Qualification Accredited

OCR
Oxford Cambridge and RSA

AS LEVEL

Examiners' report

CHEMISTRY A

H032

For first teaching in 2015

H032/01 Summer 2024 series

Version 1

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 answers 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 OCR.

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:
• showed knowledge of key chemical concepts such as dot-and-cross diagrams in Question 23(c); molecular shapes in Question 24(c); and construction of balanced equations in Questions 21(b)(i) and 25(a) • produced clear and concise responses for explanations of chemical knowledge and understanding, e.g. explaining the physical conditions that would produce a large equilibrium yield in Question 23(a)(ii) and explanation for the different boiling points of alkanes in Question 24(a) • performed calculations proficiently and clearly, e.g. calculating the volume of gas produced in a reaction from the mass of reactant and a balanced equation in Question 21(c); titration calculations in Question 22(b)(iii); and determination of a bond energy from provided enthalpy data in Question 23(b) • showed organic structures using different unambiguous formula (skeletal, structural or displayed) in Questions 25(b) and 25(d)(i) • wrote equations involving radicals for a radical substitution including use of 'dots', •, to represent radicals.	• found it difficult to apply what they had learnt in situations that are unfamiliar • produced responses that lacked depth and were often rambling in explanations, e.g. explaining the physical conditions that would produce a large equilibrium yield in Question 23(a)(ii) and their explanations for the different boiling points of alkanes in Question 24(a) • did not clearly set out unstructured calculations, e.g. titration calculations in Question 22(b)(iii); determination of a bond energy from provided enthalpy data in Question 23(b) • did not use significant figures appropriately in Question 24(c)(i) • displayed organic structures that were unclear or unambiguous in Questions 25(b) and 25(d)(i) • displayed some lack of basic chemical knowledge and understanding, e.g. writing a systematic name from a formula and balancing a simple equation in Questions 22(b)(i), (ii) and 25(a)(i).

There was no evidence that any time constraints had led to a candidate underperforming or of scripts where there were no responses to many questions.

Note
Candidates have been provided with a fixed number of answer lines and an additional answer space. The additional answer space will be clearly labelled as additional and is only to be used when required. Teachers are encouraged to keep reminding students about the importance of conciseness in their responses.

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.

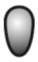
Most questions performed well. Question 11 rarely gained marks, but apart from that there was good range of marks.

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. Attempts at changing a letter often result in illegibility, with no mark being given.
- Candidates should never leave a multiple-choice question with no letter. A guess may turn out to be correct. A 'no response' can only result in no mark.

Question 1

1 Which diagram shows a p-orbital?

A	
B	
C	
D	

Your answer **[1]**

Most candidates recognised C as a diagram for a p orbital.

Question 2

2 Which row shows the atomic structure of $^{25}Mg^{2+}$?

	Protons	**Neutrons**	**Electrons**
A	10	12	13
B	10	15	12
C	12	13	10
D	12	13	14

Your answer ☐ **[1]**

Most candidates recognised the correct atomic structure, a basic chemical skill taken forward from GCSE.

Question 3

3 A nitrogen oxide contains 36.84% of nitrogen by mass.

What is the empirical formula of the nitrogen oxide?

A NO

B NO_2

C N_2O

D N_2O_3

Your answer ☐ **[1]**

Most candidates selected D as the correct formula. They usually showed their working alongside the options which is good practice. B was the main distractor and working suggested that such candidates had over-rounded their ratio of 1:1.5 to 1:2.

Question 4

4 Carbon monoxide reacts with oxygen to form carbon dioxide:

$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

Which volumes of CO(g) and O_2(g) produce the largest volume of CO_2(g)?

All gas volumes are measured at RTP.

A 1.00 dm^3 CO and 4.00 dm^3 O_2

B 2.00 dm^3 CO and 3.00 dm^3 O_2

C 3.00 dm^3 CO and 2.00 dm^3 O_2

D 4.00 dm^3 CO and 1.00 dm^3 O_2

Your answer ☐ **[1]**

Candidates found this question very difficult. Scripts showed a general lack of working, suggesting that candidates did not know how to approach the problem. Candidates had to first work out which reactant was in excess and to use the limiting reagent to determine the volumes of CO_2 formed.

The question did not discriminate very well, suggesting that many candidates guessed.

C was the correct response with A and D being the main distractors, presumably because these contained the largest volumes of O_2 (in A) and of CO (in D).

