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June 2025

Int Advanced Level Chemistry WCH11 01

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June 2025

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Introduction

The paper was accessible to the majority of candidates and produced a full range of marks. Candidates with a sound knowledge of the chemistry covered in this unit were able to score high marks. Q23 was about structure and bonding and worth a total of 21 marks, the average mark for this question was 10.95. Many parts of Q23 were aimed at all candidates. The mean mark for the paper was nearly 49 and Section A scored an average of over 14. Candidates of all abilities gained marks on Question 1 (atomic structure), Questions 3 and 11 (moles), Question 6 (mass spectrometer), Question 10 (atom economy), Question 17 (isomers), Question 21(a) (third ionisation) and Question 23(b)(ii) (dot and cross diagrams). The graphical Question 21(c)(i) was answered well by the majority of candidates. Some of the questions were more challenging, particularly the multi-step calculation (Q20(b)(iii)) and Questions 20(b)(iv) (drawing the two missing diethyl isomers of dodecane) and 23(b)(v) (differences in melting temperature between a simple molecule and a polymer).

It was noticeable that many candidates had lost marks as they did not read the question and so missed out on several marking points.

Question 20(a)

This question was aimed across the skill spectrum. The majority of candidates scored 3 of the 4 available marks. The final mark being lost for not converting cubic centimetres into cubic metres.

A full mark response.

SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

20 This question is about carbon dioxide.

(a) According to data from 2021, there are 415 ppm of carbon dioxide in the atmosphere by volume.

Calculate the moles of carbon dioxide present in 1.00 m^3 of air at 20.0 °C and 101 kPa.

[Ideal gas equation $pV = nRT$
$R = 8.31\ J\ mol^{-1}\ K^{-1}$]

(4)

$101\,000 \times 1 = n \times 8.31 \times 293$

$n = \frac{101\,000 \times 1}{8.31 \times 293} = 41.48$ moles of air

$\frac{n}{41.48} \times 10^6 = 415$

~~n = 0.017~~

$n = \frac{415}{10^6} \times 41.48 = 0.017$ moles

Examiner Comments

The candidate has laid out the calculation in an easy-to-follow manner. All units correctly converted and the ideal gas equation rearranged appropriately. Final answer rounded correctly.

One of the many ways to score three marks.

SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

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(a) According to data from 2021, there are 415 ppm of carbon dioxide in the atmosphere by volume.

Calculate the moles of carbon dioxide present in 1.00 m^3 of air at 20.0 °C and 101 kPa.

[Ideal gas equation $pV = nRT$
$R = 8.31\ J\,mol^{-1}\,K^{-1}$]

(4)

Vgas

$PV = nRT$

$n = \frac{PV}{RT}$

$n = \frac{101 \times 10^3 \times 1}{293 \times 8.31}$

$n = 41.48$ moles.

ResultsPlus
Examiner Comments

In this clip the candidate did not convert the 415 ppm into cubic metres.

SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

20 This question is about carbon dioxide.

(a) According to data from 2021, there are 415 ppm of carbon dioxide in the atmosphere by volume.

Calculate the moles of carbon dioxide present in $1.00\,m^3$ of air at 20.0 °C and 101 kPa.

[Ideal gas equation $pV = nRT$
$R = 8.31\,J\,mol^{-1}\,K^{-1}$]

(4)

Temperature = 20°C

Preassure = 101kPa

Carbon present in Air = 415ppm

$R = 8.31\,J\,mol^{-1}\,K^{-1}$

$$n = \frac{pV}{RT}$$

$$= \frac{101\,kPa \times 1}{8.31\,J\,mol^{-1}\,K^{-1} \times 148\,K}$$

$$\boxed{n = 0.082\,mol}$$

ResultsPlus
Examiner Comments

In this clip the candidate did not correctly convert either the temperature or the volume, but they have used the ideal gas equation correctly and evaluated their answer.

Question 20(b)i

This question was brought from an essentially GCSE level to first year A level by the requirement to mention an excess of oxygen or sufficient oxygen to burn the fuel. The products of combustion were not required as a full balanced equation was needed to answer the next question and the production of carbon dioxide was given in the question stem.

(b) Dodecane $C_{12}H_{26}$, is found in kerosene and forms carbon dioxide during its complete combustion.

(i) State what is meant by complete combustion.

(1)

It is when a Compound reacts with exess oxygen to form Carbon dioxide and water

ResultsPlus Examiner Comments

A fully correct response.

Question 20(b)ii-iii

This question was again spread across the skills spectrum, with some marks accessible by all candidates.

Q20(b)(ii) was balancing an equation for the complete combustion of dodecane including state symbols. Many candidates were able to balance but several lost the state symbol mark, with dodecane labelled as (g), (s) and occasionally (aq).

Q20(b)(iii) was a multi-step calculation. All the operations involved either multiplication or division and consequently the order of the operations did not affect the final value.

(ii) Write a balanced equation for the complete combustion of dodecane, $C_{12}H_{26}$.

Include state symbols.

(2)

$$C_{12}H_{26}(l) + 18.5\,O_2(g) \rightarrow 12CO_2(g) + 13H_2O(l)$$

(iii) Kerosene is used as aeroplane fuel. A jet plane can carry a maximum of 800 passengers and uses 11 400 dm^3 of fuel per hour.

Calculate the mass, in kg, of carbon dioxide emitted from the engine per passenger on a full flight from Sydney to Hong Kong, flight time 9 hours 15 minutes.

Give your answer to three significant figures.
[Assume kerosene consists solely of $C_{12}H_{26}$

Density of dodecane = 0.749 g cm^{-3}]

(6)

$$9.25 \times 11400 = 105450 \text{ dm}^3$$

$$\frac{105450 \text{ dm}^3}{800} = 131.8125 \text{ dm}^3$$

$$131.8125 \times 1000 = 131812.5 \text{ cm}^3$$

$$0.749 \times 131812.5 = 98727.56 \text{ g}$$

$$\frac{98727.56}{12 \times 12 + 26} = 580.75 \text{ mol}$$

$$580.75 \times 12 = 6969 \text{ mol}$$

$$6969 \times (12 + 16 \times 2) = 306636 \text{ g}$$

$$= 306.6 \text{ kg}$$

$$\approx 307 \text{ kg}$$

ResultsPlus
Examiner Comments

A fully correct response for both Q20(b)(ii) and Q20(b)(iii).

(ii) Write a balanced equation for the complete combustion of dodecane, $C_{12}H_{26}$.

Include state symbols.

(2)

$C_{12}H_{16\,(aq)} + 16O_{2\,(g)} \longrightarrow 12CO_{2\,(g)} + 8H_2O_{(l)}$

(iii) Kerosene is used as aeroplane fuel. A jet plane can carry a maximum of 800 passengers and uses 11 400 dm^3 of fuel per hour.

