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Examiners' Report
June 2025

Int GCSE Chemistry 4CH1 2C

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June 2025

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Introduction

Question 1 was an easy starter with many having all six marks.

Question 2 was unusual and discriminated well. Q02(e) is no longer allowed for double arrows or just straight lines. It has to be arrows shown in the right directions.

Question 3 was also discriminated well. It was pleasing to see some very good answers of Q03(d).

Question 4 is an organic topic and discriminated well.

Question 5 was a titration and also a practical which was again discriminated well.

Question 6 was about reversible reactions and a tricky calculation in Q06(c) with few candidates achieving four marks.

Question 1(b)(i)

This was well done with the majority stating fractional distillation.

Question 1(b)(ii)

This was also well known and candidates usually wrote aircraft fuel, jet fuel or sometimes (aero)plane fuel. A few lost the mark by just stating aircraft and not mentioning fuel.

Question 2(a)

The majority stated that heat was released or was lost to the surroundings. A few lost the mark for just saying that energy was released. It must be heat or thermal energy to gain the mark.

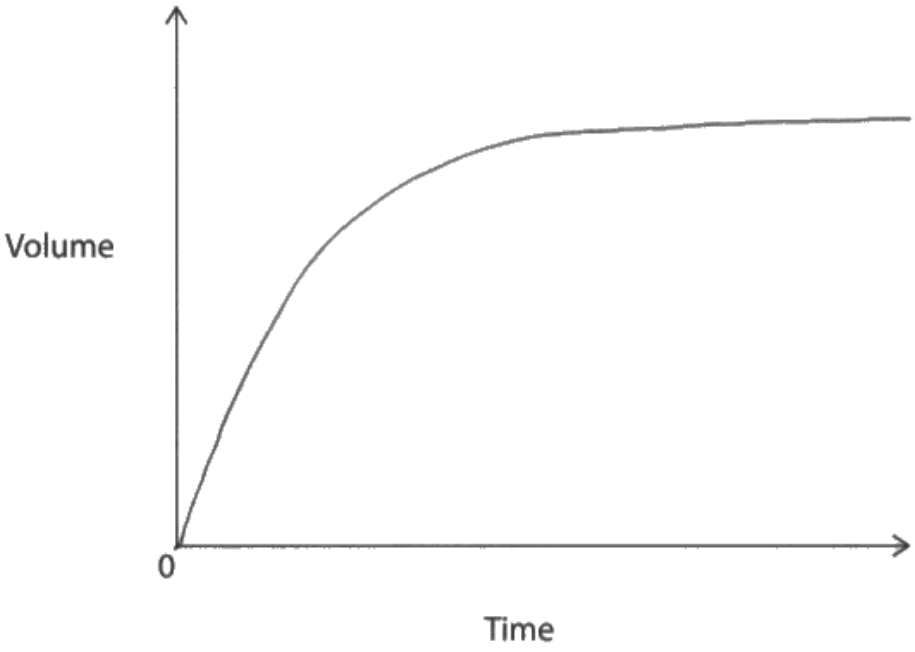
Question 2(b)

The majority gained the mark for $MgCl_2$ and H_2. Some candidates did MgCl instead of $MgCl_2$ which lost the mark. Subscripts or superscripts and case must be correct, but it was pleasing to see that very few were penalised for this.

Question 2(c)

In order to gain two marks the curve started at the origin and there was a smooth curve and finally a horizontal line. Some lost the mark for a straight line from the origin or others did not do a horizontal line. Most gained at least one mark or others two marks.

(c) Draw a sketch graph to show how the volume of hydrogen changes with time until the reaction has finished.



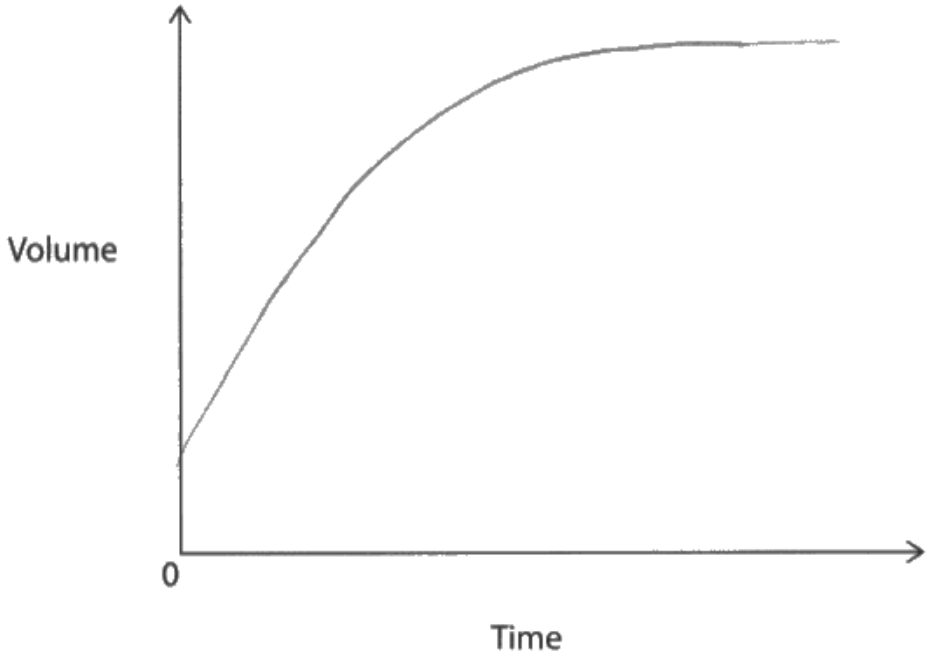
ResultsPlus
Examiner Comments

A smooth curve starting at the origin and is acceptable for a horizontal line for two marks.

ResultsPlus
Examiner Tip

Make sure you start at the origin and continue to finish the horizontal line.

(c) Draw a sketch graph to show how the volume of hydrogen changes with time until the reaction has finished.



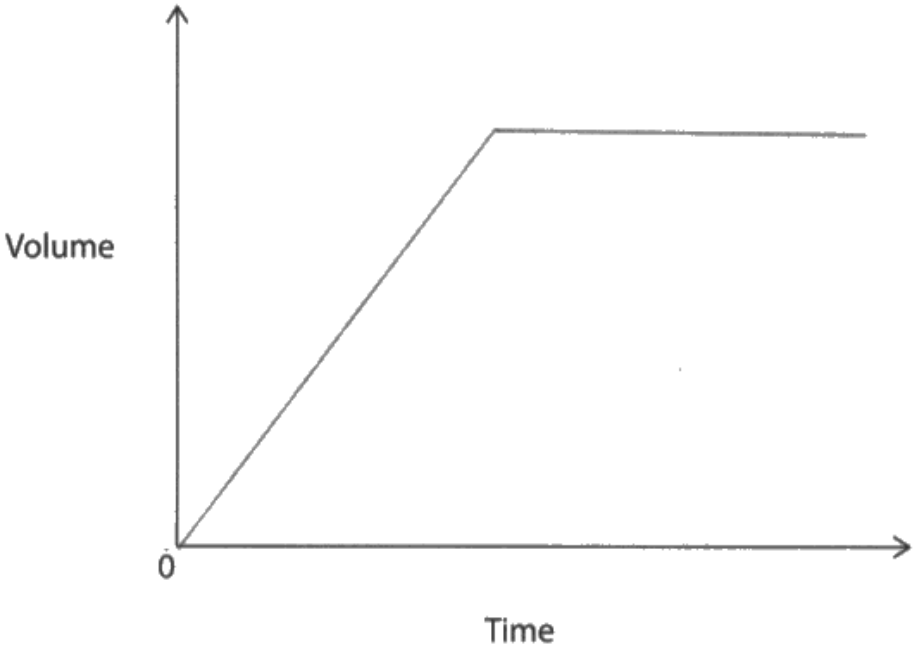
ResultsPlus
Examiner Comments

The curve must start at the origin for M1, but the horizontal line is accepted for one mark.