This would be a good question to use with high-attaining candidates.

Question 5

5 Which reaction produces a product with linear molecules?

A $2B + 3F_2 \rightarrow$

B $C + O_2 \rightarrow$

C $2H_2 + O_2 \rightarrow$

D $N_2 + 3H_2 \rightarrow$

Your answer ☐ **[1]**

Most candidates identified CO_2 as the product with linear molecules, suggesting that knowledge of bond shapes is good.

Question 6

6 Which statement about the periodic table is **not** correct?

A Elements in the same group have similar **chemical** properties.

B The elements are ordered by increasing atomic mass.

C The elements are ordered by increasing atomic number.

D There is a repeating trend of **physical** and **chemical** properties across the periods.

Your answer ☐ **[1]**

This question did discriminate, but the correct option of B was missed by many candidates. D was the main distractor, despite the question assessing basic chemical facts.

This multiple-choice question required candidates to choose the option that is not correct, and some candidates may not have read the question closely enough. It is recommended that candidates underline the word **not** in such MCQs to highlight what is required.

Question 7

7 Group 2 compounds can be used in agriculture to neutralise acid soils and in medicine to treat indigestion.

Which Group 2 compound is **not** suitable for either use?

A $Mg(OH)_2$

B $MgSO_4$

C $CaCO_3$

D CaO

Your answer ☐ **[1]**

Some candidates correctly chose $MgSO_4$. No option showed up as a 'main' distractor and many candidates may have just guessed. As this question assesses recall of a specification learning outcome, this suggests that the content had not been learnt by many candidates. Note also the points made in Question 6 about underlining the word 'not'.

Question 8

8 In the UK, water companies typically treat drinking water with chlorine gas at a concentration of 0.500 mg dm^{-3} or less.

Which statement about UK drinking water is correct?

A Chlorine in drinking water can catalyse the breakdown of ozone.

B Chlorine may form toxic chlorinated hydrocarbons.

C Drinking water with a chlorine gas concentration of 0.500 mg dm^{-3} contains 2.12×10^{18} chlorine molecules in each dm^3.

D In hot weather, chlorine can vaporise from drinking water to cause global warming.

Your answer ☐ **[1]**

Overall, candidates had little difficulty with this question and most selected B. Options C and D were the main distractors, with few choosing option A. The question did not discriminate well across the ability range, suggesting that many candidates guessed.

Question 9

9 Which reaction does **not** show disproportionation of chlorine?

A $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

B $Cl_2 + H_2O \rightarrow HCl + HClO$

C $2ClO_2 + 2NaOH \rightarrow NaClO_2 + NaClO_3 + H_2O$

D $2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$

Your answer ☐ **[1]**

About half of the candidates chose A correctly. Most candidates wrote oxidation numbers below the chlorine in the equations, which is good practice, with C proving to be the main distractor. Note also the point made in Question 6 about underlining the word '**not**'.

Question 10

10 An unknown compound is tested to identify whether it contains sulfate, carbonate or halide ions.

What is the correct sequence of tests required?

A carbonate, halide, sulfate

B carbonate, sulfate, halide

C halide, carbonate, sulfate

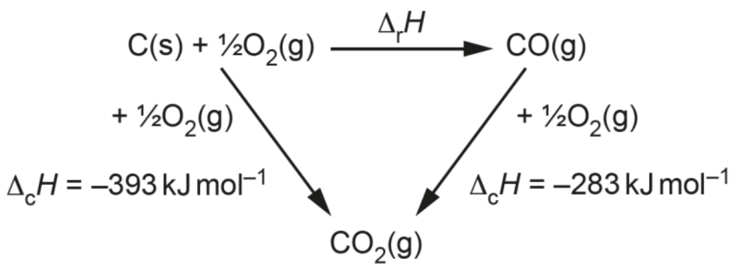
D sulfate, carbonate, halide

Your answer **[1]**

This question was answered well with most candidates correctly selecting the sequence shown in B.

Question 11

11 An enthalpy cycle is shown below.



What is $\Delta_r H$, in $kJ\ mol^{-1}$, shown in the enthalpy cycle?

A +676

B +110

C –110

D –676

Your answer **[1]**

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

Question 12

12 A mixture of gases is heated in a closed container. The reaction rate increases.

Which statement explains why the rate increases?

