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Examiners' report

AS LEVEL

CHEMISTRY A

OCR Level 3 Advanced Subsidiary GCE in Chemistry A

H032

For first teaching in 2015

H032/01 Summer 2025 series

Version 1

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Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Paper 1 series overview

H032/01 is one of the two examination components for the AS Level examination for GCE Chemistry A. It is worth 70 marks, split into two sections and assesses content from all teaching modules, 1 to 4. Candidates answer all questions.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• produced clear and concise responses when answering questions requiring explanations, using the appropriate technical terms, e.g. when relating the shape of the graph to rate and collision theory in Question 21 (d) (ii) and explaining relative reactivity in Question 22 (b) (i) • performed calculations logically and clearly, e.g. calculating the concentration of HCl using information from the graph in Question 21 (d) (i), determination of a bond enthalpy from provided enthalpy data in Question 23 (b) and use of the ideal gas equation to calculate gas volume in Question 25 (c) • showed organic structures using unambiguous formula, e.g. Questions 24 (a) (i), 24 (c) (i) and 25 (a) • displayed good knowledge and understanding of organic reactions and mechanisms, e.g. Questions 24 (c) (i) and 25 (a) • performed well on multiple-choice questions, showing evidence of clear working out to arrive at the correct response.	• found it difficult to apply what they had learned in situations that are unfamiliar, e.g. Questions 21 (d) (ii), 23 (b) and 25 (a) • produced responses that were unnecessarily long and contained irrelevant material, e.g. Questions 21 (c) and 22 (b) (i) • used scientific terminology incorrectly, e.g. using 'nuclear charge' when they meant 'nuclear attraction' in Question 22 (b) (i) • did not read the question carefully in order to answer all parts required, e.g. not giving the K_c expression in Question 23 (c) and not using significant figures or standard form correctly in Questions 21 (d) (i) and 23 (c).

There was no evidence that time constraints led to candidates underperforming. Scripts where there were no responses to many questions were very rare and generally very low scoring.

Note
Candidates should be reminded to lay their work out logically, crossing out any abandoned attempts, especially for calculations.

Section A overview

Section A comprises 20 multiple-choice questions that assess many different areas of the specification. This section of the paper is worth 20 marks. Most questions performed well. Question 15 proved difficult for many candidates, but apart from that there was a good range of marks.

Candidates should take note of the following general points:

- Candidates must write the letter for their choice clearly. It is sometimes very difficult to decipher a letter, particularly between a B and a D. If the letter cannot be definitively identified by the marker, no mark can be given.
- If a candidate changes their mind, they should cross out the letter and write the replacement alongside. It does not matter if the chosen letter is outside the box, as long as it is clear.
- Candidates should never leave a multiple-choice question with no letter. A guess may turn out to be correct.

Question 1

1 The burette readings from a titration are shown below.

Initial reading / cm^3	4.95
Final reading / cm^3	23.10

The burette used has an uncertainty of 0.05 cm^3 for each reading.

What is the percentage uncertainty of the resulting titre?

A 0.22%

B 0.28%

C 0.44%

D 0.55%

Your answer ☐ **[1]**

Most candidates gave the correct answer. B was the most common incorrect response, suggesting they had not multiplied by 2 to consider that the titre was calculated from two separate readings.

OCR support

Section M1.3 of the Mathematical Skills Handbook gives details of calculating relative uncertainties, including values calculated by difference.

Question 2

2 How many p electrons does an atom of chlorine have?

A 5

B 7

C 11

D 17

Your answer ☐ **[1]**

Most candidates answered this correctly, showing good knowledge of electron configuration.

Question 3

3 What is the number of hydrogen atoms in 6.8 g NH_3?

A 2.408×10^{23}

B 3.612×10^{23}

C 7.224×10^{23}

D 1.806×10^{24}

Your answer ☐ **[1]**

Many candidates gave C as the correct response suggesting they were well-prepared for a calculation involving Avogadro's constant. A was a very common incorrect response which gives the number of molecules of ammonia instead of hydrogen atoms.

Question 4

4 Which reaction to extract iron (Fe) has the highest atom economy?

A $2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$

B $FeO + CO \rightarrow Fe + CO_2$

C $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

D $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

Your answer ☐ **[1]**

Most candidates correctly calculated atom economy. They usually showed their working alongside the options which is good practice.

Question 5

5 Phosphorus is burnt in oxygen to produce a mixture of oxides.

Which oxide has the closest to 50% by mass of phosphorus?

A PO_2

B P_2O_3

C P_2O_5

D P_4O_9

Your answer ☐ **[1]**

Many candidates gave the correct response of A. B was the most common incorrect response, presumably assuming the 2:3 ratio of atoms is closest to 50:50 (and not taking into account relative atom masses).