ResultsPlus
Examiner Tip

You must always start at the origin.

(c) Draw a sketch graph to show how the volume of hydrogen changes with time until the reaction has finished.



ResultsPlus
Examiner Comments

This needs to be a curve not a straight line, so no mark for M1. The horizontal line is accepted for M2, so one mark is awarded.

ResultsPlus
Examiner Tip

The curve starts steep and becomes shallow when hydrochloric acid has almost been used up until it becomes horizontal.

Question 2(d)

This was done well often gaining around three marks. Some candidates lost marks for not saying that there were more frequent collisions or sometimes did not mention more successful collisions. Most gained rate of reaction increases and particles move faster.

(d) Explain why increasing the temperature of the hydrochloric acid affects the rate of the reaction.

Refer to collision theory in your answer.

(4)

increasing temperature will increase the kinetic energy of the particles this means there will be more frequent collisions as the particles will be moving around faster. As a result there will be more successful collision thus increasing the rate of reaction.

ResultsPlus
Examiner Comments

A good answer covering all four marks.

ResultsPlus
Examiner Tip

Four marks needed for increasing rate of reaction, more frequent and successful collisions and particles move faster.

(d) Explain why increasing the temperature of the hydrochloric acid affects the rate of the reaction.

Refer to collision theory in your answer.

(4)

Increasing the temperature of the acid results in an increase in the ~~ki~~ heat energy of the particles. These gain more kinetic energy, and so travel faster. This means that there will be more frequent collisions between them; the rate of reaction therefore increases.

Three marks for M1, M2 and M3 but no mention of more successful collisions or more particles have the activation energy so no M4.

When there is an increase in temperature they need to mention more successful collisions.

(d) Explain why increasing the temperature of the hydrochloric acid affects the rate of the reaction.

Refer to collision theory in your answer.

(4)

- as temperature increases, the kinetic energy of the molecules increases
- this means more collisions take place
- and more particles collide with a greater force
- this means the rate of reaction is increased

ResultsPlus
Examiner Comments

M2 for kinetic energy of the molecules increases and rate of reaction increases for M1. But no mention of more frequent collisions and no mention of more successful collisions so the candidate just scored two marks.

ResultsPlus
Examiner Tip

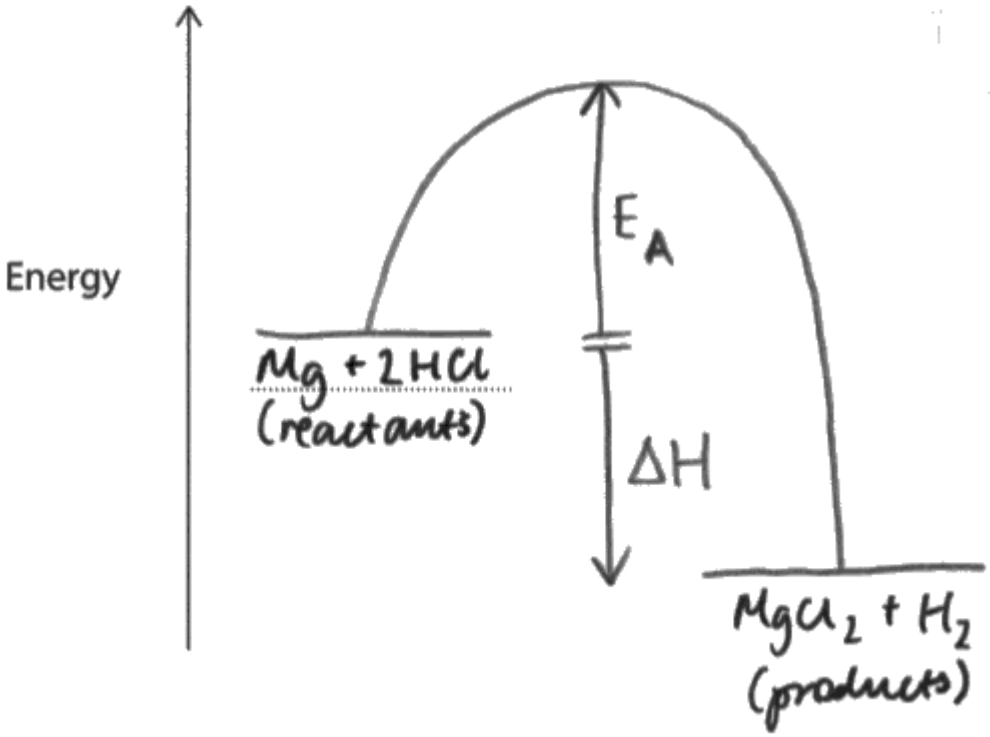
Candidates must talk about more frequent successful collisions to gain two extra marks.

Question 2(e)

This discriminated well with all five different marks. The minority scored five marks, but many lost marks for not drawing and labelling the arrows properly. Most gained the right positions, the reactants and products and often the activation hump.

(e) Draw a reaction profile diagram for the reaction, showing ΔH and activation energy.

Label the reactants and products.



ResultsPlus
Examiner Comments

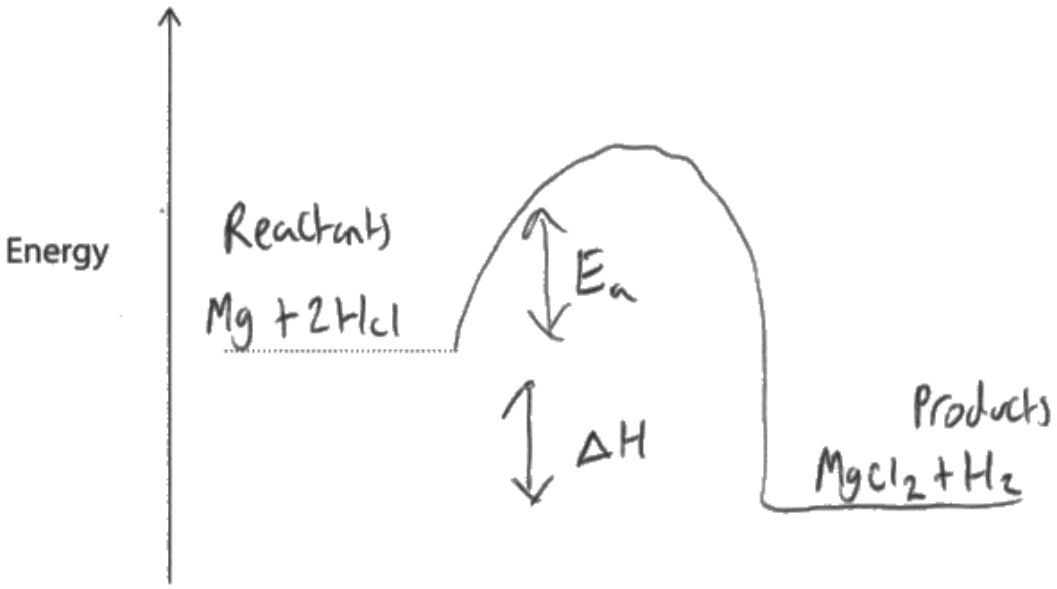
This was a good answer gaining all five marks. Arrows were labelled clearly and were the right length. At the right positions, the hump shown and the formulae are correct.

