$

$= -910\text{ kJ/mol}$

$= -900\text{ kJ/mol (1 sf)}$

$n = \frac{m}{RFM}$

$n = \frac{0.92}{46}$

$n = 0.02\text{ mol}$

ResultsPlus
Examiner Comments

This was a well-constructed answer which showed clear working and gained both marks.

ResultsPlus
Examiner Tip

In a 'show that' question make sure that you show all the steps in your working. Underlining or circling important data in the question can be helpful in constructing your answer.

(b) In one experiment, the student burns 0.92 g of ethanol.

The student calculates that the heat energy absorbed by the water is 18.2 kJ.

Show that the results of this experiment give an approximate value for the enthalpy of combustion of ethanol of $\Delta H = -900$ kJ/mol.

[M_r of ethanol = 46]

(2)

$\frac{0.92}{46} = 0.02$

ResultsPlus
Examiner Comments

This candidate gained the first marking point for calculating the moles of ethanol but they have not gone on to show that the enthalpy of combustion is approximately – 900kJ/mol so the second mark cannot be awarded.

ResultsPlus
Examiner Tip

If you have not shown that the answer is approximately – 900kJ/mol you cannot be awarded both marks.

Question 7 (c)

The majority of candidates gained the first marking point for mentioning heat loss with only a minority giving one of the other alternative answers. Some candidates mentioned heat loss to the surroundings and also heat being absorbed by the apparatus but these statements were the same marking point so only one mark could be awarded.

(c) The data book value of ΔH for the combustion of ethanol is –1367 kJ/mol.

Give two reasons why the student's value is much lower than the data book value.

(2)

1 Incomplete combustion of ethanol.

2 Heat is lost to the surroundings.

ResultsPlus
Examiner Comments

This is the mark scheme answer scoring both the first and second marking points.

ResultsPlus
Examiner Tip

Make sure you give two different reasons for the value being lower than expected.

(c) The data book value of ΔH for the combustion of ethanol is −1367 kJ/mol.

Give two reasons why the student's value is much lower than the data book value.

(2)

1 Because energy is lost into surrounding

2 ~~There are impurities in the fuel~~
The fuel hasn't reacted completely.

ResultsPlus
Examiner Comments

Unfortunately this candidate has not been awarded any marks as they have not mentioned heat or thermal energy. Saying that the fuel hasn't reacted completely is not the same as stating incomplete combustion.

ResultsPlus
Examiner Tip

Make sure you mention heat or thermal energy when you answer a question involving enthalpy changes or exothermic and endothermic reactions, as just referring to energy is too vague an answer and not creditworthy.

Question 7 (d)(i)

This question discriminated well and gave a range of marks with many candidates often scoring 3 or 4 marks.

(i) Calculate the bond energy of the C—H bond, using information from the equation and the table.

(4)

$(4x) + 498 + 498 = 4x + 996$

$805 + 805 + (4 \times 463) = 3462$

$4x + 996 - 3462 = -890$

$4x + 996 = 2572$

$4x = 1576$

$x = 394$

C—H bond energy = 394 kJ/mol

ResultsPlus
Examiner Comments

This answer showed all the steps in the working and was clear to follow. The correct answer of 394kJ/mol gained all four marks.

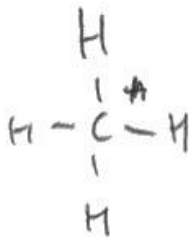
ResultsPlus
Examiner Tip

Always show your working as if you make a mistake at some stage, you may still be awarded error carried forward marks.

(i) Calculate the bond energy of the C—H bond, using information from the equation and the table.

(4)

4x



$+ 2 \times 498 = 2 \times 805 + 4 \times 463$

996

$4x + 996 = 1610 + 1852$

$4x = 2466$

$x = 616.5$

C—H bond energy = 616.5 kJ/mol

ResultsPlus
Examiner Comments

This answer gained the first two marking points. The candidate then failed to include the – 890kJ/mol in the calculation so the third marking point was not awarded, however as they divided their answer by 4, they gained the fourth marking point as an error carried forward mark.