Question 6

6 What is the oxidation number of S in $Na_2S_2O_3$?

A –4

B –2

C +2

D +4

Your answer ☐ **[1]**

A significant number of candidates were unable to apply the oxidation number rules correctly to arrive at C as the correct response. Many candidates gave D as the response by forgetting to calculate per S atom. Some chose B, perhaps confusing this with the charge on a sulfide ion.

Question 7

7 Which of the following is **not** a redox reaction?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

B $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

C $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

D $Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$

Your answer ☐ **[1]**

Many candidates wrote oxidation numbers below the equations, which is generally good practice. However, in this case, the incorrect options can be quickly excluded as they include an element with an oxidation state of zero, which clearly changes in the reaction. Over half obtained the correct response of B (a neutralisation reaction).

Question 8

8 Which compound has molecules with a trigonal planar shape?

A $BeCl_2$

B BCl_3

C NCl_3

D PCl_3

Your answer ☐ **[1]**

Most candidates identified BCl_3 as the trigonal planar molecule, suggesting that knowledge of bond shape examples is good.

Question 9

9 Which equation describes the second ionisation energy of magnesium?

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

B $Mg(s) \rightarrow Mg^{2+}(g) + 2e^-$

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

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

Your answer ☐ **[1]**

This question was answered well with most candidates correctly selecting C.

Question 10

10 Which molecule is polar?

A H_2S

B CO_2

C CCl_4

D C_2F_4

Your answer ☐ **[1]**

Just under half of candidates did not spot that H_2S would be polar. There was no clear distractor, suggesting that many responses may have been guesses.

Question 11

11 The equation for the complete combustion of methanol, CH_3OH, is shown below.

$$CH_3OH(l) + 1\frac{1}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

The table shows standard enthalpy changes of formation, $\Delta_f H^{\ominus}$, in $kJ\,mol^{-1}$.

Substance	$CH_3OH(l)$	$O_2(g)$	$CO_2(g)$	$H_2O(l)$
$\Delta_f H^{\ominus}$ / kJ mol^{-1}	–239	0	–393	–286

What is the enthalpy change of combustion of $CH_3OH(l)$, in $kJ\,mol^{-1}$?

A +726

B +440

C –440

D –726

Your answer ☐ **[1]**

Over half of candidates correctly calculated the enthalpy change of combustion. A was the most common incorrect response, due to the Hess cycle being the wrong way round. In some instances, candidates corrected this error by appreciating the reaction would be exothermic and therefore picked the negative value instead.

Question 12

12 Hydrogen and iodine react in the reaction below.

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

Which row is correct when pressure is **increased**?

	Rate of reaction	Equilibrium yield of HI
A	Increases	Increases
B	Increases	No effect
C	Increases	Decreases
D	Decreases	No effect

Your answer ☐ **[1]**

Overall, candidates had little difficulty with this question and most selected B.

Question 13

13 Which statement is **not** a sustainability benefit of an industrial process using a catalyst?

A Lower temperatures can be used.

B The position of equilibrium moves towards the products.

C The reaction takes place in less time.

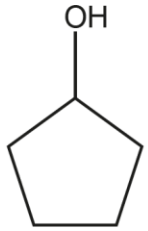
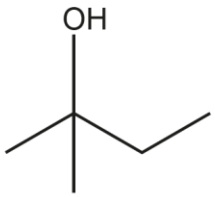
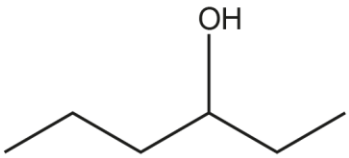
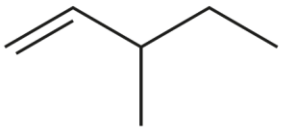
D There is reduced energy demand.

Your answer ☐ **[1]**

The correct option of B was missed by a quarter of candidates. C was the main distractor, ignoring that a catalyst has no effect on the position of equilibrium.

Question 14

14 The skeletal formulae of four alcohols, **W**, **X**, **Y**, **Z**, are shown below.

W	
X	
Y	
Z	

Which pair of alcohols are structural isomers of each other?

A **W** and **X**

B **W** and **Y**

C **W** and **Z**

D **X** and **Y**

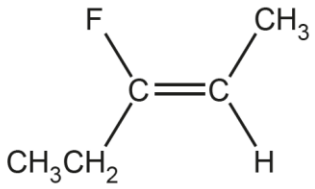
Your answer ☐ **[1]**

Just under half of candidates did not gain this mark, with A being a common wrong response. This reflects the general difficulty that students have interpreting skeletal formula and would be a good area on which to focus practice.

Question 15

15 A compound is shown below.

What is the systematic name of this compound?



A *E*-3-fluoropent-2-ene

B *E*-3-fluoropent-3-ene

C *Z*-3-fluoropent-2-ene

D *Z*-2-fluoropent-3-ene

Your answer [ ] **[1]**

Candidates found this question challenging. A was the most common wrong response given, suggesting students have difficulty applying Cahn-Ingold Prelog rules.