ResultsPlus
Examiner Tip

Make sure the arrows are at the right size and labelled clearly.

(e) Draw a reaction profile diagram for the reaction, showing ΔH and activation energy.

Label the reactants and products.



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Examiner Comments

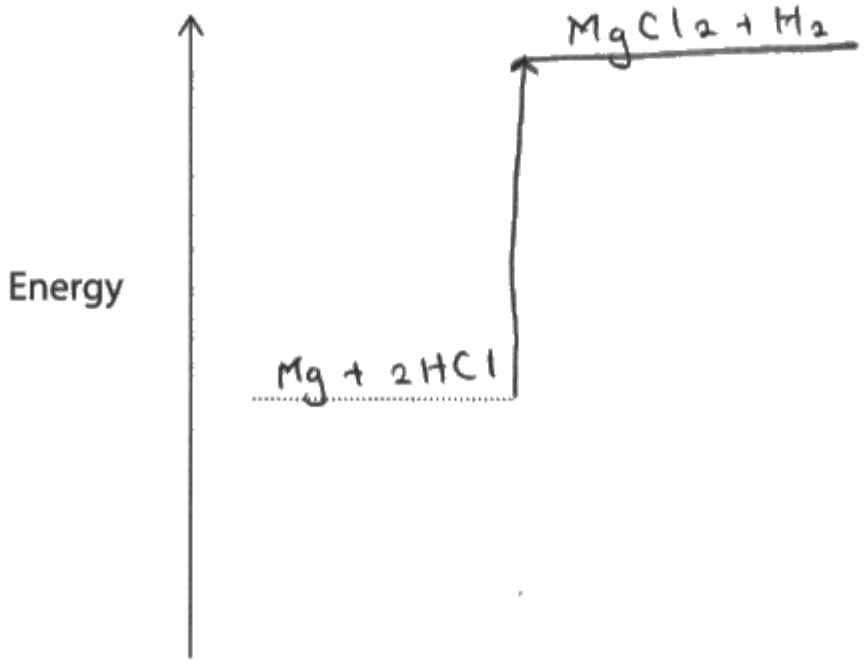
M1, M2 and M3 were awarded, but delta H is too short and also E_a. Even if they were the right length, they were still not awarded as double headed arrows are not accepted. Regarding delta H the arrow needs to be downwards and E_a needs to be upwards.

ResultsPlus
Examiner Tip

Make sure your arrows are the right size and in the right directions.

(e) Draw a reaction profile diagram for the reaction, showing ΔH and activation energy.

Label the reactants and products.



ResultsPlus
Examiner Comments

Earlier in the question exothermic is in bold so is not an endothermic reaction, so no M2. M1 can be awarded for the formulae in the right place for M1. The arrow moving up is in the right place and would have been awarded for delta H. However as it is not labelled we do not know whether it is delta H or E_a so we cannot award it.

ResultsPlus
Examiner Tip

The reaction clearly states that delta H needs to be labelled otherwise it does not score.

Question 3(a)(i)

The majority has stated the same number of protons and different number of neutrons so has scored both marks.

3 This question is about Group 2 elements and their compounds.

(a) A sample of magnesium contains three isotopes.

Mass number of isotope	24	25	26
Percentage abundance (%)	76.5	10.5	13.0

(i) State, in terms of subatomic particles, what is meant by the term **isotopes**.

when atoms have same atomic number but different mass number.

ResultsPlus
Examiner Comments

Unfortunately, same atomic number and different mass number does not score.

ResultsPlus
Examiner Tip

Read the question as subatomic particles are needed, not atomic number or mass number.

3 This question is about Group 2 elements and their compounds.

(a) A sample of magnesium contains three isotopes.

0.314 2.38 2

Mass number of isotope	24	25	26
Percentage abundance (%)	76.5	10.5	13.0

(i) State, in terms of subatomic particles, what is meant by the term **isotopes**.

(2)

An atom with the same number of protons, but different number of neutrons.

ResultsPlus
Examiner Comments

Mark scheme answer gains both marks.

ResultsPlus
Examiner Tip

Learn the definitions as often asked.

Question 3(a)(ii)

Most candidates gain all three marks for this calculation. A few lost a mark for not reading the question and did not give one decimal place.

(ii) Calculate the relative atomic mass (A_r) of magnesium.

Give your answer to one decimal place.

(3)

$$\frac{(24 \times 76.5) + (25 \times 10.5) + (26 \times 13)}{100} = 24.365$$

A_r = 24.7

ResultsPlus Examiner Comments

Unfortunately 24.7 is not the correct answer so this candidate has lost a mark.

ResultsPlus Examiner Tip

This was a slip and could be corrected. If you have the time check your working.

(ii) Calculate the relative atomic mass (A_r) of magnesium.

Give your answer to one decimal place.

(3)

$$\frac{(24 \times 78.5) + (25 \times 10.5) + (26 \times 13)}{100} = 24.365$$

A_r = 24.365

ResultsPlus
Examiner Comments

Only two marks again has not read the question and giving it one decimal place.

ResultsPlus
Examiner Tip

Read all the question to stop losing an unnecessary mark.

(ii) Calculate the relative atomic mass (A_r) of magnesium.

Give your answer to one decimal place.

(3)

$$\frac{(24 \times 76.5) + (25 \times 10.5) + (26 \times 13)}{100}$$

$= 24.365$

≈ 24.4

$A_r =$ 24.4

ResultsPlus Examiner Comments

Correct answer gets all three marks.

ResultsPlus Examiner Tip

Make sure you show all your working as sometimes can be error carried forward.

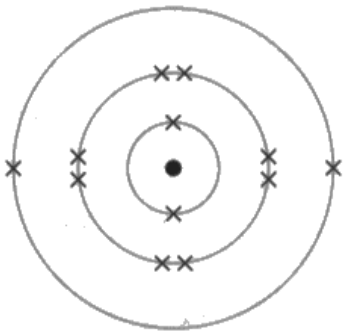
Question 3(c)

The majority gained three marks. Some lost a mark for the wrong charges. A few lost all the marks for a covalent compound even though it said it was ionic.

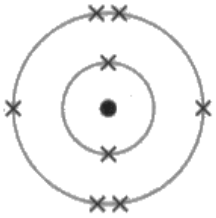
(c) Magnesium oxide is an ionic compound.

The diagrams show the atoms of magnesium and oxygen.

MgO.