Calculate the mass, in kg, of carbon dioxide emitted from the engine per passenger on a full flight from Sydney to Hong Kong, flight time 9 hours 15 minutes.

Give your answer to three significant figures.
[Assume kerosene consists solely of $C_{12}H_{26}$

Density of dodecane = 0.749 g cm^{-3}]

$\frac{m}{D \mid v}$

$\frac{m}{n \mid mr}$

(6)

M of Kerosene = 0.749 × 11 400 000 cm^3
= 8538600 g

n of Kerosene = $\frac{8538600}{170}$
= 50227.058 g/mol

n of CO_2 = 50227.058 × $\frac{12}{1}$
= 602724.7059 g/mol

m of CO_2 = 602724.7059 × (12+16+16)
= 26519887.06 g
or

1 hour CO_2 mass → 26519.88 Kg

9 h 15 m = ~~26519.88 × 9.~~
~~238678.98~~
~~238678.98×~~
= 26519.88 × 9.25
= 245308.89 KG

1 passenger = $\frac{245308.89}{800}$
= 306.6 Kg

of CO_2 emitted for the full flight.

ResultsPlus
Examiner Comments

Q20(b)(ii) – the clip shows 'dodecane' state symbol as (aq). The clip also shows that there was an error copying from the question, consequently the equation has not been correctly balanced. Q20(b)(iii) – the clip shows an appropriately laid out calculation, with the only error being the not rounding to three significant figures as asked for in the question.

ResultsPlus
Examiner Tip

Ensure that the question is read carefully and the stem information is correctly utilised in the answer.

(ii) Write a balanced equation for the complete combustion of dodecane, $C_{12}H_{26}$.

Include state symbols.

(2)

~~$50_2(g) + C_{12}H_{26}(s) \rightarrow 13H_2O(g) + 12CO_2(g)$~~

$25\,O_2(g) + C_{12}H_{26}(s) \longrightarrow 13H_2O(g) + 12CO_2(g)$

(iii) Kerosene is used as aeroplane fuel. A jet plane can carry a maximum of 800 passengers and uses 11 400 dm^3 of fuel per hour.

Calculate the mass, in kg, of carbon dioxide emitted from the engine per passenger on a full flight from Sydney to Hong Kong, flight time 9 hours 15 minutes.

Give your answer to three significant figures.
[Assume kerosene consists solely of $C_{12}H_{26}$

Density of dodecane = 0.749 g cm^{-3}]

(6)

$9\frac{1}{4} \times 11400 = 105450\ dm^3$

$105450 \times 10^3 \times 0.749 = 78982050.$

ResultsPlus
Examiner Comments

In this clip only two of the six operations have been carried out. The total volume of fuel has been calculated (x 9.25) and the total mass of fuel has been calculated (x 0.749). So two marks awarded.

ResultsPlus
Examiner Tip

It is always worth trying to answer the question, even if the entire calculation cannot be completed.

Question 20(b)iv

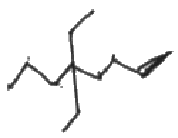
This question was aimed at the most able candidates. In order to answer the question, it was necessary to realise that the ethyl branches had to be placed on at least the third carbon in from either end, otherwise they were just increasing the carbon chain length.

(iv) The formula $C_{12}H_{26}$ represents many isomers, including six diethyloctanes.
The names of four of these diethyloctanes are

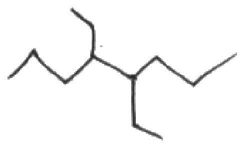
3,3-diethyloctane, 3,4-diethyloctane, 3,5-diethyloctane,
3,6-diethyloctane.

Draw the **skeletal** formulae of the remaining two diethyloctanes.

(2)



4,4-diethyloctane



4,5-diethyloctane

(Total for Question 20 = 15 marks)

ResultsPlus
Examiner Comments

A fully correct response. The clip shows that names have been included, they were not necessary for the mark and were ignored even if incorrect.

ResultsPlus
Examiner Tip

While the names were not required in this question it can be a useful way to check that isomers have been drawn.

(iv) The formula $C_{12}H_{26}$ represents many isomers, including six diethyloctanes. The names of four of these diethyloctanes are

3,3-diethyloctane, 3,4-diethyloctane, 3,5-diethyloctane, 3,6-diethyloctane.

Draw the **skeletal** formulae of the remaining two diethyloctanes.

(2)

(Total for Question 20 = 15 marks)

ResultsPlus
Examiner Comments

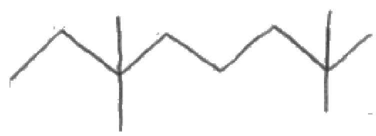
This clip shows a 12 carbon chain with ethyl side groups, so not isomers of dodecane.

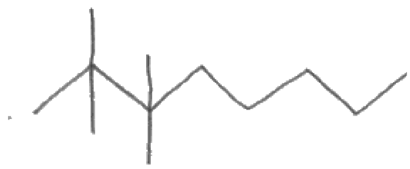
(iv) The formula $C_{12}H_{26}$ represents many isomers, including six diethyloctanes. The names of four of these diethyloctanes are

3,3-diethyloctane, 3,4-diethyloctane, 3,5-diethyloctane, 3,6-diethyloctane.

Draw the **skeletal** formulae of the remaining two diethyloctanes.

(2)





(Total for Question 20 = 15 marks)

ResultsPlus
Examiner Comments

The clip shows two tetra methyl isomers.

ResultsPlus
Examiner Tip

Ensure that the question has been read carefully.

Question 21(a)

A 'simple' question accessible to the majority of candidates and most candidates did score all three marks.

21 This question is about ionisation energy.

(a) Write the equation for the third ionisation energy of calcium.

Include state symbols.

(3)

$$Ca \rightarrow 2\bar{e} + Ca^{2+}$$

ResultsPlus
Examiner Comments

The clip shows calcium starting as an atom losing two electrons and forming a doubly charged positive calcium ion. No state symbols are given. No marks awarded.

21 This question is about ionisation energy.

(a) Write the equation for the third ionisation energy of calcium.

Include state symbols.

(3)

$Ca_{(g)} \rightarrow Ca^{+}_{(g)} + e^{-}$

$Ca^{+}_{(g)} \rightarrow Ca^{2+}_{(g)} + e^{-}$

$Ca^{2+}_{(g)} \rightarrow Ca^{3+} + e^{-}$

ResultsPlus
Examiner Comments

The first marking point is not scored as this is a list. The second marking point can be scored as they have correctly balanced all 3 ionisation equations. The third marking point is not scored as the gas state symbol is missing from line 3.

ResultsPlus
Examiner Tip

It is best not to give an array of answers. Any 'working' should be struck through, so that the final answer is obvious to the examiner.

Question 21(b)i

This question was aimed at the more able candidates and just over half the cohort scored both marks. Most candidates did identify the 'big jump' from 6 to 7 but then gave the element from another period. Period three was given in the stem of the question.