Misconception

Many students incorrectly assigned CH_3CH_2- as higher priority than F (presumably by using the M_r of the entire side chain). To correctly assign priority, use the atomic number of the atoms directly attached to each carbon in the double bond.

Question 16

16 Which equation is a **propagation** step in the catalytic breakdown of ozone?

A $C_2F_2Cl_2 \rightarrow C_2F_2Cl\bullet + Cl\bullet$

B $O_3 + O \rightarrow 2O_2$

C $Cl\bullet + Cl\bullet \rightarrow Cl_2$

D $ClO\bullet + O \rightarrow Cl\bullet + O_2$

Your answer ☐ **[1]**

This was well-answered with most candidates identifying D as a propagation step.

Question 17

17 How many structural isomers of $C_5H_{12}O$ are secondary alcohols?

A 1

B 2

C 3

D 4

Your answer ☐ **[1]**

More than half of candidates gained this mark. However, the question did not discriminate very well, suggesting that some candidates may have guessed. Students should be encouraged to draw structures out as working – those who did often gave the correct response.

Question 18

18 The hydrolysis of 1-iodopropane by aqueous potassium hydroxide takes place at a faster rate than 1-bromopropane.

Which statement explains the different rates of reaction?

A Iodine is less reactive than bromine.

B The C–I bond enthalpy is less than the C–Br bond enthalpy.

C The C–I bond is less polar than a C–Br bond.

D The C–I bond length is shorter than the C–Br bond length.

Your answer ☐ **[1]**

This question was generally well-answered.

Question 19

19 In a mass spectrum, which alkene is likely to have a fragment ion at $m/z = 29$?

A $H_2C{=}CHCH{=}CH_2$

B $H_2C{=}C(CH_3)_2$

C $H_3CCH{=}CHCH_3$

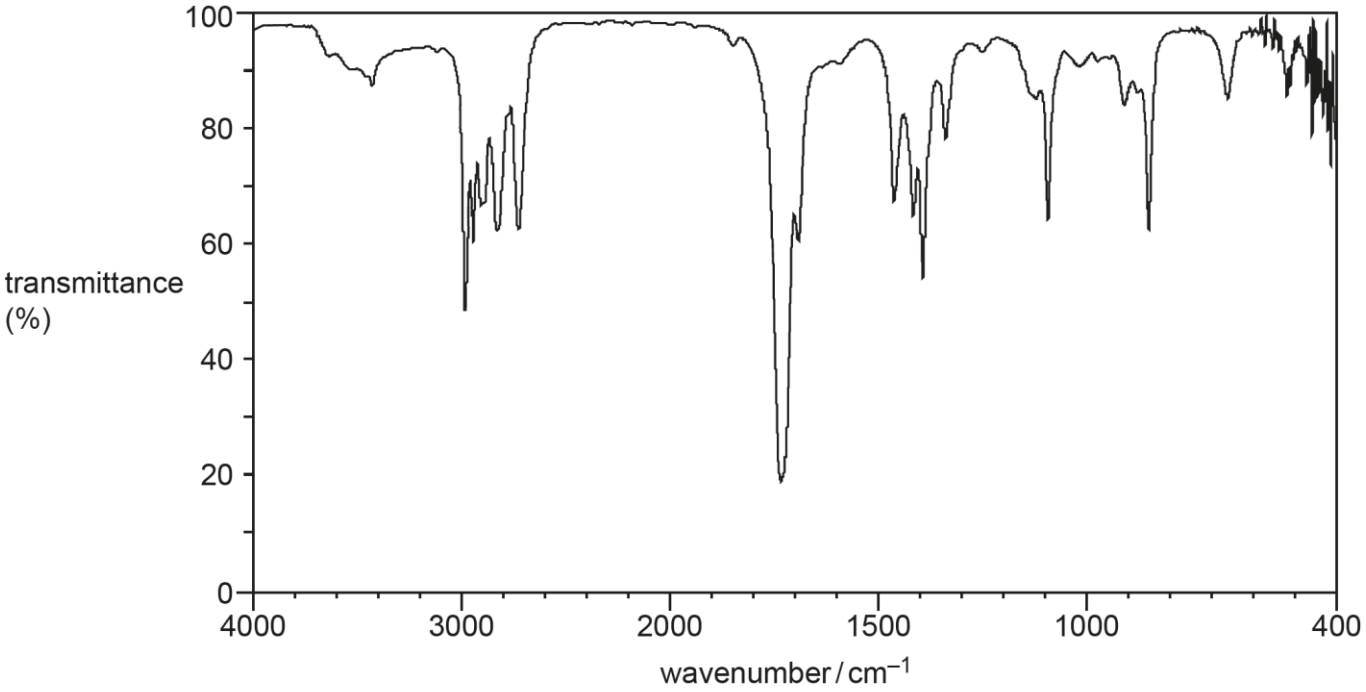
D $H_3CCH{=}CHCH_2CH_3$

Your answer ☐ **[1]**

A significant number did not recognise the CH_3CH_2 group in D would give the fragment ion at m/z = 29.