A More molecules have an energy greater than the activation energy.

B The activation energy decreases.

C The activation energy increases.

D The concentration of the gases increases.

Your answer ☐ **[1]**

Most candidates were aware that heat increases the number of molecules that have energy greater than the activation energy (A).

Question 13

13 The reversible reaction below is at equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

What is the expression for K_c?

A $\dfrac{[SO_2(g)]^2\,[O_2(g)]}{[SO_3(g)]^2}$

B $\dfrac{[SO_3(g)]^2}{[SO_2(g)]^2\,[O_2(g)]}$

C $\dfrac{2[SO_2(g)] + [O_2(g)]}{2[SO_3(g)]}$

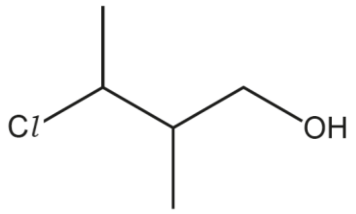
D $\dfrac{2[SO_3(g)]}{2[SO_2(g)] + [O_2(g)]}$

Your answer ☐ **[1]**

Almost all candidates were aware of how to express the K_c expression for an equilibrium, choosing the correct option B.

Question 14

14 What is the name of the compound below?



A 1-chloro-1,2-dimethylpropan-3-ol

B 2-chloro-3-methylbutan-4-ol

C 3-chloro-2-methylbutan-1-ol

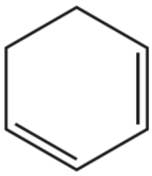
D 3-chloro-2,3-dimethylpropan-1-ol

Your answer **[1]**

About half the candidates correctly chose C. Options A and B were incorrectly chosen by many candidates, presumably by counting from the left or not first identifying the longest carbon chain. This question proved to be an excellent discriminator.

Question 15

15 The structure of a hydrocarbon is shown below.



Which terms describe this hydrocarbon?

A Alicyclic and saturated

B Aliphatic and alicyclic

C Aliphatic and aromatic

D Aromatic and unsaturated

Your answer **[1]**

This question assessed understanding of important terms used in organic chemistry, with some candidates correctly choosing B as the correct option. The question discriminated well with less successful responses choosing D, presumably thinking that the two double bonds in a cyclic structure makes the compound aromatic.

Misconception

A cyclic organic molecule containing single and/or double bonds is aliphatic. The molecule is described as aromatic if it contains a benzene ring.

Question 16

16 Which property explains the low reactivity of alkanes?

A Low C–C bond enthalpy.

B Low bond enthalpy of π-bonds.

C Low polarity of σ-bonds.

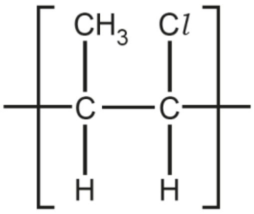
D Low reactivity of carbon and hydrogen.

Your answer [1]

Some candidates chose B as the correct option. The other options were chosen randomly, suggesting that many had not learnt this specification content and had guessed.

Question 17

17 The repeat unit of an addition polymer is shown below.



Which statement about this addition polymer is correct?

A Combustion produces toxic alkaline fumes.

B The addition polymer is biodegradable.

C The monomer is $H_3CCH{=}CHCl$.

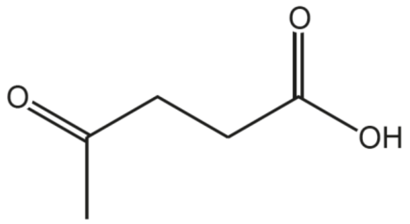
D The repeat unit above is shown as a displayed formula.

Your answer [1]

This question proved to be an excellent discriminator with most above average candidates choosing monomer (option C).

Question 18

18 Which functional groups are present in the compound below?



A Alcohol and aldehyde.

B Alcohol and ketone.

C Carboxylic acid and aldehyde.

D Carboxylic acid and ketone.

Your answer **[1]**

Many candidates wrote the functional groups on the structure shown on their scripts, which reflects good exam technique. Most correctly identified that the compound contains ketone and carboxylic acid functional groups (D). This was an excellent discriminator.

Question 19

19 Which statement about infrared radiation (IR) is **not** correct?

A Absorption of IR by molecules such as CO_2, H_2O and CH_4 has been linked to global warming.

B IR causes CFC molecules to produce chlorine radicals that initiate ozone breakdown in the upper atmosphere.