Mg

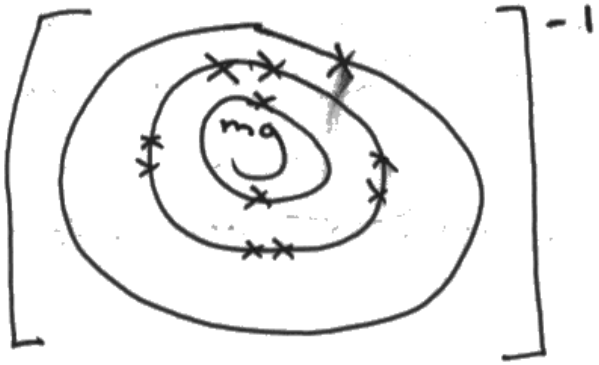


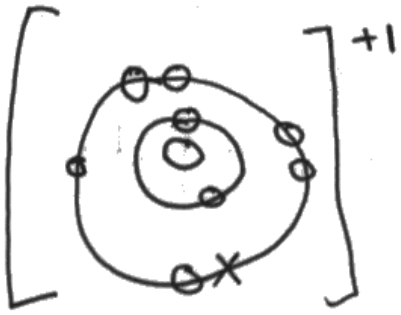
O

Draw diagrams to show the structure of each ion in magnesium oxide.

Include the charge on each ion.

(3)





ResultsPlus
Examiner Comments

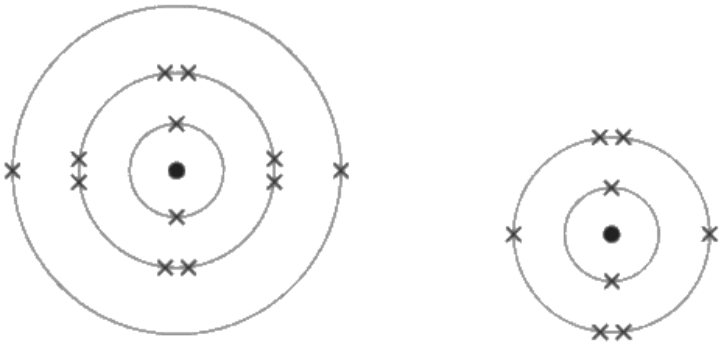
Unfortunately only one cross is transferred to the oxygen instead of two crosses were needed. Also the charges were wrong so no mark was scored.

ResultsPlus
Examiner Tip

To become stable there need to be eight electrons on both shells.

(c) Magnesium oxide is an ionic compound.

The diagrams show the atoms of magnesium and oxygen.

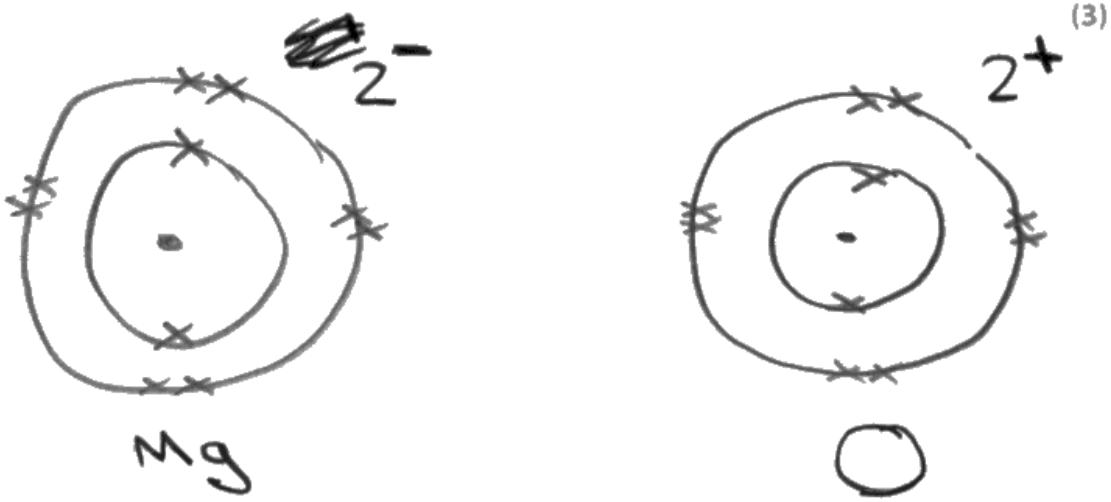


Mg O

Draw diagrams to show the structure of each ion in magnesium oxide.

Include the charge on each ion.

(3)



ResultsPlus
Examiner Comments

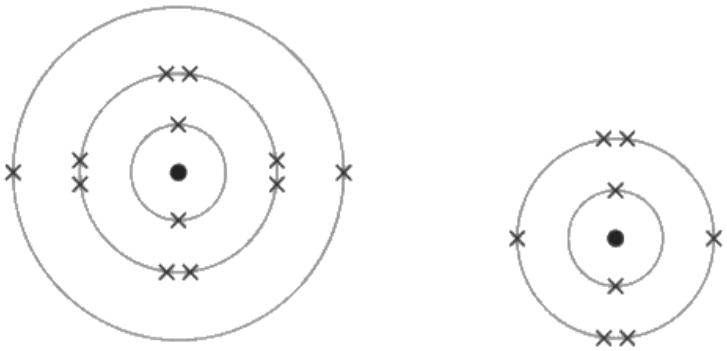
Two marks for the right number of crosses but Mg should have been 2+ and O 2- so no marks for M3.

ResultsPlus
Examiner Tip

When you lose two electrons Mg becomes 2+ and when you gain two electrons O becomes 2-.

(c) Magnesium oxide is an ionic compound.

The diagrams show the atoms of magnesium and oxygen.

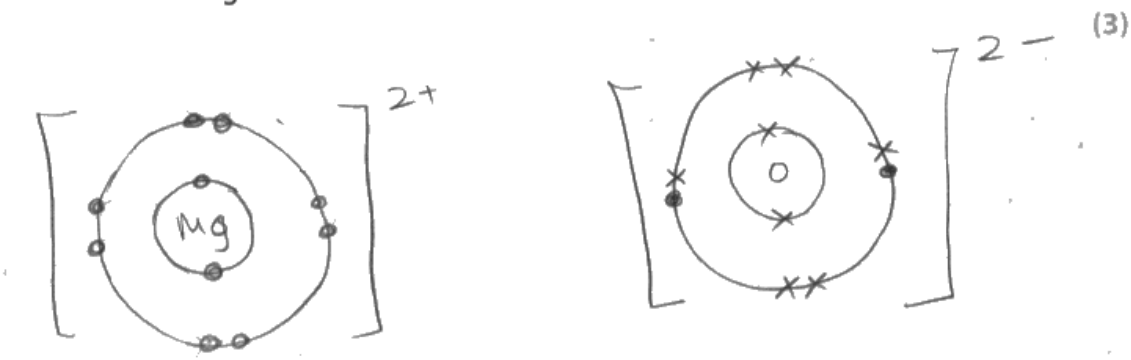


Mg O

Draw diagrams to show the structure of each ion in magnesium oxide.

Include the charge on each ion.

(3)



ResultsPlus
Examiner Comments

Perfect answer showing all three marks.

ResultsPlus
Examiner Tip

Make sure you show the charges correctly as well as the right configurations.

Question 3(d)

The candidates discriminated well gaining all the range of marks. Water must be covalent and magnesium chloride must be ionic. When these were not mentioned they gained very few marks. Some lost a mark for stating that delocalised electrons were present for M5, and others lost a mark for mentioning intermolecular forces in magnesium chloride. There were some good answers gaining all five marks.

(d) The table lists some substances and shows which substance conducts electricity.

Substance	Conducts electricity?
water	no
solid magnesium chloride	no
aqueous magnesium chloride	yes

Explain these observations.