Question 20

20 The IR spectrum of a compound is shown below.



Which compound could have produced the IR spectrum?

A $CH_3CH{=}CH_2$

B CH_3CH_2CHO

C $CH_3CH_2CH_2OH$

D CH_3CH_2COOH

Your answer ☐ **[1]**

Roughly half of candidates gained this mark, with D being the most common incorrect response (mistaking the peaks at around 3000cm^{-1} as a broad peak caused by a O-H bond in a carboxylic acid).

Section B overview

Section B includes short response question styles (structured questions, problem solving, calculations, practical) and extended response questions. This section of the paper is worth 50 marks.

Question 21 (a)

21 This question is about atomic structure and isotopes of two elements in Period 3.

(a) This part of the question is about sulfur.

Complete the table below.

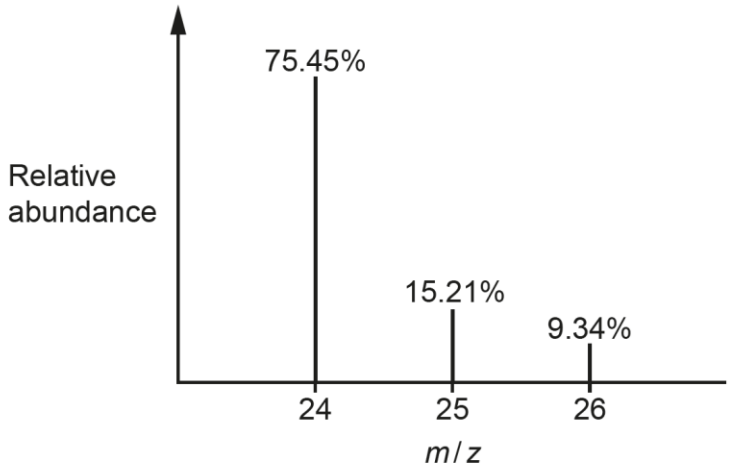
Species	Protons	Neutrons	Electrons
^{34}S			16
		16	18

[2]

This question proved low scoring, with many candidates not using the information in the question and giving species other than sulfur. 'Ar' was the most common error, which lost both marks as 18 was usually then given as the proton number (incorrectly assumed from the species having 18 electrons).

Question 21 (b)

(b) The mass spectrum of a sample of magnesium is shown below.



Calculate the relative atomic mass of magnesium in the sample.

Give your answer to **2** decimal places.

Relative atomic mass = ... **[2]**

Candidates answered this question very well. A few mistyped the numbers into their calculator after giving the correct calculation and even fewer made rounding errors. This type of question has featured on previous examinations, and it was encouraging to see how well it was answered.

Question 21 (c)

(c) Magnesium has a giant metallic structure.

- Draw a labelled diagram to show the bonding and structure in magnesium. Include the correct charges on the metal particles in your diagram.
- Explain how the structure of magnesium allows it to conduct electricity.

Diagram

Explanation .....

.....

.....

.....

[3]

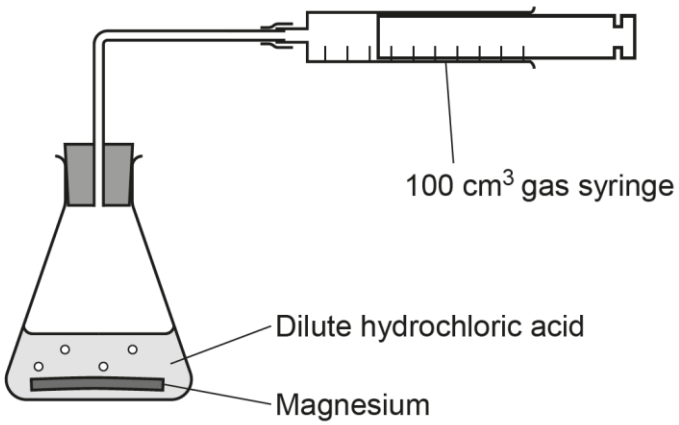
The majority of candidates were able to link movement of electrons to the ability of magnesium to conduct electricity. However, sometimes 'electrons carry charge' was not developed to explicitly state that they are mobile. Many diagrams were unclearly drawn and unlabelled, with the charge of the Mg^{2+} ion incorrectly shown.

Question 21 (d) (i)

(d) Magnesium reacts with dilute hydrochloric acid, as shown in the equation.