C IR causes some covalent bonds to vibrate more and absorb energy.

D IR is used in modern breathalysers to detect ethanol.

Your answer **[1]**

Some candidates correctly chose option B, with the other options being chosen randomly. From the importance placed on the causes of global warming, it was interesting to see that many incorrectly chose option A.

Note also the points made in Question 6 about underlining the word '**not**'.

Question 20

20 An alcohol $CH_3CH_2CH(CH_3)OH$ produces a mass spectrum.

The mass spectrum contains a large fragment ion at *m*/*z* = 45.

What is the possible identity of this fragment ion?

A CH_2CHOH^+

B $CH_2CH_2OH^+$

C CH_3CHOH^+

D $CH_3CH_2CH^+$

Your answer ☐ **[1]**

Most candidates first worked out the molecular mass of each fragment and annotated their scripts with this information, eliminating options A and C in the process. More successful responses than drew out the structure of the alcohol, to work out that only option C could have produced the fragment. This is evidence of good exam technique. Predictably, option B was the main distractor. This question discriminated well.

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 iron.

(a) A sample of iron is isolated from a meteorite and analysed by mass spectrometry.

The mass spectrum shows peaks with the relative abundances below.

Isotope	^{54}Fe	^{56}Fe	^{57}Fe	^{58}Fe
Relative abundance	78.54%	8.88%	5.10%	7.48%

Calculate the relative atomic mass of the iron in the sample.

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

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

Candidates answered this question very well. A few mis-wrote the numbers and even fewer gave responses to the incorrect number of decimal places. This type of question has featured on previous examinations, and it was encouraging to see how well it was answered, even with more isotopes being included than previously.

Question 21 (b) (i)

(b) Iron can be extracted from iron ores containing the oxide Fe_2O_3.

(i) What is the systematic name for Fe_2O_3?

.... **[1]**

This question required candidates to work out a systematic name from a formula. Transition elements can have different oxidation numbers in their compounds and the systematic name needs to contain a Roman numeral. Approximately half the candidates were able to write the correct name as iron(III) oxide. An array of incorrect names were seen, commonly iron(II) oxide, presumably from the number of iron atoms in Fe_2O_3.

Misconception

A systematic name may contain the oxidation number, not the number of atoms in the formula. So Fe_2O_3 is iron(III) oxide and **not** iron(II) oxide.

Question 21 (b) (ii)

(ii) Balance the equation for the reduction of Fe_2O_3 with carbon monoxide.

.... Fe_2O_3 + ... CO → .... Fe + ... CO_2 **[1]**

Most candidates were able to balance this straightforward equation.

Question 21 (c)

(c) The iron compound, $Fe(NO_3)_3$, decomposes when heated.
The equation for the decomposition of $Fe(NO_3)_3$ is shown below.

$$4Fe(NO_3)_3(s) \rightarrow 2Fe_2O_3(s) + 12NO_2(g) + 3O_2(g)$$

Molar mass of $Fe(NO_3)_3$ = 241.8 g mol^{-1}

4.836 g of $Fe(NO_3)_3$ is heated until it has completely decomposed.

Calculate the **total** volume of gas, in dm^3, produced at RTP.

total volume of gas = ... dm^3 **[3]**

Most candidates were given at least one of the three available marks for calculating the amount of $Fe(NO_3)_2$ as 0.0200 mol. Candidates then needed to determine the moles of gas (NO_2 + O_2) as 0.0750 mol, which has a volume at RTP of 0.0750 × 24.0 = 1.80 dm^3.

The most common error was omission of ÷4 from the equation when working out the moles of gas and obtaining a total volume of 1.80 × 4 = 7.20 dm^3. Such a response could still be given 2 marks by error carried forwards.

Question 22 (a)

22 This question is about the reactions of acids.

(a) What is the difference between a **strong** acid and a **weak** acid?

....

.... **[1]**

Most candidates described a strong and a weak acid in terms of dissociation or ionisation, with few just describing one of the two types of acid.

Question 22 (b) (i)

(b) Ethanoic acid, CH_3COOH, is found in some descalers to soften hard water.

A student carries out a titration with a standard solution of sodium carbonate, Na_2CO_3, to determine the percentage composition by mass of CH_3COOH in a descaler.

The equation is shown below.