(b) (i) The following data show the first seven ionisation energies for an element in Period 3. Deduce, with a reason, the identity of the element.

(2)

Ionisation number	1	2	3	4	5	6	7
Energy / kJ mol^{-1}	1000	2251	3361	4564	7012	8496	27107

Sulfur. Because there are a huge jump between the 6th and 7th ionisation energy. So it has 6 electron in it's outer shell. So it need a large amount of energy to remove the 7th electron from it's stable inner shell.

ResultsPlus
Examiner Comments

A fully correct response.

(b) (i) The following data show the first seven ionisation energies for an element in Period 3. Deduce, with a reason, the identity of the element.

(2)

Ionisation number	1	2	3	4	5	6	7
Energy / kJ mol^{-1}	1000	2251	3361	4564	7012	8496	27107

There is a large jump between 6th & 7th ionization energy, this means it has 6 valence electrons in outer shell, so selenium

ResultsPlus
Examiner Comments

Correct identification of the 'big jump', but the element given as selenium in period 4.

ResultsPlus
Examiner Tip

Ensure that the entire question has been read carefully.

Question 21(b)ii

A question aimed to be accessible to all candidates, with the vast majority scoring this mark.

(ii) State the general trend in first ionisation energies across Period 3.

(1)

Increasing trend.

ResultsPlus Examiner Comments

A fully correct response.

(ii) State the general trend in first ionisation energies across Period 3.

(1)

First ionisation energies reduce as you go across the period because of the electron to electron repulsion involve in the outermost shell of an element

ResultsPlus Examiner Comments

The clip shows a quite verbose and incorrect response.

ResultsPlus Examiner Tip

Check the number of marks available for a response.

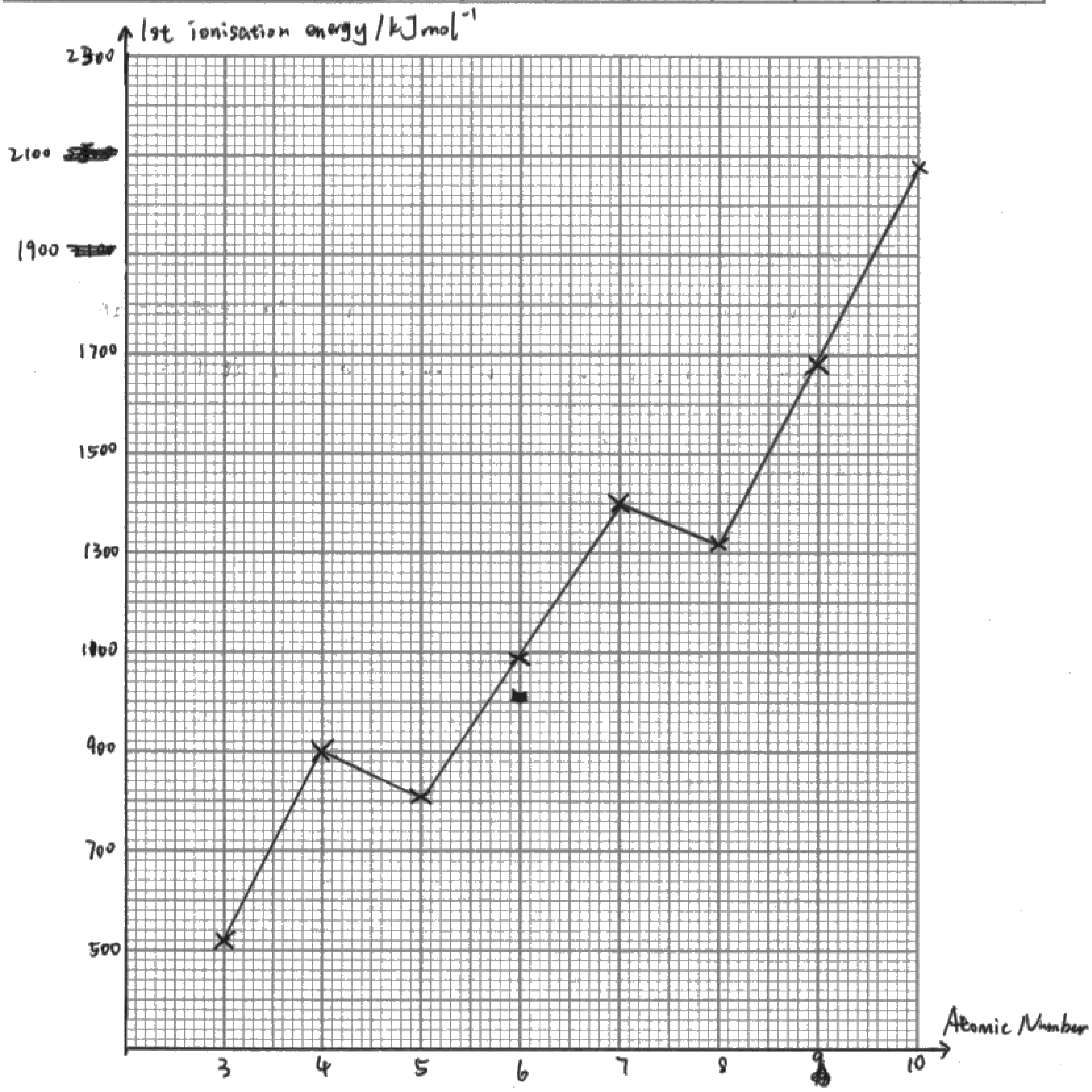
Question 21(c)i

This question was aimed to be accessible to nearly all candidates. It tested the candidate's ability to draw a graph. There were several very poor choices of scale and this made plotting more difficult for the candidates. There were also non-linear scales and this meant it was not possible to award either the scale or plotting marks. Lines were not required on the graph.

(c) (i) Plot the following first ionisation energies of the elements in Period 2 on the grid below.

(3)

Element	Li	Be	B	C	N	O	F	Ne
1st ionisation energy / kJ mol^{-1}	520	900	801	1086	1402	1314	1681	2081



Examiner Comments

M1 – the axes are labelled correctly, although in an odd place and the atomic number has been used instead of the chemical symbol on the x axis. M2 – they have used a scale that covers half the grid and sensibly a 0 has not been written at the bottom of the y axis. M3 – they have plotted the data correctly.