$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

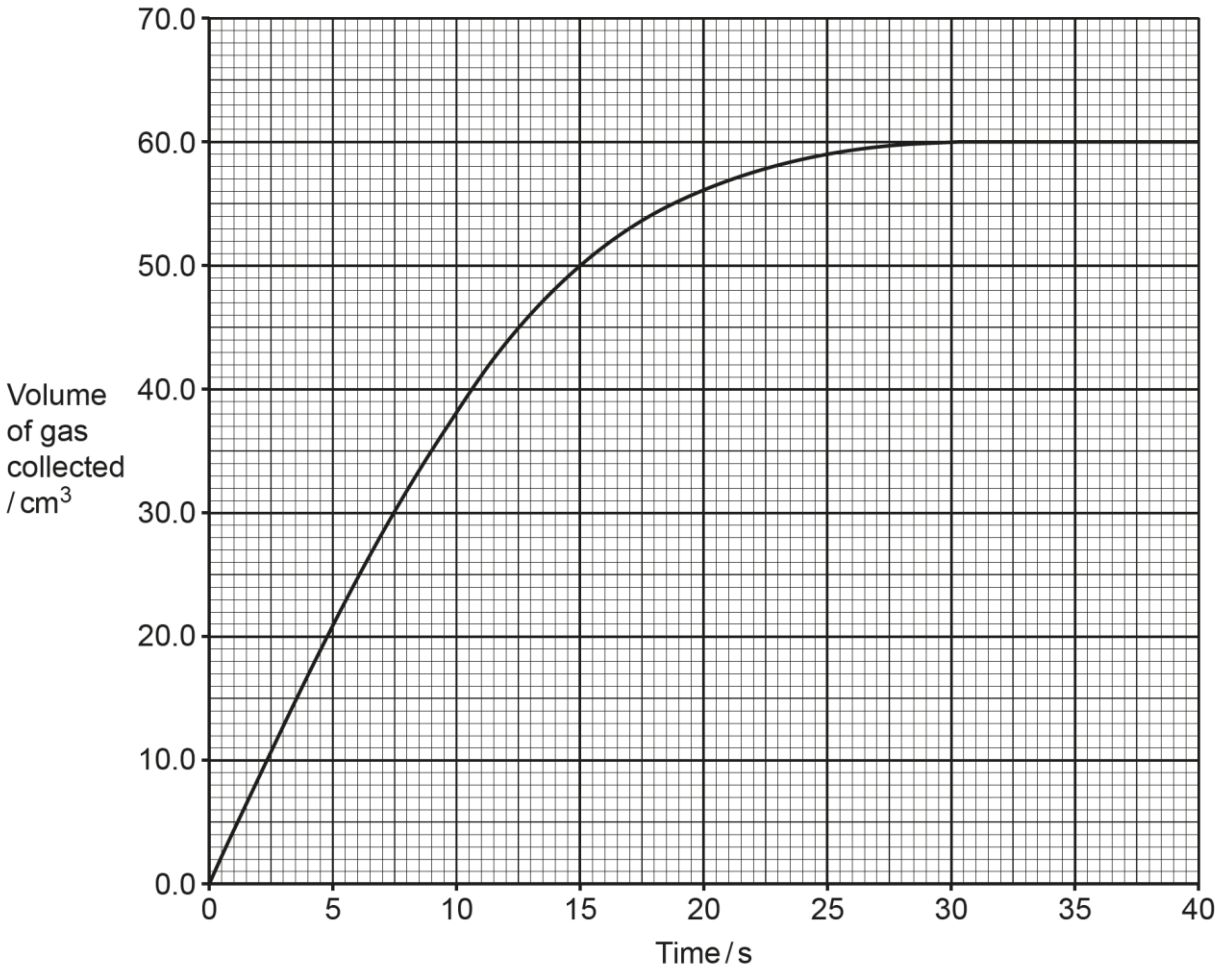
A student reacts an excess of Mg with 24.5 cm^3 $HCl(aq)$ using the apparatus below.



The student measures the volume of gas collected over time. All gas volumes are measured at RTP.

A graph of the student's results is shown in **Fig. 21.1** below.

Fig. 21.1



(i) Calculate the concentration of HC*l* that the student used.

Give your answer to **2** significant figures and in standard form.

Concentration of HC*l* = ... $mol\,dm^{-3}$ **[3]**

This question discriminated well. It requires the use of the graph to determine that 60 cm^3 was the volume of gas evolved and hence calculate moles of H_2. Many low scoring candidates did not read the volume of gas from the graph, using 24.5 cm^3 instead. 'Error carried forward' marks could be given to candidates who subsequently multiplied an incorrectly calculated value by two to reflect stoichiometry and hence calculate moles of HCl reacted. The final mark needed use of moles = concentration x volume to calculate HCl concentration (as well converting to standard form and giving to 2 significant figures).

Candidates who scored low on the whole paper tended to struggle to make an attempt on this question.