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

(i) The method is outlined below:

- Dissolve 6.50 g of the descaler in distilled water.
- Transfer the solution into a 250.0 cm^3 volumetric flask.
- Make up to the mark with distilled water and invert several times.
- Pipette 25.0 cm^3 of this solution into a conical flask and add a few drops of indicator.
- Titrate this solution with 0.200 mol dm^{-3} Na_2CO_3(aq), in the burette.

The student carries out a trial titration, followed by further titrations.

The results are shown in the table below.

The trial titration has been omitted.

Titration	**1**	**2**	**3**
Final reading / cm^3	48.95	24.15	48.35
Initial reading / cm^3	24.55	0.00	24.10
Titre / cm^3			

Complete the table by adding the titres.

[1]

Most candidates were able to work out these simple subtractions. Candidates were told that the titration readings were read to the nearest 0.05 cm^3, requiring volumes to be recorded to two decimal places, which may include a '0'. The right-hand initial reading is therefore 24.10 cm^3 and not 24.1 cm^3, which continues to be the commonest error seen.

Question 22 (b) (ii)

(ii) Calculate the mean titre, to the nearest 0.05 cm^3, that the student should use for analysing these results.

mean titre = ... cm^3 **[1]**

Candidates are expected to use only concordant titres when working out the mean titre and the left-hand titre of 24.40 cm^3 should be rejected. Most candidates did this to produce 24.20 cm^3 as their mean titre. Use of 24.2 was allowed because rounding of a '0' as the second decimal place had already been penalised in Question 21 (b) (i). Predictably, the most common error was to use all three titres to produce the incorrect mean of 20.27 cm^3.

Question 22 (b) (iii)

(iii) Calculate the percentage composition by mass of CH_3COOH in the descaler.

Assume that CH_3COOH is the only acid in the descaler.

Give your answer to **3** significant figures.

percentage composition by mass = ... % **[5]**

Many candidates followed a well drilled method to analyse their titration results:

- Moles of Na_2CO_3 in the mean titre
- Moles of CH_3COOH in 25 cm^3
- Scaling ×10 for moles of CH_3COOH in 250 cm^3

Candidates then needed to process their titration results further to determine the percentage composition:

- Mass of CH_3COOH in 250 cm^3
- Percentage composition of CH_3COOH to 3 significant figures.

Most candidates were able to make some progress through the analysis. Common errors included:

- Not ×2 to obtain the moles of CH_3COOH
- Omission of the scaling stage.

Some candidates ignored the titration results entirely, instead calculating the number of moles of CH_3COOH in 6.5 g of the descaler as 0.1083 mol by assuming that all of the descaler was CH_3COOH. This approach was flawed and could not be given any marks.

A final comment must be made about the presentation of many of the responses. Numbers had often been sprayed across the page and it could be difficult to see how these related to a cohesive solution. It was often impossible to give marks for such responses.

The question discriminated extremely well with some candidates given all 5 marks. Less successful responses demonstrated problems with approaching this type of question and some were given no marks at all.

Exemplar 1

Give your answer to **3** significant figures.

106

24.20 cm^3 Na_2CO_3 ~~x~~ 0.2 mol dm^{-3}

4.84×10^{-3} mol

60

9.68×10^{-3} mol ethanoic acid

$\frac{0.5808g}{6.5} \times 100$

8.935384615

8.94 %

percentage composition by mass = 8.94 % **[5]**

Exemplar 1 shows a well-presented response, with the only error being not scaling the moles of CH_3COOH from 25 to 250 cm^3. The result is a percentage composition of 8.94 % instead of 89.4 %. The clear presentation allowed the examiner to follow how the incorrect response had been obtained. Error carried forward allowed marks can be given for a correct method, giving a total of 4 out of 5 marks.

Question 23 (a) (i)

23 This question is about covalent compounds of nitrogen.

(a) Ammonia, NH_3, is manufactured by reacting nitrogen and hydrogen gases.

This is a reversible reaction and the equilibrium is shown below.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$

(i) This is an example of a dynamic equilibrium.

State **2** 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 marks 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 'reversible reaction' and 'concentrations are the **same**'.

Question 23 (a) (ii)

(ii) State and explain the conditions of temperature and pressure that would produce a large equilibrium yield of NH_3.

....

....

....

....

....

....

.... **[3]**

This long-response question was approached very well and there were some excellent and concise responses.