Refer to structure and bonding in your answer.

☆ cathode vs anode? mins + positive charges?

(5)

water will not conduct electricity as it has no valence electrons to move freely throughout the structure and carry charge. Solid magnesium chloride also stays in a rigid 3D structure with no free outer shell electrons, so will not conduct electricity. Aqueous magnesiumchloride is in a solution, and is not bonded in every dimension, so has valence electrons that can carry the charge throughout the structure, meaning it will conduct electricity.

There was no mention of covalent structure of water or ionic of magnesium chloride, so the only mark that can be awarded is by saying no valence electrons to move freely. Also there was a mention of electrons carrying the charge which implies a metal rather than ions moving.

This candidate scored one mark.

They must mention water covalent and magnesium chloride ionic, otherwise only one mark can be awarded.

(d) The table lists some substances and shows which substance conducts electricity.

Substance	Conducts electricity?
water	no
solid magnesium chloride	no
aqueous magnesium chloride	yes

Explain these observations.

Refer to structure and bonding in your answer.

(5)

water doesn't conduct electricity due to its ionic bonding because of the there are no ions that are free to move and carry a charge.
Solid magnesium chloride is unable to conduct electricity as it is arranged in a ~~rec~~ organised lattice resulting in no free ions to carry the charge
Aqueous magnesium chloride is able to carry the charge as it is now a liquid so the structure is random resulting in the ions being free to move and carry the charge.

ResultsPlus
Examiner Comments

No marks for M1 as water is not ionic. M2 for no ions that are free to move. No mention of magnesium chloride being ionic for M3 but allow no more ions to move for M4, and when aqueous the ions are free to move for M5. Therefore, this answer scored three marks.

ResultsPlus
Examiner Tip

If water was ionic it would have conducted electricity so must be covalent.

(d) The table lists some substances and shows which substance conducts electricity.

Substance	Conducts electricity?
water	no
solid magnesium chloride	no
aqueous magnesium chloride	yes

Explain these observations.

Refer to structure and bonding in your answer.

(5)

Water does not conduct electricity as it is a covalent compound, therefore it does not contain any free moving charged particles to conduct the elecrity with. ~~a~~ aqueous magnessium chloride does conduct electricity as ~~it's~~ it is an ionic compound, and therefore ~~it~~ contains charged ions, in an aqueous solution, as we have here, these ions are free to move, therefor they conduct electricty. Solid magnessium chloride however does not conduct electricity, as it's ion's are held in an ionic lattice, therefore they are not free to move, and thus they don't conduct electricity.

ResultsPlus
Examiner Comments

All five marks can be awarded for this answer.

ResultsPlus
Examiner Tip

Stating what is covalent for water and what is ionic for magnesium chloride and explaining when it is conducted or not is enough for all five marks.

Question 3(e)(i)

Some good answers. Some candidates lost marks for Cl^- and Cl or Cl^{2-} occasionally.

(e) A concentrated aqueous solution of magnesium chloride is electrolysed.

Chlorine forms at the positive electrode.

(i) Give the half-equation for the reaction at the positive electrode.

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

ResultsPlus
Examiner Comments

Correct answer for one mark.

ResultsPlus
Examiner Tip

Make sure charges are balanced.

(e) A concentrated aqueous solution of magnesium chloride is electrolysed.

Chlorine forms at the positive electrode.

(i) Give the half-equation for the reaction at the positive electrode.

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

ResultsPlus
Examiner Comments

Unfortunately a 2 was needed infront of Cl^- and $2e^-$ was on the wrong side so no mark was awarded.

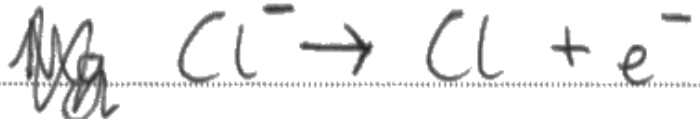
ResultsPlus
Examiner Tip

Make sure Cl is balanced and the charges are the same on each side. Not 3- and nothing on the other side.

(e) A concentrated aqueous solution of magnesium chloride is electrolysed.

Chlorine forms at the positive electrode.

(i) Give the half-equation for the reaction at the positive electrode.



ResultsPlus
Examiner Comments

Cl_2 is diatomic so even though it is balanced they need to put $2e^-$ and Cl_2 are needed to get the mark.

ResultsPlus
Examiner Tip

Remember the halogens are always diatomic. Cl does not exist alone.

Question 3(e)(ii)

Loses are electrons are sufficient for the mark. Chloride ions and Cl^- also loses electrons are acceptable. However the minority often loses the mark by stating chlorine, Cl and Cl_2 loses electrons, which was not creditworthy.

Question 4(a)(i)

The majority mentioned sulfuric acid. Some just said water or some other random reagents.

Question 4(a)(ii)

This was disappointing because only the minority got two marks. Some had orange and green being the wrong way round. Some got green but not orange and there were many different colours rather than orange and green.

Question 4(b)(i)

This was found difficult and only the minority got two marks. Some scored one mark for CO_2 and H_2O but some lost the second mark for putting twos or threes in front.

(b) Ethanoic acid reacts with solid sodium carbonate.

(i) Complete the chemical equation for this reaction.

$2CH_3COOH + Na_2CO_3 \rightarrow$ 2 CH_3COONa + H_2O + CO_2

ResultsPlus
Examiner Comments

Correct answer which scored both marks.

ResultsPlus
Examiner Tip

Make sure you balanced correctly on the product side.

(b) Ethanoic acid reacts with solid sodium carbonate. Sodium ethanoate

(i) Complete the chemical equation for this reaction.

(2)

$2CH_3COOH + Na_2CO_3 \rightarrow$ $NaCH_3COOH$ + CO_2 + H_2O

ResultsPlus
Examiner Comments

One mark for CO_2 and H_2O but the first equation is incorrect.

ResultsPlus
Examiner Tip

This is not balanced as an extra CH_3 is needed and a couple of Os.

(b) Ethanoic acid reacts with solid sodium carbonate.

(i) Complete the chemical equation for this reaction.

(2)

$2CH_3COOH + Na_2CO_3 \rightarrow$ $2NaCH_3$ + H_2O + $3CO_2$

ResultsPlus
Examiner Comments

M1 is incorrect and the $3CO_2$ is also incorrect so no marks were gained.

ResultsPlus
Examiner Tip

There are not $3CO_2$ in this equation.

Question 4(b)(ii)

The majority scored one mark for fizzing, bubbles or effervescence. Fewer knew that sodium carbonate disappears or gets smaller. No marks were scored for just saying that "a gas" is produced as this is not an observation.

Question 4(c)(i)

The majority knew that there was a catalyst or speeded up the reaction.

Question 4(c)(ii)

Many said that ethanol or the mixture was flammable for one mark. A few talked about the water bath and did not mention flammable or can ignite so lost the mark.

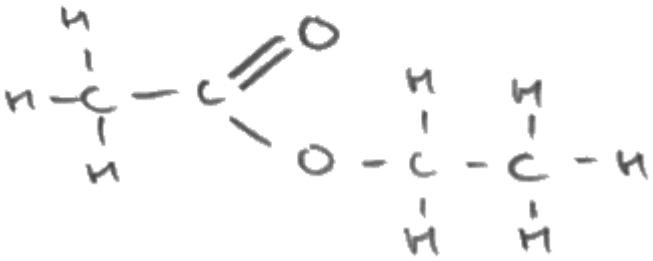
Question 4(c)(iii)

Sweet or fruity smell was often mentioned for one mark. Just a smell or strong smell was ignored and not creditworthy. A few mentioned an oily liquid which was allowed.

Question 4(c)(iv)

Many did not know the formula of ethyl ethanoate and scored no marks. Those who had the functional group correct usually gained both marks.

(iv) Draw the displayed formula of ethyl ethanoate.



ResultsPlus
Examiner Comments

Correct displayed formula for both marks.

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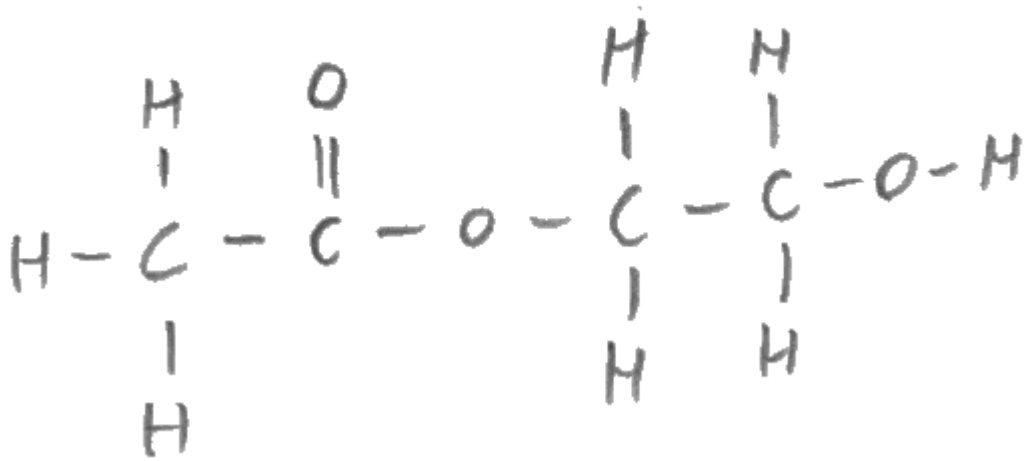
Examiner Tip

Make sure there are 4 bonds to carbon and 2 bonds to oxygen and 1 bond for hydrogen.

(iv) Draw the displayed formula of ethyl ethanoate.



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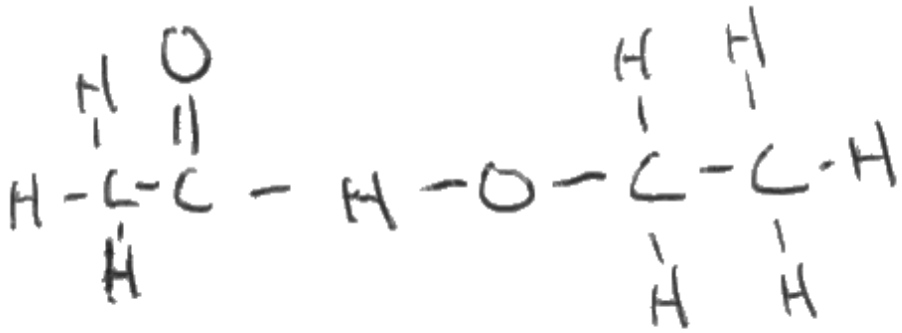
Examiner Comments

The functional group is correct so one mark was achieved, but unfortunately the extra oxygen was incorrect for ethyl ethanoate so the candidate lost the second mark.

ResultsPlus
Examiner Tip

Bonds are all correct here but there was O-H at the end, so this is not ethyl ethanoate.

(iv) Draw the displayed formula of ethyl ethanoate.



ResultsPlus
Examiner Comments

This is not a functional group so no marks were awarded as M2 is dependent on M1.

ResultsPlus
Examiner Tip

The extra H has two bonds to the C and O so H should only have one bond. If the extra H was not there both marks would have been awarded.

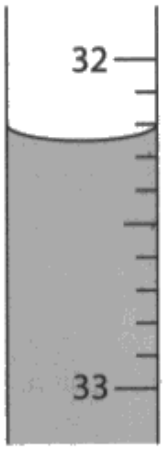
Question 5(a)ii

The majority knew that there was a colour change that was seen more clearly. It had to be a colour change not just colour for the mark. Some just mentioned the universal indicator but did not mention the colour change so their answer was not creditworthy.

Question 5(b)

Most gained one mark for either M1 or correct subtracting the second mark, but only the minority had both marks.

(b) The diagram shows the final burette reading.



The initial burette reading is given in the table.

Complete the table, giving both values to the nearest 0.05 cm^3.

final burette reading	32.25
initial burette reading	4.15
volume of sulfuric acid added in cm^3	28.1

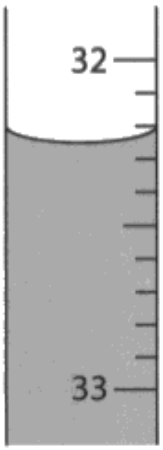
ResultsPlus
Examiner Comments

This was a common mistake. M1 was correct but had to be 28.10 to gain the second mark.

ResultsPlus
Examiner Tip

The marks had to be in two decimal places to score both marks.

(b) The diagram shows the final burette reading.



The initial burette reading is given in the table.

Complete the table, giving both values to the nearest 0.05 cm^3.

final burette reading	32.2
initial burette reading	4.15
volume of sulfuric acid added in cm^3	28.05

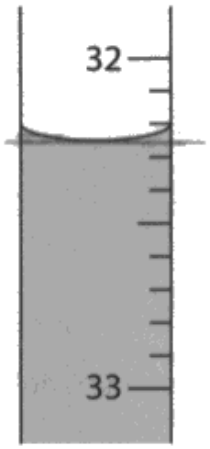
ResultsPlus
Examiner Comments

The 32.2 was incorrect and also should have had two decimal places. Error carried forward was allowed for the correct subtraction and had the two decimal places. This answer scored one mark.

ResultsPlus
Examiner Tip

Note that the meniscus was at 32.25 and not at 32.20.

(b) The diagram shows the final burette reading.



The initial burette reading is given in the table.

Complete the table, giving both values to the nearest 0.05 cm^3.

final burette reading	32.25
initial burette reading	4.15
volume of sulfuric acid added in cm^3	28.10

ResultsPlus
Examiner Comments

Both values were correct and scored both marks.

ResultsPlus
Examiner Tip

28.10 was needed to award M2.

Question 5(c)

This was well done with the majority scoring both marks. A few lost the first mark for the wrong concordant results, but sometimes scored the second mark for the correct answer for two decimal places.

(c) The student repeats the titration more accurately four times.

The table shows their results.

titration number	1	2	3	4
volume of sulfuric acid added in cm^3	27.40	27.65	27.30	27.35
concordant results	✓		✓	✓

Concordant results are those within 0.20 cm^3 of each other.

(i) Place ticks (✓) in the table to show which results are concordant.

(1)

(ii) Use the concordant results to calculate the mean volume of sulfuric acid added.

(1)

$$\frac{27.40 + 27.35 + 27.30}{3} = 27.35$$

mean volume of sulfuric acid = 27.35 cm^3

ResultsPlus Examiner Comments

Correct answer for both marks.

ResultsPlus Examiner Tip

Working shown and the correct answer on the answer line.

(c) The student repeats the titration more accurately four times.

The table shows their results.

titration number	1	2	3	4
volume of sulfuric acid added in cm^3	27.40	27.65	27.30	27.35
concordant results	✓		✓	

Concordant results are those within 0.20 cm^3 of each other.

(i) Place ticks (✓) in the table to show which results are concordant.

(1)

(ii) Use the concordant results to calculate the mean volume of sulfuric acid added.

(1)

$\frac{27.40 + 27.30}{2} = 27.35$

mean volume of sulfuric acid = 27.35 cm^3

ResultsPlus
Examiner Comments

This candidate lost the first mark for only showing two results, but scored the second mark for 27.35.

ResultsPlus
Examiner Tip

The question says concordant results are within 0.20 cm^3 of each other, so 1, 3 and 4 are clearly within range.

(c) The student repeats the titration more accurately four times.

The table shows their results.

titration number	1	2	3	4
volume of sulfuric acid added in cm^3	27.40	27.65	27.30	27.35
concordant results			✓	✓

Concordant results are those within 0.20 cm^3 of each other.

(i) Place ticks (✓) in the table to show which results are concordant.

(1)

(ii) Use the concordant results to calculate the mean volume of sulfuric acid added.

(1)

$\frac{27.30 + 27.35}{2} =$

mean volume of sulfuric acid = 27.325 cm^3

ResultsPlus
Examiner Comments

Again only two marks are ticked so no M1. M2 is 27.325 which is the right sum but three decimal places cannot be that accurate so we only allowed two decimal places so no marks.

ResultsPlus
Examiner Tip

Must be two decimal places to score. 27.33 would have been scored for M2.

Question 5(d)(i)

Many scored three marks for this calculation. Some lost a mark for not dividing by 2.

(d) Another student also does the titration.

$25.0 \div 1000 = 0.025 dm^3$

(i) The student uses 25.0 cm^3 of potassium hydroxide solution with a concentration of 0.500 mol/dm^3.

The mean volume of sulfuric acid added is 26.50 cm^3. → $\div 1000 = 0.0265 dm^3$

This is the equation for the reaction.

$$2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

Calculate the concentration of the sulfuric acid.

(3)

mol KOH = $0.025 \times 0.500 = 0.0125$

mol H_2SO_4 = $0.0125 \div 2 = 6.25 \times 10^{-3}$

Conc = $\frac{6.25 \times 10^{-3}}{0.0265}$ =

concentration of sulfuric acid = 0.236 mol/dm^3

ResultsPlus
Examiner Comments

Correct answer scoring three marks and working clearly shown.

ResultsPlus
Examiner Tip

Always show your working as sometimes you can get marks from errors carried forward.

$1dm^3 = 1000\ cm^3$

(d) Another student also does the titration.

(i) The student uses 25.0 cm^3 of potassium hydroxide solution with a concentration of 0.500 mol/dm^3.

The mean volume of sulfuric acid added is 26.50 cm^3.

$\frac{26.5}{1000} = 0.0265$

This is the equation for the reaction.

$$2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

Calculate the concentration of the sulfuric acid.

$\frac{25}{1000} = 0.025$

(3)

Concentration = $\frac{\text{moles}}{\text{volume}}$

$\frac{0.25 \times 0.5}{0.0265} = 0.472$

concentration of sulfuric acid = 0.47 mol/dm^3

ResultsPlus
Examiner Comments

A common answer. Two marks awarded but no M2 has not divided by 2.

ResultsPlus
Examiner Tip

The working was combined to show 0.47. Two marks were gained as there was only one error by not dividing by 2.

(d) Another student also does the titration.

(i) The student uses 25.0 cm^3 of potassium hydroxide solution with a concentration of 0.500 mol/dm^3.

The mean volume of sulfuric acid added is 26.50 cm^3.

This is the equation for the reaction.

$$2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

Calculate the concentration of the sulfuric acid.

(3)

mols of KOH = $0.025 \times 0.5 = 0.0125$

mols of H_2SO_4 = $0.0125 \times 2 = 0.025$

$n = cv$

$\frac{n}{v} = c \rightarrow \frac{0.025}{0.0265} = 0.943$. $\frac{n}{v} = c$ $\frac{26.5}{1000}$

concentration of sulfuric acid = 0.943 mol/dm^3

ResultsPlus
Examiner Comments

M1 for the correct moles, but no M2 as multiplied by 2 instead of divided. M3 was error carried forward so scored two marks.

ResultsPlus
Examiner Tip

Look at the equation before doing the calculation. It needs to be divided by 2 to get the correct concentration of sulfuric acid.

Question 5(d)(ii)

The minority did get all four marks. Some forgot to cool and others forgot to filter. M1 and M4 were often scored. Only a very few were heated to dryness.

(ii) The student repeats the titration without the methyl orange indicator.

They add exactly 26.50 cm^3 of sulfuric acid to the potassium hydroxide solution.

Describe how the student could obtain pure, dry potassium sulfate crystals from the reaction mixture.

(4)

The students should heat the reaction mixture with a bunsen burner. However, they should only partially evaporate it until crystals start to form and at that point the heating should stop. Leave the mixture to cool for a while and then filter off any excess liquid. Finally, place the crystals in a dessicator or warm oven to dry.

ResultsPlus
Examiner Comments

This was a clear answer for all four marks: ie heat to partially evaporate, leave to cool, filter and place the crystals in a warm oven.

ResultsPlus
Examiner Tip

It is a good idea to put some bullet points to plan your answer.

(ii) The student repeats the titration without the methyl orange indicator. ROY

They add exactly 26.50 cm^3 of sulfuric acid to the potassium hydroxide solution.

Describe how the student could obtain pure, dry potassium sulfate crystals from the reaction mixture.

(4)

- Take the reaction mixture and put into an evapourating dish
- Heat the reaction mixture with a bunsen burner until about half the mixture is gone, and small crystals start to form around the edges.
- Leave the dish to cool and evapourate
- Once all the solution has evapourated, dab the crystals with blotting paper to dry them.

ResultsPlus
Examiner Comments

Three marks were awarded as heating for about half the mixture, leave to cool and dry crystals with blotting paper. No M3 as no mention of filtering the mixture.

ResultsPlus
Examiner Tip

Learn this practical technique as it is often tested.

(ii) The student repeats the titration without the methyl orange indicator.

They add exactly 26.50 cm^3 of sulfuric acid to the potassium hydroxide solution.

Describe how the student could obtain pure, dry potassium sulfate crystals from the reaction mixture.

(4)

Mix the sulfuric acid and potassium hydroxide solution together to react the two. ~~[illegible]~~ Place the solution into an evaporating basin and heat it with a bunsen burner to evaporate half of the solution. Pour the rest of the solution into crystallising dish and allow it to dry out in a ~~[illegible]~~ warm dry area. The mixture will crystallise into pure, dry potassium sulfate crystals.

ResultsPlus
Examiner Comments

M1 for heating half the solution, but no cooling and no filtering but M4 for dry crystals in a warm area.

ResultsPlus
Examiner Tip

Cooling and filtering are needed to complete the process.

Question 6(a)(i)

The majority gained the mark for a lit splint and a squeaky pop test. A few lost the mark for a glowing splint and others just said a squeaky pop test without mentioning lighting the splint.

Question 6(a)(ii)

A large majority gained the mark for a reversible reaction. Occasionally an equilibrium or dynamic equilibrium was seen and that was ignored. A few lost the mark for saying a **reverse** reaction, which is not the same as a **reversible** reaction. Some said goes both ways and that was allowed.

Question 6(b)(i)

The majority knew that the yield increases and often said that it went in the forward reaction. Most also stated that it was endothermic.

(b) In a sealed container at equilibrium, the reaction conditions are 500°C and 2 atm.

(i) The temperature of the reaction mixture is increased to 600°C, but the pressure is kept at 2 atm.

Explain the effect, if any, on the yield of hydrogen iodide at equilibrium.

(2)

The yield of hydrogen iodide will increase as the forward reaction is endothermic, which takes in heat.

ResultsPlus
Examiner Comments

Both marks were awarded for the yield increase as the forward reaction is endothermic.

ResultsPlus
Examiner Tip

When the temperature increases the yield increases because it is endothermic.

(b) In a sealed container at equilibrium, the reaction conditions are 500°C and 2 atm.

(i) The temperature of the reaction mixture is increased to 600°C, but the pressure is kept at 2 atm.

Explain the effect, if any, on the yield of hydrogen iodide at equilibrium.

(2)

The yield would increase as the equilibrium shifts towards the products as the reactant temperature increased so it needs to be shifted to produce more yield

ResultsPlus
Examiner Comments

One mark for the yield increase towards the products, but no mention of it saying that it is endothermic so this answer does not gain the second mark.

ResultsPlus
Examiner Tip

An explanation is needed to state that the yield increases because it is endothermic.

(b) In a sealed container at equilibrium, the reaction conditions are 500°C and 2 atm.

(i) The temperature of the reaction mixture is increased to 600°C, but the pressure is kept at 2 atm.

Explain the effect, if any, on the yield of hydrogen iodide at equilibrium.

(2)

The yield of hydrogen iodide decreases because the equilibrium will shift in the exothermic direction (LHS) to counteract the changes made [illegible].

ResultsPlus
Examiner Comments

The yield does not decrease so no marks as dependent on yield increases or missing.

ResultsPlus
Examiner Tip

When it is endothermic the yield increases when the temperature becomes hotter.

Question 6(b)(ii)

This was not as well done as Q06(b)(i). Quite a few candidates thought that yield was either increases or decreases. Those that appreciated there was no change often also stated that there were the equal number of moles on both sides.

(ii) The pressure of the reaction mixture is decreased to 1 atm but the temperature is kept at 500°C.

Explain the effect, if any, on the yield of hydrogen iodide at equilibrium.

(2)

It will have no effect on the yield of hydrogen iodide, this is because both sides of the reaction have equal moles of gas.

ResultsPlus
Examiner Comments

No effect on the yield and have equal moles of gas gained both marks.

ResultsPlus
Examiner Tip

Pressure only changes when there are different moles of gas.

(ii) The pressure of the reaction mixture is decreased to 1 atm but the temperature is kept at 500°C.

Explain the effect, if any, on the yield of hydrogen iodide at equilibrium.

(2)

there is no reaction as pressure doesn't change the yield or rate of reaction in the container.

ResultsPlus
Examiner Comments

One mark for doesn't change the yield but no M2 as no mention of moles of gas.

ResultsPlus
Examiner Tip

Needs to explain why there are equal moles of gas so the yield doesn't change.

(ii) The pressure of the reaction mixture is decreased to 1 atm but the temperature is kept at 500°C.

Explain the effect, if any, on the yield of hydrogen iodide at equilibrium.

(2)

yield

~~The yield decreases~~, increase

~~no effect~~, because both forward and backward has the same number of molecules

ResultsPlus
Examiner Comments

Unfortunately yield increases lost both marks as dependent on M1 or missing, even though the same number of molecules was correct.

ResultsPlus
Examiner Tip

It only affects the yield when the number of moles are different.

Question 6(c)

This was difficult with only the minority gaining all four marks. Common errors included not giving your answer in standard form, not dividing by 1000 and not using the 80%. However some often managed to gain two or three marks.

(c) An excess of hydrogen reacts with 50.8 g of iodine. $127 \times 2 = 254$

At equilibrium, the yield of hydrogen iodide is 80%.

Calculate the volume, in cm^3, of hydrogen iodide produced at rtp.

Give your answer in standard form.

[at rtp, molar volume = 24 000 cm^3]

(4)

$\frac{50.8\,g}{254\,g} = 0.2\ mol$

$0.2\ mol \times 2 = 0.4\ mol$

$0.4\ mol \times 24000\,cm^3 = 9600\,cm^3$

$9600\,cm^3 \times 0.8 = 7680\,cm^3$

$= 7.68 \times 10^3\,cm^3$

volume of hydrogen iodide = 7.68×10^3 cm^3

ResultsPlus
Examiner Comments

A perfect answer showing the working clearly and scored all four marks.

ResultsPlus
Examiner Tip

Always show your working in a logical order.

(c) An excess of hydrogen reacts with 50.8 g of iodine.

At equilibrium, the yield of hydrogen iodide is 80%.

Calculate the volume, in cm^3, of hydrogen iodide produced at rtp.

Give your answer in standard form.

[at rtp, molar volume = 24 000 cm^3]

(4)

n of I_2 = $\frac{50.8}{254}$

= 0.2 moles

$\frac{80}{100} \times 4800 = 3840$

No of H_2 = 0.2

$V = 0.2 \times 24\,000$

$= 4800\ cm^3$

3.84×10^3

volume of hydrogen iodide = 3.84×10^3 cm^3

ResultsPlus
Examiner Comments

M1 for 0.2 moles, but no M2 as 80% was converted but was not times by 2. M3 for multiplying by 0.2 x 24000 and M4 for correct answer in standard form. This answer scored three marks.

ResultsPlus
Examiner Tip

Use the equation to times by 2 to get 2HI.

(c) An excess of hydrogen reacts with 50.8 g of iodine.

At equilibrium, the yield of hydrogen iodide is 80%.

Calculate the volume, in cm^3, of hydrogen iodide produced at rtp.

Give your answer in standard form.

[at rtp, molar volume = 24 000 cm^3]

(4)

moles of iodine = $\frac{50.8}{127}$

moles of Hydrogen Iodide = $\frac{50.8}{127} \times 2$

moles x yield = $\frac{101.6}{127} \times \frac{4}{5}$

= 0.64

$0.64 \times 24000 = 15360$

volume of hydrogen iodide = 15360 cm^3

ResultsPlus
Examiner Comments

No M1 as divided by 127, not 254. M2 for times by 2 and 4 divided by 5. M3 for multiplying 0.64 x 24000 but no M4 as not in standard form.

ResultsPlus
Examiner Tip

Read all the question, as it has clearly stated it is in standard form.

Paper Summary

Based on their performance on this paper, candidates should:

- Make sure they did correct rounding as incorrect rounding can lose unnecessary marks.
- Revise all experimental practical works as this comprises 22%.
- Remember that delocalised electrons are not always required and adding them when not there loses unneccessary marks.
- Always show working for calculations as you can pick up marks for errors carried forward.
- Remember that for longer mark questions it is a good idea to jot down a few bullet points to construct your answer.
- Use their ruler in Q02(e) and draw the arrows and lines accurately.

Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link: https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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