Question 21 (d) (ii)

(ii) Explain the shape of the graph in **Fig. 21.1**, in terms of concentration, collisions and time.

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.....

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.....

..... **[3]**

This question required candidates to appreciate that initially concentration of HCl is at its highest, leading to more frequent collisions. As the reaction proceeds, concentration and collision frequency decrease until HCl is used up and the reaction stops (shown by the graph plateauing).

The first marking point ignored candidates incorrectly discussing concentration of solid magnesium, but candidates need to be clear that only the (limiting) reactant, HCl, was used up when the reaction stopped for the third marking point. This last point was often missed, and this would be a good question to use with high-attaining candidates. Apart from the last point, there was an even spread of marks given; the second point was often missed through lack of 'frequency' or other link to collision rate.

Analysing data in graphs

Lower scoring candidates often stated that 'the line increases because rate/concentration increases'. Students should be encouraged to carefully read axes to make sure they are identifying the correct trend from a graph.

Question 22 (a)

22 This question is about halogens and their compounds.

(a) An aqueous solution of bromine reacts with cold aqueous sodium hydroxide in a disproportionation reaction.

The equation is shown below.

$Br_2(aq) + 2NaOH(aq) \rightarrow NaBr(aq) + NaBrO(aq) + H_2O(l)$

Explain what is meant by the term **disproportionation**.

Use the equation above and oxidation numbers.

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..... **[3]**

Over half of candidates scored full marks on this question, clearly stating the definition of disproportionation. Where a response did not state 'element' in the definition, the candidate usually went on to gain the first mark by clearly stating that bromine is oxidised and reduced.

Oxidation numbers were usually assigned correctly, but marks were missed by not linking changes to chemicals, or by not stating which change was oxidation and/or reduction. These marks could sometimes be given from working around the equation, but candidates should be encouraged to include these links in their written response.

Question 22 (b) (i)

(b) An aqueous solution of chlorine also reacts with cold, aqueous sodium hydroxide.
The reaction is more vigorous than the reaction of $Br_2(aq)$ with NaOH(aq) in **(a)**.

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..... **[3]**

This long response question was approached well and there were some excellent and concise answers. However, some candidates tried to link reactivity to electronegativity or confused the question with boiling point trends and London forces.

Candidates are well-versed with tackling this type of question and most were able to write sensible explanations. However, marks could not be given for insufficiently specific responses, for example, repeating the idea of attracting an electron for the third marking point.

Responses could be improved if candidates read through what they write to see if it makes cohesive sense. There was a fairly even spread of marks obtained, with 2 marks given most frequently.

Question 22 (b) (ii)

(ii) Chlorine is used in water treatment.

State **one** disadvantage of treating water with chlorine.

.....

..... **[1]**

This question was generally well answered, although a few candidates put an advantage down instead such as 'kills harmful bacteria'.

Question 22 (c)

(c) A group of students is provided with aqueous solutions of sodium chloride, sodium bromide and sodium iodide in three unlabelled bottles.

Explain how the students can identify which bottle contains each aqueous solution using precipitation reactions and the solubility of any precipitate formed.

Include an **ionic** equation in your answer.

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.....

..... **[4]**

This question was a very good discriminator. Most candidates knew that silver nitrate should be added to the solutions and knew the colour of precipitates produced. Some candidates did not score the second mark by only giving colours and not stating they were solids. Many candidates were also able to give a correct ionic equation, with only the highest scoring candidates explicitly stating it was the AgX precipitates which had different solubilities in ammonia.

A small number of candidates mistook this for a question on halogen displacement, scoring no marks.

Exemplar 1

The students can add $AgNO_3$ to each test tube.
The test tube with NaCl will form a white precipitate,
the one with NaBr will form a cream precipitate,
the one with NaI will form a yellow precipitate.
$Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$
$Ag^+_{(aq)} + Br^-_{(aq)} \rightarrow AgBr_{(s)}$
$Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$
Also AgCl will dissolve in dilute ammonia
AgBr will dissolve in concentrated ammonia
AgI will not dissolve in ammonia **[4]**

Exemplar 1 shows an excellent response. The explanation is clear, and the candidate is precise in naming the solution and its result. Ionic equations are given (although only one is needed) and relative solubilities of the precipitates in ammonia are stated. This response was given the full 4 marks.

Question 23 (a)

23 This question is about equilibrium and bond enthalpies.

The chemical industry manufactures sulfur trioxide, SO_3, by reacting sulfur dioxide, SO_2, and oxygen. This is a reversible reaction which can reach dynamic equilibrium.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H = -196 \text{ kJ mol}^{-1}$ **Equilibrium 23.1**

(a) State **two** features of a **dynamic equilibrium**.

1 .....

.....

2 .....

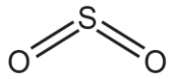
.....

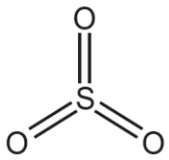
[2]

Most candidates identified at least one feature of a dynamic equilibrium. 'In a closed system' was given most often, and other mark-worthy features were 'the same rate for forward and reverse reactions' and 'concentrations do not change'. Less successful responses that were not given marks included 'forward reaction is the same as reverse' and 'concentrations are the same'.

Question 23 (b)

(b) The displayed formulae of SO_2 and SO_3 are shown below.





The bond enthalpies for the S=O bond in SO_2 and SO_3 are **not** the same.

The table shows bond enthalpies.

Bond	Bond enthalpy / kJ mol^{-1}
O=O	+494
S=O in SO_2	+522

Calculate the S=O bond enthalpy in **SO_3**.

Use the information in the table and **Equilibrium 23.1**.

Bond enthalpy of S=O in SO_3 = ... kJ mol^{-1} **[3]**

This bond energy calculation proved difficult for some. Roughly a third of candidates obtained the correct enthalpy change of 463 kJ mol^{-1} for all 3 marks, but 0 marks was the next common score.

Despite evidence that candidates had clearly practised this type of problem and they recognised that there were going to be three stages to the calculation, candidates frequently did not use the stoichiometry shown in the equation and therefore divided by 2 and 3 respectively for marking points 1 and 3 (rather than 4 and 6). Another common error was incorrect treatment of the enthalpy of reaction value (subtracting rather than adding 196 for the second marking point or omitting it altogether). Drawing out the total number of molecules helped students understand the numbers of bonds involved and should be encouraged. It is also worth reiterating the sign for bond enthalpies.

As with all multi-stage calculations, error carried forward was applied, allowing credit to be given for a subsequent correct method.

Question 23 (c)

(c) The table shows equilibrium concentrations for **Equilibrium 23.1**.

$[SO_2(g)]$ / mol dm^{-3}	$[O_2(g)]$ / mol dm^{-3}	$[SO_3(g)]$ / mol dm^{-3}
25.0	108	42.0

For **Equilibrium 23.1**

- write the expression for the equilibrium constant, K_c
- calculate K_c to **3** significant figures and in standard form.

K_c = ... dm^3 mol^{-1}

[3]

Following browsing of candidate responses, marks were given for correctly writing the K_c expression, substituting the terms with values, and finally, giving the calculated response to three significant figures and standard form.

Most candidates scored either 2 or 3 marks. However, this question highlights the need for candidates to read the question carefully, with many responses not giving the K_c expression, or not giving the answer in standard form, or both.

Question 24 (a) (i)

24 This question is about alkenes.

(a) 2-Chloropropene can form an addition polymer.

(i) Draw **two** repeat units of the polymer formed by 2-chloropropene.

[1]

Under half of candidates scored this mark, suggesting students would benefit from practising drawing repeat polymer units. A structure with six carbons in the chain was a common error.

Question 24 (a) (ii)

(ii) 2-Chloropropene can be disposed of by combustion. This process releases the greenhouse gas carbon dioxide.

State **one** other problem with this method of disposal.

.....

.....

.....

..... **[1]**

Over half of candidates gained this mark, most often by stating chlorine, HCl or, more rarely, CO was produced. Common responses which didn't score included 'takes lots of energy and 'produces greenhouse gases' (which is a repetition of the question).

Question 24 (b)

(b) Pentene, C_5H_{10}, can undergo complete combustion to produce the same products as the combustion of an alkane.

Write the equation for the complete combustion of C_5H_{10}.

..... **[1]**

This was well answered by the majority of candidates. Where the mark was missed, it was either through incorrect products or incorrect balancing of oxygen.

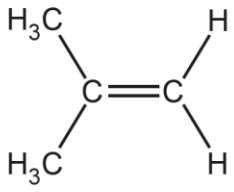
Question 24 (c) (i)

(c) Methylpropene, $(CH_3)_2C=CH_2$, reacts with HCl to form a mixture of two products. Compound **A** is the major product.

(i) Outline the mechanism for the formation of the major product, compound **A**.

The structure of $(CH_3)_2C=CH_2$ has been provided.

Include curly arrows and relevant dipoles, the structure of compound **A** and the name of the mechanism.



Compound A

Name of mechanism .....

[5]

Many candidates scored well on this question, drawing a clear mechanism and correctly giving the major product. However, mistakes were often seen with the direction of arrows and a minority of students gave the minor product for Compound A and/or named the mechanism incorrectly. Partial charges on the carbons of the double bond and lack of charge on the chloride ion were also common errors. This question proved to be an excellent discriminator.

Question 24 (c) (ii)

(ii) Explain why compound **A** is the major product.

.....

.....

.....