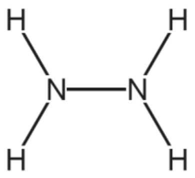
Only the less successful responses did not identify the main trends.

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, some candidates stated that increased pressure would shift the equilibrium in the direction with fewer moles, without stating what that direction was for this equilibrium. It was also common to see explanations that contradicted earlier statements.

Responses could be improved if candidates read through what they write to see if it makes cohesive sense. Nearly half of the scripts were given the full 3 marks, the question proving to be a good discriminator.

Question 23 (b)

(b) Hydrazine, N_2H_4, shown below, can be used as a rocket fuel.



As a fuel, N_2H_4 reacts with oxygen as shown below.

$N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H = -581\ kJ\ mol^{-1}$

Average bond enthalpies are shown in the table.

Bond	N–N	O=O	N≡N	O–H
Average bond enthalpy / kJ mol^{-1}	+158	+498	+945	+464

Calculate the average bond enthalpy of the N–H bond.

average bond enthalpy of N–H = ... kJ mol^{-1} **[3]**

This bond energy calculation contained more values than in recent papers and many candidates found analysing the data difficult.

Despite this, the question discriminated extremely well with about half the candidates obtaining the correct enthalpy change of 391 kJ mol^{-1} for all 3 marks, despite an incorrect final response.

Successful responses showed that some candidates had clearly practised this type of problem and they recognised that there were going to be three stages to the calculation:

- use of 945 and 4 ´ –464 to obtain 2801
- correct incorporation of the other ΔH values to obtain 1564 for 4 N–H
- division by 4 for 1 N–H bond to obtain 391 kJ mol–^{1}

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

The commonest errors were:

- use of 2 O–H instead of 4 O–H in the 1st step.
- use of 158 for N–N in the 1st step instead of 945 for N≡N (Did these candidates not recall that N_2 has a triple bond?)
- omission of some data for the second step.

Question 23 (c)

(c) Hydrogen cyanide, HCN, is bonded by a single bond between the H and C atoms and a triple bond between the C and N atoms.

Draw a 'dot-and-cross' diagram for a molecule of HCN.

Use different symbols for electrons from H, C and N.

Show outer electrons only.

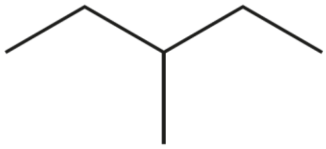
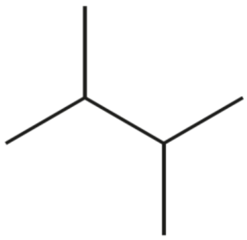
[2]

This question was well answered with 'dot-and-cross' diagrams usually correct. Most candidates obtained both marks. The most common error was omission of the nitrogen lone pair.

Question 24 (a)

24 This question is about hydrocarbons.

(a) The skeletal formulae and boiling points of three isomers of C_6H_{14} are shown in the table below.

Isomer	Molecular formula	Skeletal formula	Boiling point / °C
A	C_6H_{14}		69
B	C_6H_{14}		63
C	C_6H_{14}		58

State and explain the trend in the boiling points shown in the table.

Refer to the isomers **A**, **B** and **C** in your answer.

....

....

....

....

....

.... **[4]**

Most candidates were given 3 or 4 marks. The most common omission was the idea of surface contact. Most candidates identified London forces or induced dipole interactions as the relevant intermolecular force. A few candidates gave a general comment in terms of 'intermolecular' forces without specifying the type of intermolecular forces.

There has been a general improvement in candidate responses to this type of question with fewer candidates than in previous exams suggesting the breaking of hydrogen bonds or covalent bonds.

Exemplar 2

Refer to the isomers **A**, **B** and **C** in your answer.

Isomers A, B and C have the same molecular formulae but different structural formulae. Boiling point decreases down the table from A to C because there is more branching so fewer surface points of contacts. This results in fewer London forces between the molecules so less energy is required to overcome these London forces. (All going down the table from A to C)

Exemplar 2 shows an excellent response. The explanation is clear and the candidate is aware of the main factors responsible for the trend in boiling points. This response was given the full 4 marks.

Question 24 (b)

(b) The hydrocarbon C_2H_6 reacts with bromine, Br_2, to form C_2H_5Br under suitable conditions.

Complete the table below to show the mechanism for the three stages of the reaction of C_2H_6 with Br_2 to form C_2H_5Br.