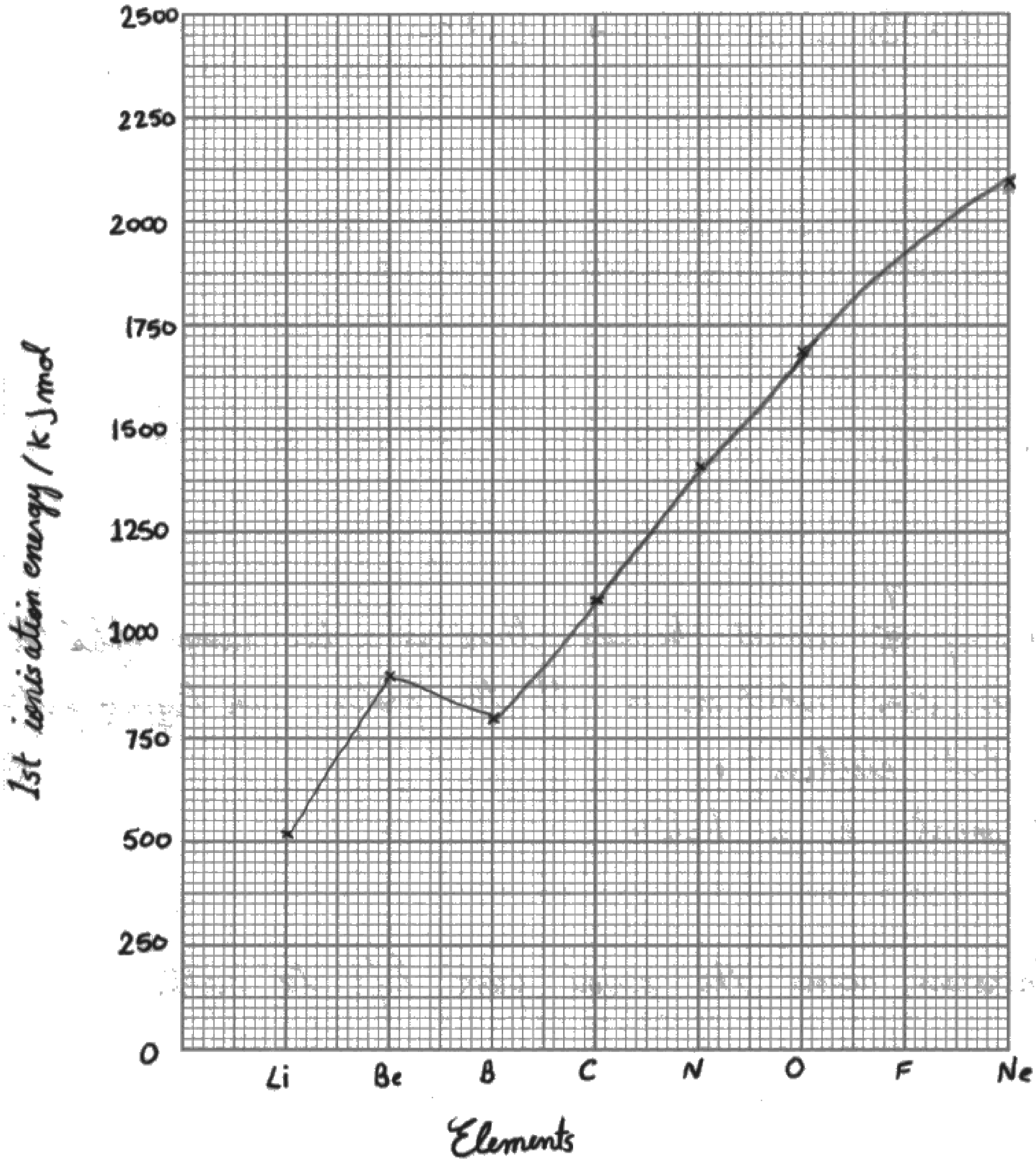
Examiner Tip

Not putting 0 at the bottom of the y axis means this is a linear scale.

(c) (i) Plot the following first ionisation energies of the elements in Period 2 on the grid below.

(3)

Element	Li	Be	B	C	N	O	F	Ne
1st ionisation energy / kJ mol^{-1}	520	900	801	1086	1402	1314	1681	2081



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Examiner Comments

The clip shows a graph with labelled axes and units on the y axis and a scale that covers over half the grid. The plotting mark has been lost.

Question 21(c)ii

This question required an explanation straight from the specification (2.10), so should have been accessible to most candidates but just over half the cohort scored no marks at all for this item.

(ii) Explain the difference in first ionisation energies between beryllium and boron.

(2)

The electron removed during the 1st ionization of Be is from the s orbital, while the electron removed ~~during~~ during the 1st ionization of B is from the p orbital which is at a higher energy level than the s ~~M~~ orbital. Therefore, needing less ~~energy~~ energy to remove.

ResultsPlus
Examiner Comments

A fully correct response.

(ii) Explain the difference in first ionisation energies between beryllium and boron.

(2)

Boron's outermost electron is in the $2p_x^1$ orbital. This means it is further away from the nucleus, hence easier to remove despite boron's higher proton number.

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Examiner Comments

In the clip only boron has been discussed when the question asked for the difference between boron and beryllium. So the first marking point cannot be awarded. The second marking point cannot be awarded as "further away from the nucleus" was not enough to score the mark.

ResultsPlus
Examiner Tip

Ensure that the response given fully answers the question asked.

Question 21(c)iii

Another question straight from the specification (2.10), and again marks should have been accessible to all candidates. Just under half the cohort scored one of the two marks available.

(iii) Explain the difference in first ionisation energies between carbon and nitrogen.

(2)

Nitrogen have more ionisation energy than Carbon because Nitrogen have more electrons than Carbon and Nitrogen have a smaller ionic radius than Carbon

(Total for Question 21 = 13 marks)

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Examiner Comments

In this clip there has been no mention of the increased number of protons for nitrogen and no mention of electrons being removed from the 2p sub-shell or orbital.

Question 22(a)

Over half the cohort scored the mark for this question. The candidates were asked to name the reaction type and mechanism for the reaction between alkanes and halogens.

22 This question is about alkanes and halogens.

Alkanes can react with halogens to form halogenoalkanes.

(a) Name the type and mechanism for the reaction between halogens and alkanes.

(1)

Free radical ~~substution~~ subsitution

ResultsPlus
Examiner Comments

A fully correct response.

22 This question is about alkanes and halogens.

Alkanes can react with halogens to form halogenoalkanes.

(a) Name the type and mechanism for the reaction between halogens and alkanes.

(1)

electrophilic substitution

ResultsPlus
Examiner Comments

While substitution is correct, the electrophilic is wrong.

22 This question is about alkanes and halogens.

Alkanes can react with halogens to form halogenoalkanes.

(a) Name the type and mechanism for the reaction between halogens and alkanes.

(1)

electrophidic addition

ResultsPlus
Examiner Comments

No part of this response is correct.

Question 22(b)i

Over 60% of the cohort scored both marks for this question.

(b) Chlorine reacts with butane. C_4H_{10}

(i) Give the equation for the initiation step.

Include appropriate arrows and electrons.

(2)

$$Cl-Cl \rightarrow Cl^{\bullet} + Cl^{\bullet}$$

ResultsPlus
Examiner Comments

A fully correct response, showing two 'fish hook' arrows from the chlorine to chlorine bond and balanced with two chlorine radicals as the product.

(b) Chlorine reacts with butane.

(i) Give the equation for the initiation step.

Include appropriate arrows and electrons. **(2)**

$\cdot$ ~~Cl + C_4H_{10} → $C_4H_{10}Cl$~~

$\cdot Cl + \cdot Cl \rightarrow Cl_2$

$2Cl + e^- \rightarrow Cl_2$

ResultsPlus
Examiner Comments

The clip shows a termination step, rather than an initiation step.

ResultsPlus
Examiner Tip

Ensure that the question has been read carefully.

Question 22(b)ii

Over half the cohort scored both marking points. Some had not read the question and gave the propagation steps for the reaction with methane, rather than the butane asked for in the question.

(ii) Give an equation for each of the first two propagation steps.

(2)

First propagation step

$CH_4 + Cl^{\bullet} \rightarrow CH_3Cl + H$

Second propagation step

$CH_3^{\bullet} + Cl_2 \rightarrow CH_3Cl + Cl$

ResultsPlus
Examiner Comments

In this clip methane is used instead of butane. In the first step a hydrogen radical has been formed. The second step is correct for methane but not for butane. Note the radical dots were assessed in Q22(b)(i).

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Examiner Tip

Ensure that the information given in the stem of the question is used.

(ii) Give an equation for each of the first two propagation steps.

(2)

First propagation step

$C_4H_{10} + Cl^{\bullet} \rightarrow C_4H_9^{\circ} + HCl$

Second propagation step

$C_4H_9^{\circ} + Cl_2 \rightarrow C_4H_9Cl + Cl^{\bullet}$

ResultsPlus
Examiner Comments

A fully correct response.

Question 22(b)iii

In this question a specific termination product was required – namely an alkane. Over half the cohort scored this mark.

(iii) Give the equation for the termination step to form an alkane.

(1)

$C_4H_9\bullet + C_4H_9\bullet \rightarrow C_8H_{18}$

ResultsPlus
Examiner Comments

A fully correct response.

(iii) Give the equation for the termination step to form an alkane.

(1)

$\bullet C_4H_7 + \bullet C_4H_7 \rightarrow C_8H_{14}$

ResultsPlus
Examiner Comments

These are not butyl radicals.

(iii) Give the equation for the termination step to form an alkane.

(1)

$C_4H_9\cdot + Cl\cdot \rightarrow C_4H_9Cl$

ResultsPlus
Examiner Comments

The product is not an alkane.

ResultsPlus
Examiner Tip

Ensure that the question has been read carefully.

Question 22(c)

A percentage yield question, accessible to all candidates with over half the cohort scoring all three marks.

(c) Calculate the percentage yield if 1.00 g of trichlorobutane is produced from 10.0 g butane using the overall equation shown.

$$C_4H_{10} + 3Cl_2 \rightarrow C_4H_7Cl_3 + 3HCl$$

(3)

mols = $\frac{10.0g}{(4(12)+10)}$ moles $= \frac{5}{29}$ moles

mole ratio = 1 : 1

moles of $C_4H_7Cl_3 = \frac{5}{29}$ mol

mass = $\frac{5}{29} \times (4(12) + 7 + 3(35.5))$

mass = 27.8 g

Perectange ~~yield~~ yeild = $\frac{1}{27.8} \times 100$

Percentage yield = 3.6%

ResultsPlus
Examiner Comments

A fully correct response.

(c) Calculate the percentage yield if 1.00 g of trichlorobutane is produced from 10.0 g butane using the overall equation shown.

$$C_4H_{10} + 3Cl_2 \rightarrow C_4H_7Cl_3 + 3HCl$$

(3)

$$\% \text{ yeild} = \frac{(12\times4)+(1\times7)+(3\times35.5)}{\cancel{(12\times4)+(3(35.5\times2))}\ \ 161.5 + 109.5} \times 100$$

$$= \frac{161.5\times100}{\cancel{270}\ 271}$$

$$= 59$$

ResultsPlus
Examiner Comments

The clip shows a response where the atom economy has been calculated instead of the percentage yield.

Question 22(d)

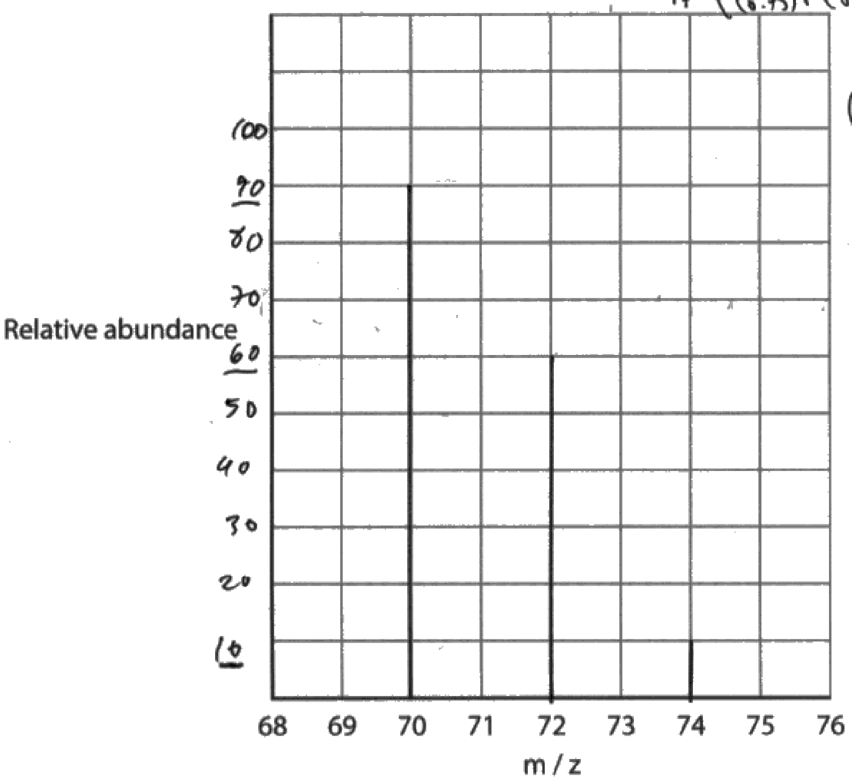
Just over a third of the cohort scored both marks for this question on the application of isotopic abundance.

(d) Chlorine can be analysed in a mass spectrometer. On the grid shown, draw the spectrum you would expect to see for the molecular ion peaks for a chlorine molecule, Cl_2.

Isotopic abundances ^{35}Cl 75% ^{37}Cl 25%

	35	37
35	$(0.75)^2$	$(0.25)(0.75)$
37	$(0.25)(0.75)$	$(0.25)^2$

(2)



(70 | 72 | 74)
9 : 6 : 1
×10
90 : 60 : 10

(Total for Question 22 = 11 marks)

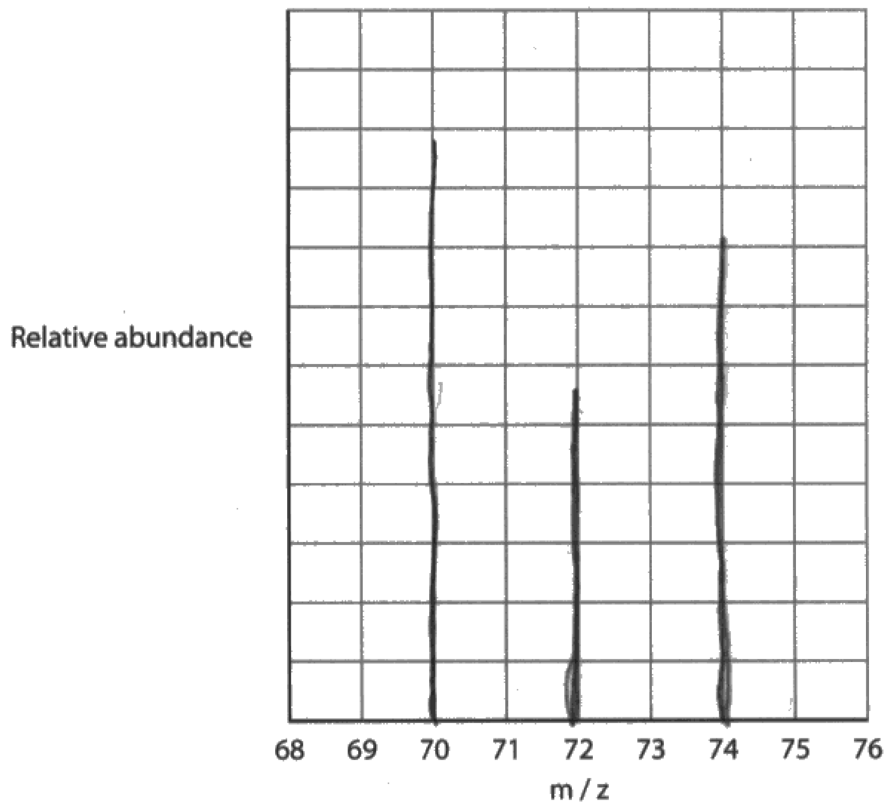
ResultsPlus
Examiner Comments

A fully correct response.

(d) Chlorine can be analysed in a mass spectrometer. On the grid shown, draw the spectrum you would expect to see for the molecular ion peaks for a chlorine molecule, Cl_2.

Isotopic abundances ^{35}Cl 75% ^{37}Cl 25%

(2)



(Total for Question 22 = 11 marks)

ResultsPlus
Examiner Comments

One mark scored for the lines drawn at the correct m/z values. The ratio mark is not scored as the lines are not shown to be in the ratio 9:6:1.

Question 23(a)i

This question was about the description of ionic bonding and was aimed to be accessible by all candidates. Over 60% of the cohort scored this mark.

23 This question is about structure and bonding.

(a) Ionic bonding occurs between metals and non-metals.

(i) Describe ionic bonding.

(1)

Electrostatic attraction between positive metal cations and negative non-metal anions.

ResultsPlus Examiner Comments

In this response the mark scheme was looking for attraction between oppositely charged ions.

23 This question is about structure and bonding.

(a) Ionic bonding occurs between metals and non-metals.

(i) Describe ionic bonding.

(1)

Electrostatic force between two oppositely charged ions.

ResultsPlus Examiner Comments

The word attraction has not been included, no mark awarded.

23 This question is about structure and bonding.

(a) Ionic bonding occurs between metals and non-metals.

(i) Describe ionic bonding.

(1)

Ionic Bonding is Bonding Between Non-Metal and metals forming positive ions (cations) and negative ions (anions). it involves one atom giving a electron to another in order for it to be stable.

ResultsPlus
Examiner Comments

The clip shows a detailed description of how ions are formed but no mention of attraction between the ions once formed.

Question 23(a)ii

The question was aimed at most of the candidates, but just under half of the cohort scored no marks for this question. They mostly failed to mention ions in the answer, to a question about ionic bonding.

(ii) Explain why the ionic bonding in magnesium fluoride might be expected to be stronger than the ionic bonding in sodium fluoride.

(2)

Mg^{2+} ions have a greater charge than Na^+ ions so would form stronger ionic bonds. Mg^{2+} ions also have a smaller ionic radius due to ~~more~~ greater charge increasing electrostatic force of attraction with Fluride ions.

ResultsPlus
Examiner Comments

A fully correct response.

(ii) Explain why the ionic bonding in magnesium fluoride might be expected to be stronger than the ionic bonding in sodium fluoride.

(2)

Magnesium ions have a charge of +2, which is larger than the charge of sodium ions which is +1. Hence Mg^{2+} cation has a higher polarising power and distorts the F^- ~~an~~ electron cloud more towards itself, so more energy is required to break the bond.

ResultsPlus
Examiner Comments

The clip shows a response where the greater charge on the magnesium ion has been scored but it does not mention the relative sizes of the sodium and magnesium ions.

(ii) Explain why the ionic bonding in magnesium fluoride might be expected to be stronger than the ionic bonding in sodium fluoride.

(2)

Magnesium fluoride, has more number of electrons than sodium fluoride so greater electrostatic forces of attraction in magnesium fluoride. Hence stronger ionic bonding.

ResultsPlus
Examiner Comments

Ions are not mentioned at all in this clip, so no indication of why the electrostatic forces are stronger.

Question 23(a)iii

This question was aimed at all candidates and over 50% of the cohort scored both marks.

(iii) Sodium and oxygen react to form sodium oxide, which is also ionic.
Draw the dot-and-cross diagram showing the ions present in sodium oxide.

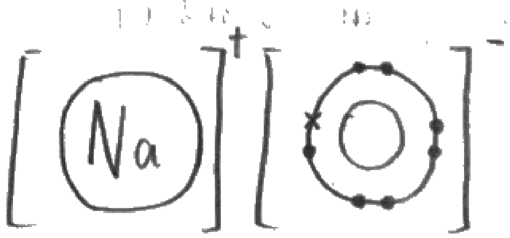
(2)

ResultsPlus
Examiner Comments

A fully correct response.

(iii) Sodium and oxygen react to form sodium oxide, which is also ionic.
Draw the dot-and-cross diagram showing the ions present in sodium oxide.

(2)



ResultsPlus
Examiner Comments

Sodium ion is correct. This could be shown as here with no electrons on the shell or showing all eight electrons. A single sodium ion is allowed. The oxide ion is incorrect, showing only one electron from elsewhere and with a single minus charge.

ResultsPlus
Examiner Tip

Dot and cross diagrams should be learned.

(iii) Sodium and oxygen react to form sodium oxide, which is also ionic.
Draw the dot-and-cross diagram showing the ions present in sodium oxide.

(2)

Na O_2

ResultsPlus
Examiner Comments

The clip shows both the sodium and oxide ions drawn correctly, but neither have a charge on them. One mark scored only.

ResultsPlus
Examiner Tip

Include correct charges on ions.

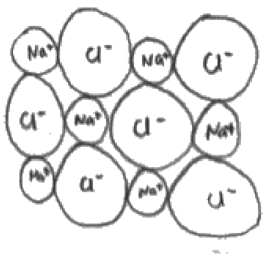
Question 23(a)iv

Over 40% of the cohort scored no marks for this question, which proved to be a good differentiator.

(iv) Draw the ionic lattice for sodium chloride.

You should show at least nine ions.

(2)



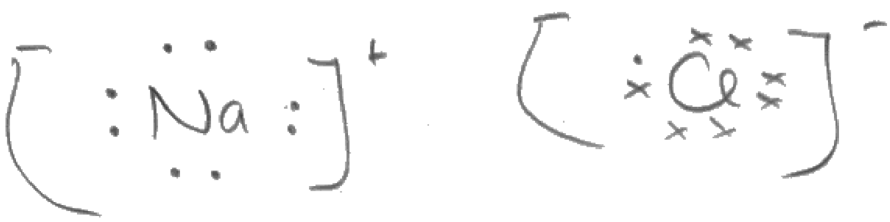
ResultsPlus
Examiner Comments

A fully correct response, even with the correct relative sizing of the ions.

(iv) Draw the ionic lattice for sodium chloride.

You should show at least nine ions. NaCl

(2)



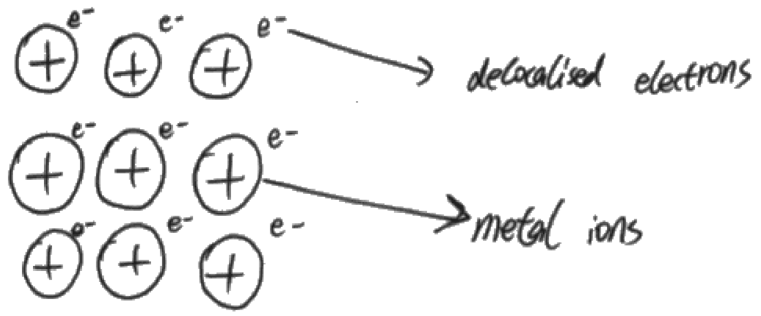
ResultsPlus
Examiner Comments

The clip does not show a lattice of nine ions. So, this did not score any marks.

(iv) Draw the ionic lattice for sodium chloride.

You should show at least nine ions.

(2)



ResultsPlus
Examiner Comments

This clip shows a metallic lattice rather than an ionic lattice.

Question 23(b)i

This question was aimed at all candidates, but over 50% failed to score this mark.

(b) Non-metal atoms join together using covalent bonds.

(i) Describe covalent bonding.

(1)

The electrostatic attraction between the shared pair of electron and the positive nuclei.

ResultsPlus
Examiner Comments

A fully correct response. This time not only was attraction required but it was also necessary to mention the shared pair of electrons.

(b) Non-metal atoms join together using covalent bonds.

(i) Describe covalent bonding.

(1)

covalent bonding involves the sharing of electrons between two non-metals without complete electron transfer.

ResultsPlus
Examiner Comments

The clip does not mention attraction, nor a shared pair of electrons.

Question 23(b)ii

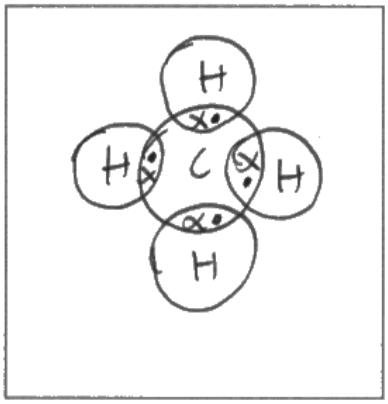
Three quarters of the cohort scored all three marks for this question.

(ii) Methane, ammonia and water are covalently bonded compounds.

Draw the dot-and-cross diagrams for the molecules of methane (CH_4), ammonia (NH_3) and water (H_2O).

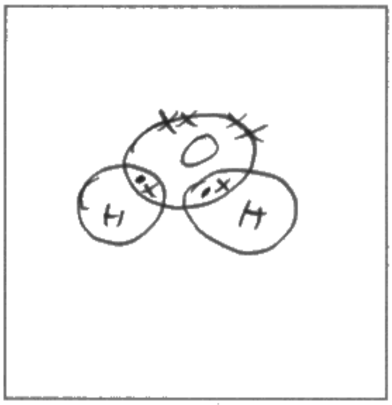
(3)

methane



ammonia

water



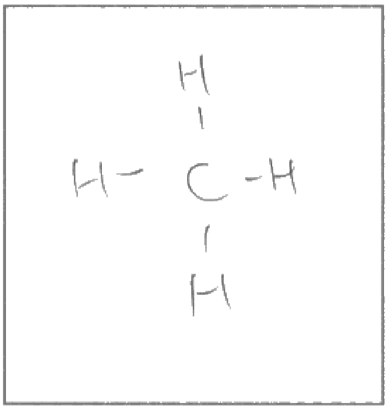
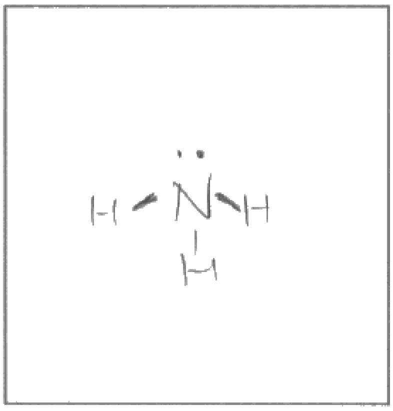
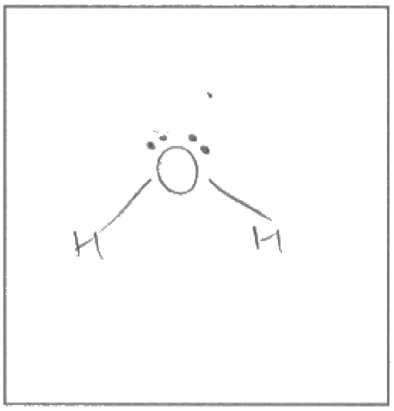
ResultsPlus
Examiner Comments

A fully correct response.

(ii) Methane, ammonia and water are covalently bonded compounds.

Draw the dot-and-cross diagrams for the molecules of methane (CH_4), ammonia (NH_3) and water (H_2O).

(3)

methane	ammonia	water
		

ResultsPlus
Examiner Comments

While the diagrams are correct for stick diagrams, they do not show dot and cross diagrams.

ResultsPlus
Examiner Tip

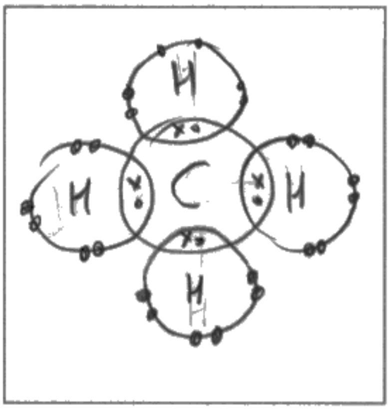
Ensure that the instructions in the question have been carried out.

(ii) Methane, ammonia and water are covalently bonded compounds.

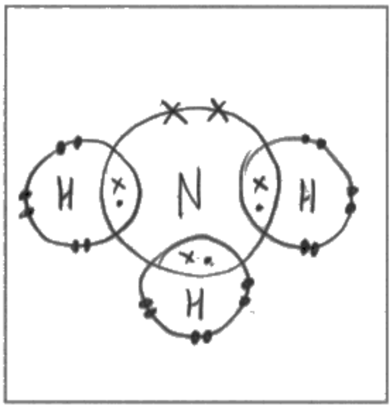
Draw the dot-and-cross diagrams for the molecules of methane (CH_4), ammonia (NH_3) and water (H_2O).

(3)

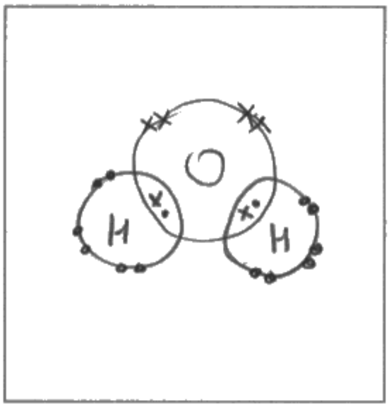
methane



ammonia



water



ResultsPlus
Examiner Comments

At first glance this clip appears to be correct. However, all the hydrogens are shown with an additional six electrons. So, no mark scored.

ResultsPlus
Examiner Tip

Hydrogen is in the first period and only has one electron.

Question 23(b)iii

Over 40% of the cohort scored all three marks for this question. It should have been accessible to most candidates.

(iii) The three molecules (methane, ammonia and water) each have a different shape. Complete the table below.

(3)

molecule	shape	bond angle
methane	tetrahedral	109.5°
ammonia	trigonal pyramidal	107°
water	V-shape	104.5°

ResultsPlus Examiner Comments

A fully correct response.

(iii) The three molecules (methane, ammonia and water) each have a different shape. Complete the table below.

(3)

molecule	shape	bond angle
methane	triyohal planer	~~180°~~ 90°
ammonia	triyohal planur	~~90°~~ 180°
water	liner	104.5°

ResultsPlus
Examiner Comments

The clip shows an incorrect response, neither methane nor ammonia are trigonal planar, and only the bond angle for water is correct. No marks scored.

ResultsPlus
Examiner Tip

The molecules given here are the ones mentioned in the specification and should be well known to all candidates.

Question 23(b)iv

This was aimed at the more able candidates and over 30% of the cohort scored at least one mark for this explanation of molecular shape question.

(iv) Explain the differences between the molecular shapes and bond angles for ammonia and water.

(2)

Ammonia have 3 bonding pairs of electrons and 1 ~~pair~~ lone pair of electrons. Water have 2 bonding pairs of electrons and 2 lone pair of electrons. Lone pair - lone pair repulsion is more than bond pair - lone pair repulsion so water has bond angle of 104.5 and ammonia has 107°. ~~the~~ Bond pair of electrons seperate further apart to minimize repulsion.

ResultsPlus
Examiner Comments

A fully correct response. The different numbers of lone pairs is given and the greater repulsion of lone pairs is mentioned.

(iv) Explain the differences between the molecular shapes and bond angles for ammonia and water.

(2)

Water has 2 bond pairs around central Hydrogen atom, bonded with two oxygen atoms. Oxygen has 6 lone pairs. Ammonia has 3 bond pairs around central Nitrogen atom and one lone pair. Maximum seperation minimum repulsion.

ResultsPlus
Examiner Comments

This clip shows a very confused response, indicating that water has two oxygen atoms and only one hydrogen atom. The bit about ammonia is correct but does not explain the different shapes of the molecules.

Question 23(b)v

This question was aimed at the most able candidates. Just under a quarter scored one of the two marks available.

(v) Ethene and poly(ethene) have different melting temperatures.

Molecule	Melting temperature (K)
ethene	104.1
poly(ethene)	400

Explain why their melting temperatures are different.

(2)

Poly(ethene) is a polymer, and consists of many strong covalent bonds that need ~~a~~ a lot of energy to be broken, whereas ethene has weak intermolecular forces that require less energy to overcome

ResultsPlus
Examiner Comments

In the clip the response mentions that poly(ethene) is a polymer but then states that the covalent bonds are broken on melting. Ethene has weak intermolecular forces but does not mention that ethene is a simple molecule. The emboldened parts scored 1 mark.

(v) Ethene and poly(ethene) have different melting temperatures.

Molecule	Melting temperature (K)
ethene	104.1
poly(ethene)	400

Explain why their melting temperatures are different.

(2)

Ethene has only two Carbon atoms and a double bond (p-bond) ~~with~~ which is not very Strong, whereas poly(ethene) has more Carbons than ethene which makes is stronger so more energy is needed to break the bonds and therefore melt the molecule.

ResultsPlus
Examiner Comments

This clip scores 0 marks as it is stating that the covalent bonds are broken on melting.

Question 23(c)i

This question was aimed at all candidates and over half of the cohort scored the mark.

(c) Metals are held together by metallic bonding.

(i) Describe metallic bonding.

(1)

The electrostatic forces of attraction between positive metal ions and the sea of delocanized electrons

ResultsPlus
Examiner Comments

A fully correct response.

(c) Metals are held together by metallic bonding.

(i) Describe metallic bonding.

(1)

Force of attraction between cations and sea of delocalised electrons

ResultsPlus
Examiner Comments

No marks awarded as there is no mention of electrostatic.

Question 23(c)ii

This question about metallic bonding was aimed at all candidates, just over 40% of the cohort scored one mark for this question.

(ii) Metals conduct electricity when solid.

Explain, with the aid of a diagram, why copper conducts electricity.

(2)

becase they have negtive decloised ~~s~~ electrons

(Total for Question 23 = 21 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

ResultsPlus
Examiner Comments

The clip show what appears to be an ionic lattice rather than a metallic lattice. There is no mention of the delocalised electrons being able to move.

ResultsPlus
Examiner Tip

Know the difference between the different types of lattices.

Paper Summary

Based on their performance on this paper, candidates should:

- Read the question carefully.
- Include labels in calculations so that you can follow your working.
- Make you final answer obvious.
- Round to the correct number of figures and include the correct units.
- Ensure that equations are balanced with correct state symbols.
- Apply IUPAC nomenclature and use this to work out isomeric structures.

Grade boundaries

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