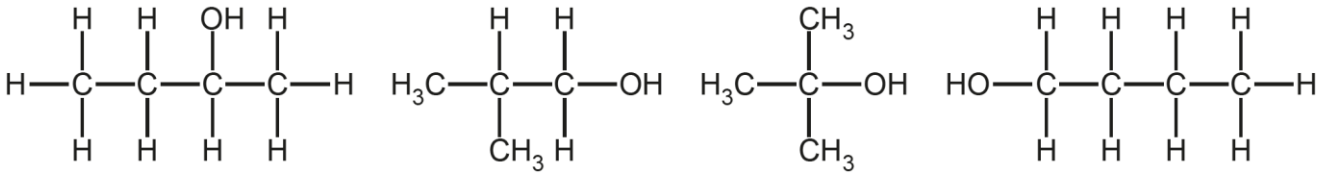
..... **[1]**

This mark required 'more stable carbocation', and just under half of candidates gained it. Some responses were excellent, identifying that the carbocation would be tertiary as opposed to primary. Incorrect identification of the carbocation as secondary was ignored, meaning more candidates were able to score. Common responses which didn't score discussed Markownikoff's rule or said that the product was more stable.

Question 25 (a)

25 This question is about alcohols.

Alcohols **D**, **E**, **F** and **G**, shown below, are structural isomers of $C_4H_{10}O$.



Alcohol **D** Alcohol **E** Alcohol **F** Alcohol **G**

(a) Alcohols **D**, **E**, **F** and **G** are each heated under reflux with $H^+/Cr_2O_7^{2-}$.

Draw the structure of the organic product that is formed from each alcohol.

If there is no reaction, state 'No reaction'.

Alcohol	Organic product
D	
E	
F	
G	

[3]

The majority of candidates scored 2 or 3 marks on this question. Occasionally some gave carbonyl structures for E and G failing to recognise that full oxidation would take place. Other errors were additional H atoms (especially on the carbonyl carbon for D) or too many carbon atoms for E. A more common error was incorrect connectivity for the OH group especially in the carboxylic acid from alcohol G. This question was a good discriminator.

Question 25 (b

(b) Alcohols **D**, **E**, **F** and **G** are each heated with concentrated H_2SO_4, which acts as an acid catalyst.

Which alcohol forms a mixture of two alkenes that are structural isomers of one another?

Alcohol ..... **[1]**

Just under half of candidates scored this with a wide range of incorrect responses. Most candidates did not appreciate that in order to form two isomeric alkenes a secondary alcohol was necessary, so that water could be eliminated from either side of the OH group.

Question 25 (c)

(c) 25.9 g of alcohol **F** is completely combusted in oxygen at a temperature of 100 °C and 1.50×10^5 Pa pressure.

The equation for this reaction is:

$C_4H_{10}O + 6O_2 \rightarrow 4CO_2 + 5H_2O$

Calculate the volume of $CO_2(g)$ produced, in cm^3.

Give your answer to an **appropriate** number of significant figures.

Volume of $CO_2(g)$ = ... cm^3 **[5]**

Many candidates followed a well drilled method to apply the ideal gas equation to this calculation (including writing each term down and converting where necessary):

- Moles of alcohol F used
- Multiplication by 4 to give moles of CO_2
- Rearranging the ideal gas equation
- Substituting the correct values using the correct conversion to Kelvin for temperature
- Converting from m^3 to cm^3 and giving the response to an appropriate number of significant figures (3 in this case)

Most candidates scored at least 3 marks on this question. Common errors were using the number of moles of alcohol instead of the number of moles of carbon dioxide in the rearranged ideal gas equation, converting from m^3 to cm^3 incorrectly in the final step (usually only multiplying by 1,000 rather than 1,000,000) and not giving the response to an appropriate number of significant figures. Occasionally, candidates did not convert to Kelvin or used the pressure in kPa instead of Pa.

OCR support

Candidates should understand that the lowest level of significant figures in the raw data provided for a calculation will determine the number of significant figures that should be given in the final answer. More details can be found in Section M1.1 of the Mathematical Skills Handbook.

Exemplar 2

$PV = nRT$

$P = 1.5 \times 10^5$

$R = 8.314$

$T = 373k$

$n = ?$

$M_r(C_4H_{10}) = 74$

$\text{moles} = \frac{25.9}{74} = 0.35$

1 : 4

mole of $CO_2 = 1.4$

$n = 1.4$

$V = \frac{nRT}{P} = \frac{1.4 \times 8.314 \times 373}{1.5 \times 10^5} = 0.02894\ dm^3$

$\times 1000 = 28.9$

Volume of $CO_2(g)$ = 28.9 cm^3 **[5]**

This response shows an example of clear working. Values are assigned to each term and moles calculated correctly. Rearrangement and substitution of values is shown and correct. The appropriate number of significant figures is given, but the response only converted to dm^3 not cm^3. This response was given 4 marks.

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