The equation for one of the possible reactions for termination has been completed.

In your equations, use molecular formulae and 'dots' (•) with any radicals.

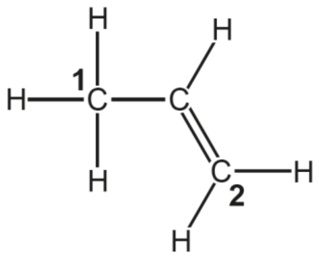
Initiation	Conditions .... Equation .... → ....
Propagation	**1** .... → .... **2** .... → ....
Termination	**1** $Br\bullet + Br\bullet \rightarrow Br_2$ **2** .... → .... **3** .... → ....

[5]

This question was answered extremely well with most candidates obtaining the full 5 marks. It was encouraging to see the widespread correct use of dots to indicate radicals, with relatively few omissions. Of the three steps, initiation and termination were answered better than the equations for propagation.

Question 24 (c)

(c) Propene, C_3H_6, has different bond angles and shapes around the carbon atoms.
The displayed formula of a propene molecule is shown below.



Predict the bond angles and the names of the shapes around the C atoms **1** and **2** above, and explain why the bond angles and shapes are different.

Carbon atom	Bond angle	Name of shape
1		
2		

Explanation: ....

....

....

....

....

.... **[5]**

The bond angles and shapes rewarded the well-prepared candidates, with many being given both available marks for this part of the question. This part discriminated very well.

For the explanation, most candidates identified 4 and 3 for C1 and C2, but candidates often linked 4 and 3 to atoms, rather than to electron pairs or bonded pairs for C1 and to bonding regions for C2.

A mark was available for stating that 'electron pairs repel', but this important fact was often omitted despite being the main principle that determines molecular shapes.

The question discriminated well, giving a good spread of marks across the five available.

Misconception

Many students think that molecular shapes are determined solely by lone pairs or by repulsion between bonded atoms. The principle behind molecular shapes is called electron pair repulsion theory because it is based on repulsion between electron pairs, which may be bonded pairs or lone pairs, but **not** atoms.

Question 25 (a)

25 Three alcohols, **A**, **B** and **C**, are structural isomers with the molecular formula $C_5H_{12}O$.

(a) **A**, **B** and **C** take part in combustion reactions.

Complete the equation for the complete combustion of $C_5H_{12}O$.

$C_5H_{12}O$ + ... **[2]**

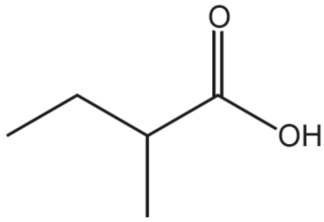
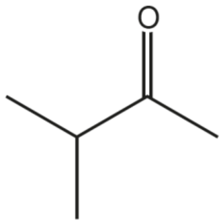
Most candidates identified the correct products of this combustion as CO_2 and H_2O. The second mark was available for a balanced equation but many balanced O_2 with an 8 rather than with 7½.

Candidates need to be very careful when writing equations for the combustion of alcohols as it is easy to miss the O atom within the alcohol formula.

Question 25 (b)

(b) Alcohols **A**, **B** and **C** are each refluxed with acidified dichromate(VI), $H^+/Cr_2O_7^{2-}$.
The organic products are shown in the table below.

Complete the table to show the structures of alcohols **A**, **B** and **C**.

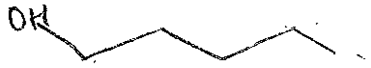
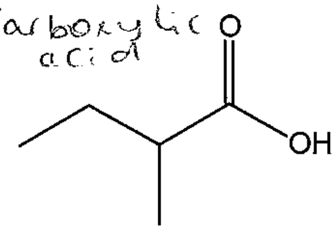
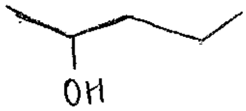
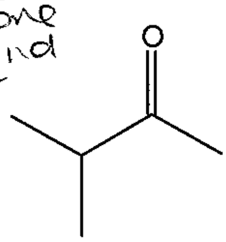
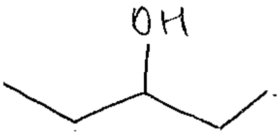
Alcohol	Structure of alcohol	Organic product after refluxing with $H^+/Cr_2O_7^{2-}$
A		
B		
C		No reaction

[3]

This question appeared to be straightforward, but many candidates got into a muddle when drawing the alcohol structures. The best tactic is to copy the carbon skeletal and to then add the functional group.