ResultsPlus
Examiner Tip

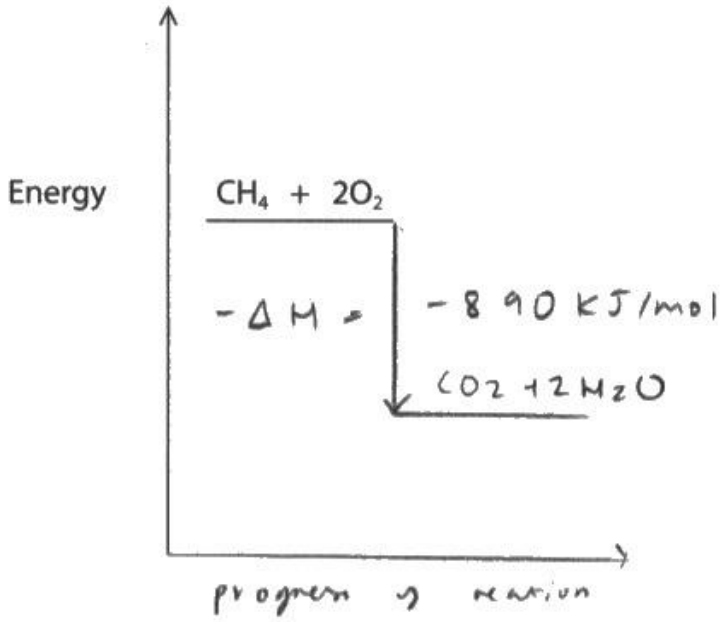
Make sure your working is clearly laid out so that error carried forward marks can be awarded if necessary.

Question 7 (d)(ii)

Most candidates scored the first marking point for giving the products in the correct position, however many failed to show the correct position of the deltaH value so they lost the second marking point. Many candidates added the activation energy hump which was not required in this question.

(ii) Complete the energy level diagram to show the products and ΔH.

(2)



ResultsPlus
Examiner Comments

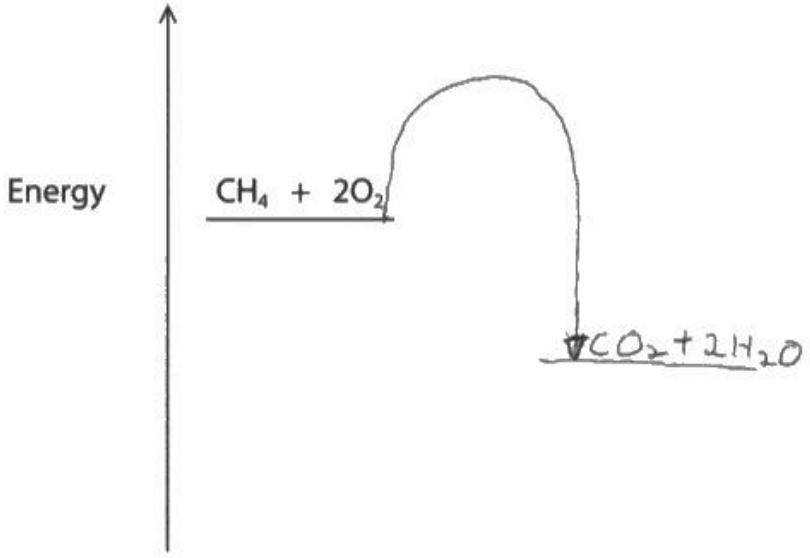
This was a clear and neatly drawn energy level diagram which was labelled correctly and scored both marking points.

ResultsPlus
Examiner Tip

When drawing an energy level diagram use a ruler to draw the horizontal and vertical lines and make sure that the line or arrow for the deltaH value goes from the reactant line to the product line.

(ii) Complete the energy level diagram to show the products and ΔH.

(2)



ResultsPlus
Examiner Comments

This candidate scored the first marking point for the products in the correct position and clearly labelled, however they have failed to include the deltaH line so the second marking point cannot be awarded.

ResultsPlus
Examiner Tip

When you are asked to draw an energy diagram it is not necessary to draw the hump which shows the activation energy. Make sure you do include and label deltaH as the question has asked you.

Paper Summary

Based on their performance on this paper, candidates should:

- learn descriptions of chemical tests.
- appreciate the different nature of ions, molecules and atoms.
- practise writing formulae, chemical equations and half equations.
- always show working clearly in calculations.
- read the questions carefully so as not to miss important points that will help you answer the questions.
- use the data provided to help you answer the questions.