Many candidates drew displayed formulae and these often contained too many carbon atoms or missing H atoms. Great care is needed in drawing organic structures.

Exemplar 3

Alcohol	Structure of alcohol	Organic product after refluxing with $H^+/Cr_2O_7^{2-}$
A		Carboxylic acid 1 
B		ketone is 2nd 
C		3rd No reaction

[3]

Exemplar 3 provides some useful lessons. The candidate draws their structures skeletally, but the skeletons do not match the product.

Structure C must be a tertiary alcohol, but the candidate has drawn the structure of a secondary alcohol.

It should be noted that, even with a correct carbon skeleton, structure A would be rejected. Incorrect connectivity of the OH group is always penalised.

Question 25 (c)

(c) Primary alcohols can be oxidised under distillation to make aldehydes.

Draw a labelled diagram to show how you would set up apparatus for distillation.

[2]

The presentation of many candidates' diagrams in questions such as this one requires improvement.

The mark scheme was generous, requiring to first see that a candidate knew what distillation is.

A first mark was given for a set up comprising a flask connected to a roughly horizontal condenser.

There had to be no gap above the condenser and the overall set up could not be a closed system.

A second mark was given for minimal labels: condenser and correct direction of water flow.

Nearly half the candidates received no marks for their diagram with only just over a quarter being given both marks.

Typical errors included:

- a reflux set up
- open above the flask
- a closed system
- water flowing the wrong way
- the condenser labelled as condensation tube, cooling tube, cooling funnel, distiller, etc.

Less successful responses showed a conical flask, beaker or test tube being heated.

The best advice is to spend some time instructing students how to draw diagrams and to label the apparatus using the accepted scientific names. Students increasingly appear to be finding these questions challenging.

Assessment for learning

Practise the drawing of common organic apparatus as part of the practical work carried out for the practical endorsement.

Question 25 (d) (i)

(d) Alcohols can be prepared by the hydrolysis of haloalkanes with aqueous alkali.

(i) Write an equation for the hydrolysis of 2-bromo-2-methylpropane.

Show organic compounds as structures.

[2]

This question discriminated very well. Most candidates were given a first mark by showing correct structures for the organic reactant and its product, 2-methylpropan-2-ol.

The question asked for an equation for alkaline hydrolysis and candidates were expected to use an alkali. Acceptable responses would include NaOH/KOH and NaBr/KBr, or OH^- and Br^-. Equations including H_2O and HBr were not given marks, a common error for alkaline hydrolysis.

Candidates are advised to carefully read the requirements in the question. For the most successful responses, candidates often underline these to draw their attention.

Question 25 (d) (ii)

(ii) A student hydrolyses a chloroalkane, RC*l*, a bromoalkane, RBr, and an iodoalkane, RI.

For a fair comparison, the student has chosen the same R group for each haloalkane.

Predict, with a reason, the relative rates of hydrolysis of these three haloalkanes.

....

....

....

.... **[2]**

Candidates found this question difficult. Many fell into a trap of their own making by comparing the relative reactivities of the halogens chlorine, bromine and iodine and it was common to see responses claiming that a chloroalkane has the fastest rate and that an iodoalkane has the slowest rate. Only the most successful candidates related a correct order of reactivity to the different strengths of the carbon–halogen bond.

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Access to Scripts

We've made it easier for Exams Officers to download copies of your candidates' completed papers or 'scripts'. Your centre can use these scripts to decide whether to request a review of marking and to support teaching and learning.

Our free, on-demand service, Access to Scripts is available via our single sign-on service, My Cambridge. Step-by-step instructions are on our website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular professional development courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is a free test-building platform, providing unlimited users exclusively for staff at OCR centres with an Interchange account.

Choose from a large bank of questions to build personalised tests and custom mark schemes, with the option to add custom cover pages to simulate real examinations. You can also edit and download complete past papers.

Find out more.

Active Results

Review students' exam performance with our free online results analysis tool. It is available for all GCSEs, AS and A Levels and Cambridge Nationals (examined units only).

Find out more.

You will need an Interchange account to access our digital products. If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit
- **ocr.org.uk/qualifications/resource-finder**
- **ocr.org.uk**
- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT