



Mark Scheme (Results)

January 2022

Pearson Edexcel International Advanced
Subsidiary Level
In Chemistry (WCH11)
Paper 01: Structure, Bonding and Introduction
to Organic Chemistry

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Using the mark scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean ALLOWing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit. () means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer. ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Section A

Question Number	Answer	Mark
1(a)	<p>The only correct answer is C (XY_2)</p> <p><i>A is not correct because Group 2 elements combine with Group 7 elements in the ratio 1:2</i></p> <p><i>B is not correct because Group 2 elements combine with Group 7 elements in the ratio 1:2</i></p> <p><i>D is not correct because Group 2 elements combine with Group 7 elements in the ratio 1:2</i></p>	(1)

Question Number	Answer	Mark
1(b)	<p>The only correct answer is D (in the liquid state and in aqueous solution only)</p> <p><i>A is not correct because the ions do not move in the solid state</i></p> <p><i>B is not correct because the ions do not move in the solid state</i></p> <p><i>C is not correct because the ions do not move in the solid state</i></p>	(1)

Question Number	Answer	Mark
2	<p>The only correct answer is B (NaF)</p> <p><i>A is not correct because the Cl^- ion is larger than F^- so ionic bonding is weaker in $NaCl$</i></p> <p><i>C is not correct because the K^+ ion is larger than Na^+ and the Cl^- ion is bigger than F^-</i></p> <p><i>D is not correct because the K^+ ion is larger than Na^+</i></p>	(1)

Question Number	Answer	Mark
3	<p>The only correct answer is C (a yellow colour has moved to the positive end and a blue colour to the negative end)</p> <p><i>A is not correct because the green colour is formed from yellow and blue ions</i></p> <p><i>B is not correct because the green colour is formed from yellow and blue ions</i></p> <p><i>D is not correct because the blue Cu^{2+} ions will move to the negative end and the yellow CrO_4^{2-} ions will move to the positive end</i></p>	(1)

Question Number	Answer	Mark
4	<p>The only correct answer is D (Al^{3+})</p> <p><i>A is not correct because the N^{3-} ion has fewer protons so is larger</i></p> <p><i>B is not correct because the F^- ion has fewer protons so is larger</i></p> <p><i>C is not correct because the Na^+ ion has fewer protons so is larger</i></p>	(1)

Question Number	Answer	Mark
5	<p>The only correct answer is D (small radius and large charge)</p> <p><i>A is not correct because radius should be small</i></p> <p><i>B is not correct because the radius should be small and the charge should be large</i></p> <p><i>C is not correct because the charge should be large</i></p>	(1)

Question Number	Answer	Mark
6	<p>The only correct answer is A (large radius and large charge)</p> <p>B is not correct because the charge should be large</p> <p>C is not correct because the charge and radius should be large</p> <p>D is not correct because radius should be large</p>	(1)

Question Number	Answer	Mark
7	<p>The only correct answer is D ($\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$)</p> <p>A is not correct because NaNO_3 is soluble</p> <p>B is not correct because the charge on the barium ion is incorrect</p> <p>C is not correct because the charge on the sodium ion is incorrect</p>	(1)

Question Number	Answer	Mark
8	<p>The only correct answer is A (CO_2)</p> <p>B is not correct because HCl is a polar molecule</p> <p>C is not correct because H_2O is a polar molecule</p> <p>D is not correct because NH_3 is a polar molecule</p>	(1)

Question Number	Answer	Mark
9	<p>The only correct answer is C (0.00005%)</p> <p><i>A is not correct because the answer shows the percentage equal to ppm</i></p> <p><i>B is not correct because the answer shows the ppm divided by 100</i></p> <p><i>D is not correct because the correct answer has been divided by 100</i></p>	(1)

Question Number	Answer	Mark
10(a)	<p>The only correct answer is B ($\text{C}_2\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_5\text{Br} + \text{HBr}$)</p> <p><i>A is not correct because hydrogen is not produced</i></p> <p><i>C is not correct because CH_3Br is not a product</i></p> <p><i>D is not correct because neither CH_4 nor CH_2Br_2 are products</i></p>	(1)

Question Number	Answer	Mark
10(b)	<p>The only correct answer is A (homolytic breaking of a Br—Br bond)</p> <p><i>B is not correct because the Br-Br bond does not break heterolytically</i></p> <p><i>C is not correct because the C-H bond is not broken by UV light</i></p> <p><i>D not correct because the C-H bond is not broken by UV light</i></p>	(1)

Question Number	Answer	Mark
11	<p>The only correct answer is B (general formula)</p> <p><i>A is not correct because only the general formula is the same for all alkanes</i></p> <p><i>C is not correct because only the general formula is the same for all alkanes</i></p> <p><i>D is not correct because only the general formula is the same for all alkanes</i></p>	(1)

Question Number	Answer	Mark
12	<p>The only correct answer is D (hexene and propane)</p> <p><i>A is not correct because these products are possible</i></p> <p><i>B is not correct because these products are possible</i></p> <p><i>C is not correct because these products are possible</i></p>	(1)

Question Number	Answer	Mark
13	<p>The only correct answer is C (4)</p> <p><i>A is not correct because there are 4 isomers</i></p> <p><i>B is not correct because there are 4 isomers</i></p> <p><i>D is not correct because there are 4 isomers</i></p>	(1)

Question Number	Answer	Mark
14	<p>The only correct answer is B (7.22×10^{21})</p> <p><i>A is not correct because a 1:1 ratio has been used instead of 1:6</i></p> <p><i>C is not correct because a 1:7 ratio has been used instead of 1:6</i></p> <p><i>D is not correct because this is the number of atomic mass units in the product</i></p>	(1)

Question Number	Answer	Mark
15	<p>The only correct answer is A (hydrogen chloride)</p> <p><i>B is not correct because sulfur is an impurity in alkane fuels and so sulfur dioxide can be produced during their combustion</i></p> <p><i>C is not correct because carbon particulates can be produced during the combustion of alkane fuels</i></p> <p><i>D is not correct because carbon monoxide can be produced during the combustion of alkane fuels</i></p>	(1)

Question Number	Answer	Mark
16	<p>The only correct answer is C (27.90 tonnes)</p> <p><i>A is not correct because the wrong ratio (2:1) has been used instead of 1:2</i></p> <p><i>B is not correct because the wrong ratio (1:1) has been used instead of 1:2</i></p> <p><i>D is not correct because the wrong ratio (1:3) has been used instead of 1:2</i></p>	(1)

Question Number	Answer	Mark
17	<p>The only correct answer is B (0.40 dm^3 of 0.03 mol dm^{-3} KCl)</p> <p><i>A is not correct because it contains 0.02 mol of ions</i></p> <p><i>C is not correct because it contains 0.018 mol of ions</i></p> <p><i>D is not correct because it contains 0.018 mol of ions</i></p>	(1)

Question Number	Answer	Mark
18	<p>The only correct answer is C (39.2%)</p> <p><i>A is not correct because the O on the right-hand side has been multiplied by 2, not 6</i></p> <p><i>B is not correct because the O on the right-hand side has been multiplied by 4, not 6</i></p> <p><i>D is not correct because the mass of oxygen has been divided by the mass of KCl</i></p>	(1)

(Total for Section A = 20 marks)

Section B

Question Number	Answer	Additional Guidance	Mark												
19(a)(i)	<table border="1"> <thead> <tr> <th data-bbox="528 341 898 376">Measurement</th> <th data-bbox="898 341 1122 376">Mass / g</th> </tr> </thead> <tbody> <tr> <td data-bbox="528 376 898 411">Mass of empty crucible</td> <td data-bbox="898 376 1122 411">21.21</td> </tr> <tr> <td data-bbox="528 411 898 517">Mass of crucible and magnesium sulfate before heating</td> <td data-bbox="898 411 1122 517">26.71</td> </tr> <tr> <td data-bbox="528 517 898 620">Mass of crucible and magnesium sulfate after heating for 2 mins</td> <td data-bbox="898 517 1122 620">24.12</td> </tr> <tr> <td data-bbox="528 620 898 655">Mass of magnesium sulfate</td> <td data-bbox="898 620 1122 655">2.91</td> </tr> <tr> <td data-bbox="528 655 898 687">Mass of water</td> <td data-bbox="898 655 1122 687">2.59</td> </tr> </tbody> </table>	Measurement	Mass / g	Mass of empty crucible	21.21	Mass of crucible and magnesium sulfate before heating	26.71	Mass of crucible and magnesium sulfate after heating for 2 mins	24.12	Mass of magnesium sulfate	2.91	Mass of water	2.59	Both masses required	(1)
Measurement	Mass / g														
Mass of empty crucible	21.21														
Mass of crucible and magnesium sulfate before heating	26.71														
Mass of crucible and magnesium sulfate after heating for 2 mins	24.12														
Mass of magnesium sulfate	2.91														
Mass of water	2.59														

Question Number	Answer	Additional Guidance	Mark
19(a)(ii)	<ul style="list-style-type: none"> <li data-bbox="421 328 689 360">• M1 M_r of MgSO_4 <li data-bbox="421 480 741 512">• M2 moles of MgSO_4 <li data-bbox="421 632 701 663">• M3 moles of H_2O <li data-bbox="421 1177 1122 1241">• M4 ratio of moles of water to moles of magnesium sulfate: to the nearest whole number 	<p data-bbox="1261 253 1563 285"><u>Example of calculation</u></p> <p data-bbox="1261 328 1675 360">(1) $(24.3 + 32.1 + (4 \times 16)) = 120.4$</p> <p data-bbox="1261 400 1391 432">Allow 120</p> <p data-bbox="1261 472 1877 504">(1) $(2.91 \div 120.4) = 0.024169 / 2.4169 \times 10^{-2}$ (mol)</p> <p data-bbox="1261 504 1641 568">Ignore SF except 1 TE from wrong mass in (a)(i)</p> <p data-bbox="1261 616 1821 647">(1) $(2.59 \div 18) = 0.14389 / 1.4389 \times 10^{-1}$ (mol)</p> <p data-bbox="1261 647 1641 711">Ignore SF except 1</p> <p data-bbox="1261 727 1641 759">TE from wrong mass in (a)(i)</p> <p data-bbox="1261 799 1626 831">No TE on wrong M_r of H_2O</p> <p data-bbox="1261 871 1715 903">Alternative method for M3 and M4</p> <p data-bbox="1261 943 1883 975">M_r of hydrate = $26.71 - 21.21 / 0.024169 = 227.56$</p> <p data-bbox="1261 1023 1794 1054">mass of water = $227.56 - 120.4 = 107.16$</p> <p data-bbox="1261 1054 1809 1086">moles of water = $107.16 / 18 = 5.9533$ x = 6</p> <p data-bbox="1261 1166 1738 1198">$(0.1438889 \div 0.0241694) = 5.9533:1$</p> <p data-bbox="1261 1238 1547 1270">(1) $(\text{MgSO}_4 \cdot 6\text{H}_2\text{O}) \quad x = 6$</p> <p data-bbox="1261 1318 1536 1350">TE from M2 and M3</p> <p data-bbox="1261 1390 1966 1422">Correct answer with some relevant working scores (4)</p> <p data-bbox="1261 1422 1541 1453">Ignore SF throughout</p>	(4)

Question Number	Answer	Additional Guidance	Mark
19(b)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li data-bbox="405 328 1245 360">• heat to constant mass/ until mass does not change (1) <li data-bbox="405 552 1245 584">• to ensure all the water is lost/ driven off (1) 	<p>Allow heat for longer Ignore any reference to repetition/ using a higher temperature/different flame/more magnesium sulfate/ any changes to the method Do not award heat under reflux for longer</p> <p>Allow more water is lost/given off Allow some water may have remained Allow all the water evaporated Ignore allow (reaction) to go to completion</p>	(2)

(Total for Question 19 = 7 marks)

Question Number	Answer	Additional Guidance	Mark
20(a)	An answer that makes reference to the following points <ul style="list-style-type: none"> • Cu ([Ar]) 3d¹⁰ 4s¹ (1) • Cu²⁺ ([Ar]) 3d⁹ (1) 	ALLOW 4s ¹ 3d ¹⁰ ALLOW 4s ⁰ 3d ⁹ Ignore 1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ in both cases	(2)

Question Number	Answer	Additional Guidance	Mark												
20(b)(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Isotope</th> <th>Protons</th> <th>Neutrons</th> <th>Electrons</th> </tr> </thead> <tbody> <tr> <td>⁶³Cu</td> <td>29</td> <td>34</td> <td>29</td> </tr> <tr> <td>⁶⁵Cu</td> <td>29</td> <td>36</td> <td>29</td> </tr> </tbody> </table>	Isotope	Protons	Neutrons	Electrons	⁶³ Cu	29	34	29	⁶⁵ Cu	29	36	29	One mark for each correct row Four or five correct scores one mark Ignore working	(2)
Isotope	Protons	Neutrons	Electrons												
⁶³ Cu	29	34	29												
⁶⁵ Cu	29	36	29												

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> • (atoms/elements that have) same number of protons/same proton number/ quoted same number of protons even if wrong (1) • (but) different numbers of neutrons/neutron number (1) 	Ignore any reference to electrons but do not award if different to the number of protons Ignore if they state the wrong number of neutrons in the 2 isotopes. If they fail to mention numbers of protons and neutrons 'same atomic number but different mass number' scores (1) Do not award atomic mass for mass number Do not award molecules but penalise once only	(2)

Question Number	Answer	Additional Guidance	Mark
20(b)(iii)	<ul style="list-style-type: none">(isotopes have) the same electronic configuration	Allow same electron arrangement/electron(ic) structure Allow the same number of electrons Ignore the same number of protons Ignore the same number of electrons in the outer shell/same number of valence electrons Ignore same period/same group Ignore any given electronic configurations/number of electrons even if wrong Ignore any reference to neutrons	(1)

Question Number	Answer	Additional Guidance	Mark
20(b)(iv)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> expression relating isotopic masses A_r and X (1) abundance of (Cu) 63 = 0.8 or 80% abundance of (Cu) 65 = 0.2 or 20% (1) <p>Alternative method</p> <p>65- 63.4 = 1.6</p> <p>63.4-63 = 0.4 (1)</p> <p>0.4/2.0 × 100 = 20% 65 1.6/2.0 × 100 = 80% 63 (1)</p>	<p><u>Example of calculation</u></p> $63.4 = \frac{(1-X) \times 65 + (X \times 63)}{1}$ $63.4 = 65 - 65X + 63X$ $63.4 = 65 - 2X$ $-1.6 = -2X$ $X / 63 = 0.8$ <p>OR</p> $63.4 = \frac{(1-X) \times 63 + (X \times 65)}{1}$ $63.4 = 63 - 63X + 65X$ $63.4 = 63 + 2X$ $0.4 = 2X$ $X / 65 = 0.2$	(2)

OR

$$63.4 = \frac{(100 - X) \times 65 + (X \times 63)}{100}$$

$$6340 = 6500 - 65X + 63X$$

$$6340 = 6500 - 2X$$

$$-160 = -2X$$

$$X / 63 = 80\%$$

OR

$$63.4 = \frac{(100 - X) \times 63 + (X \times 65)}{100}$$

$$6340 = 6300 - 63X + 65X$$

$$6340 = 6300 + 2X$$

$$40 = 2X$$

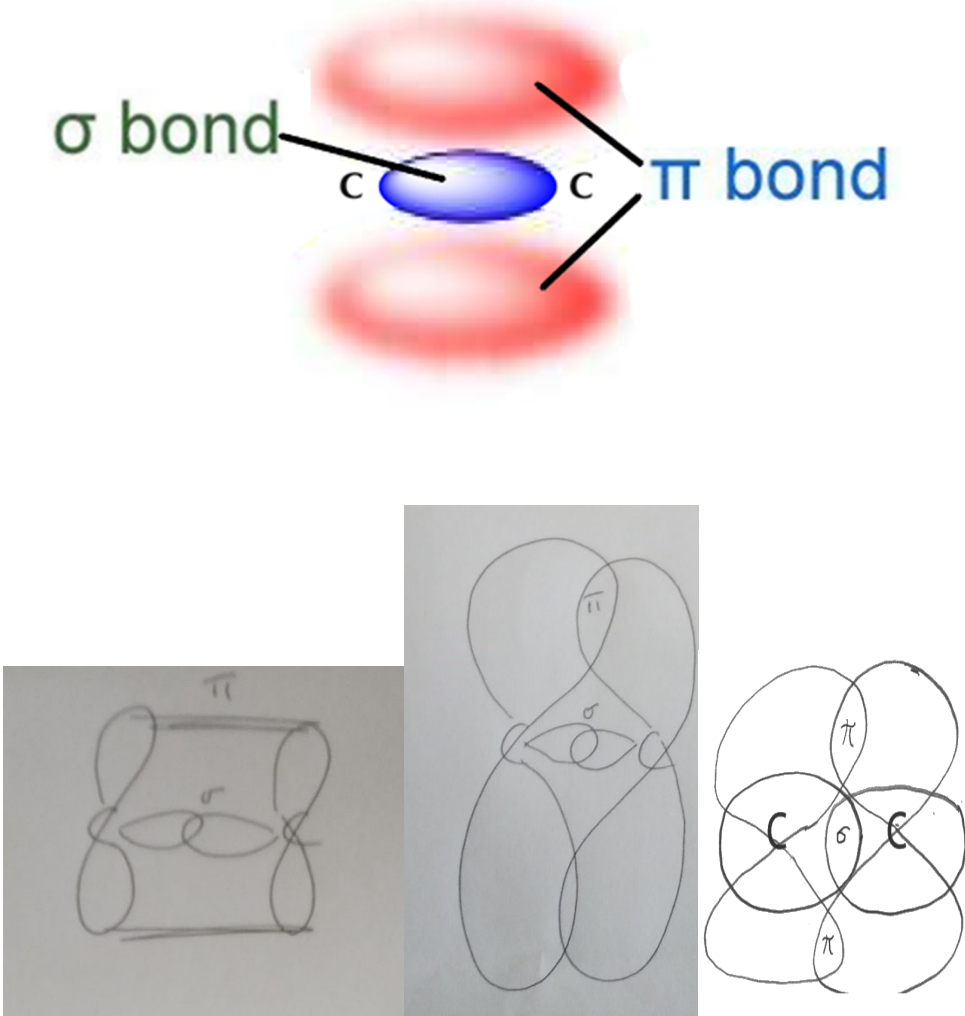
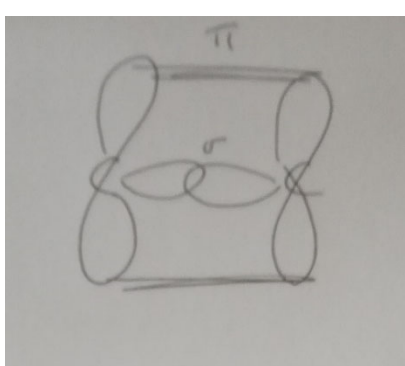
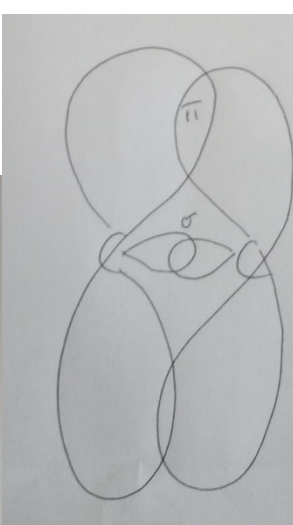
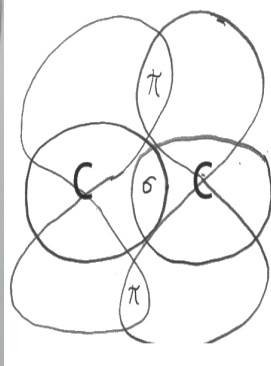
$$X / 65 = 20\%$$

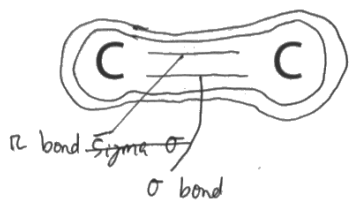
Correct answer with or without working scores (2)

Question Number	Answer	Additional Guidance	Mark
20(c)(i)	<ul style="list-style-type: none"> a correct balanced equation 	$\text{CuCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{CO}_2 + \text{H}_2\text{O}$ <p>or</p> $\text{CuCO}_3 + 2\text{H}^+ \rightarrow \text{Cu}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$ <p>Allow multiples Ignore state symbols even if incorrect Do not award H_2CO_3 as a product</p>	(1)

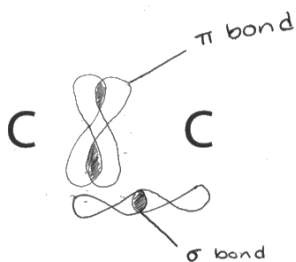
Question Number	Answer	Additional Guidance	Mark
20(c)(ii)	<ul style="list-style-type: none"> • M1 moles of sulfuric acid (1) • M2 maximum mass of copper(II) sulfate (1) • M3 percentage yield calculation (1) • M4 answer to 2 or 3 SF (1) • M1 moles of sulfuric acid (1) • M2 moles of copper sulfate (1) • M3 percentage yield calculation (1) • M4 answer to 2 or 3 SF (1) <p>Correct answer with some working scores (4)</p>	<p><u>Example of calculation</u></p> <p>$50 \times 1.00 \div 1000 = 0.05 \text{ (mol)} / 5 \times 10^{-2} \text{ (mol)}$</p> <p>$0.05 \text{ (mol)} \times 249.6 = 12.48 \text{ (g)}$</p> <p>Allow TE on M1</p> <p>$100 \times 10.87 \div 12.48 = 87.099$</p> <p>Allow TE on M2 unless over 100%</p> <p>87(%) / 87.1(%)</p> <p>Alternative method</p> <p>$50 \times 1.00 \div 1000 = 0.05 \text{ (mol)} / 5 \times 10^{-2} \text{ (mol)}$</p> <p>$10.87 \text{ (g)} / 249.6 \text{ (g)} = 0.04355 \text{ (mol)} / 4.355 \times 10^{-2} \text{ (mol)}$</p> <p>$100 \times 4.355 \times 10^{-2} / 5 \times 10^{-2} = 87.099$</p> <p>Allow TE on M1 and M2 unless over 100%</p> <p>87(%) / 87.1(%)</p> <p>M4 dependent on a sensible calculation that involves either a mass or moles that has been calculated.</p> <p>Ignore incorrect rounding by truncating intermediate figures eg 0.435 (mol)</p>	(4)

(Total for Question 20 = 14 marks)

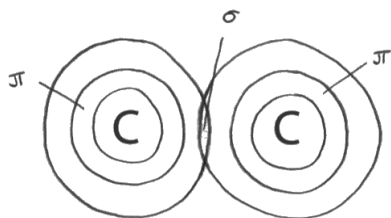
Question Number	Answer	Additional Guidance	Mark
21(a)	<p>An answer that makes reference to the following points:</p> <div style="text-align: center;">  </div> <div style="display: flex; justify-content: space-around;">    </div> <p>All three of the above score 2 marks</p>	<p>σ (1) One mark for each of the bonds labelled.</p> <p>π (1) The π bond must be above and below the carbons but only one of the lobes of the π bond needs to be labelled</p> <p>Ignore overlap of orbitals where the sigma bond extends beyond the carbon atoms</p> <p>Ignore extra labelled sigma bonds to hydrogen</p>	(2)



Scores 0



Scores 0



Scores 0

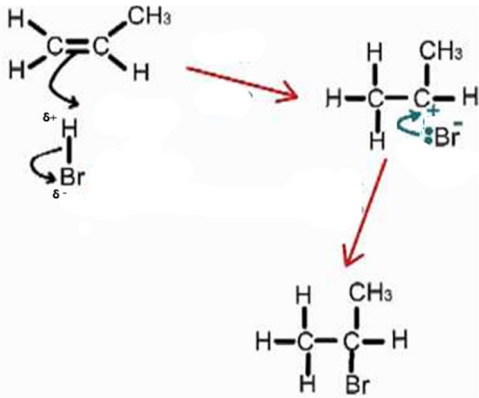
Do not award single lines as there must be an area of electron density.

Do not award if the orbitals are shown overlapping in a random position away from the Cs.

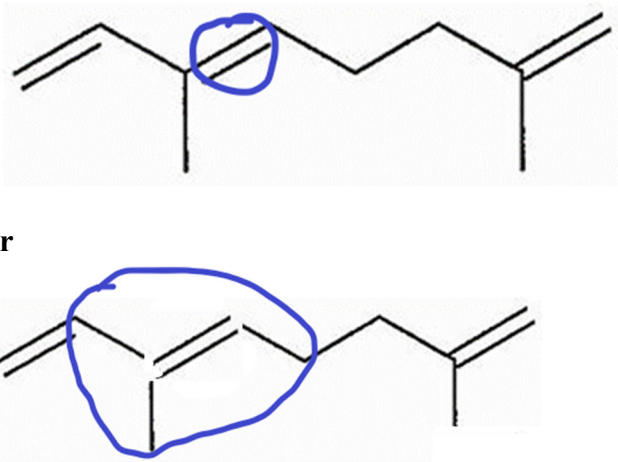
Do not award electron rings or contour lines

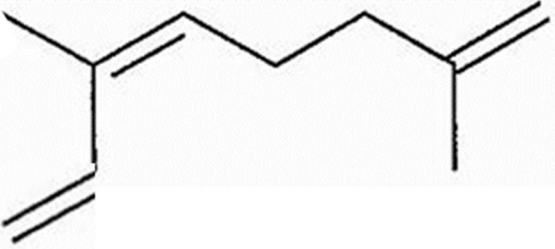
Allow if both bonds are correct and labelled the wrong way round score (1)

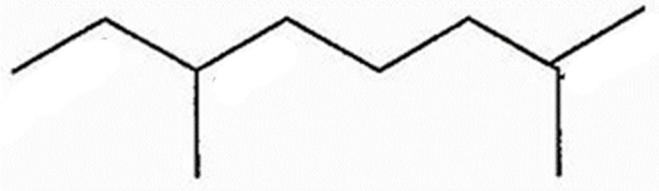
Question Number	Answer	Additional Guidance	Mark
21(b)(i)	<p>Steam and catalyst</p> $ \begin{array}{ccccc} & \text{H} & \text{OH} & \text{H} & \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{H} \\ & & & & \\ & \text{H} & \text{H} & \text{H} & \end{array} $ <p>Acidified potassium manganate(VII)</p> $ \begin{array}{ccccc} & \text{H} & \text{H} & \text{H} & \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{H} \\ & & & & \\ & \text{H} & \text{OH} & \text{OH} & \end{array} $ <p>Bromine</p> $ \begin{array}{ccccc} & \text{H} & \text{H} & \text{H} & \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{H} \\ & & & & \\ & \text{H} & \text{Br} & \text{Br} & \end{array} $	<p>Accept skeletal / structural formulae/ or a combination</p> <p>Allow</p> $ \begin{array}{ccccc} & \text{H} & \text{H} & \text{H} & \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{OH} \\ & & & & \\ & \text{H} & \text{H} & \text{H} & \end{array} $ <p>Ignore connectivity of OH unless horizontal but penalise only once Ignore names even if incorrect If wrong number of carbon atoms penalise once only. Do not award any structure with missing bonds.</p>	(3)
	(1)		
	(1)		
	(1)		

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	<p data-bbox="389 252 1167 284">An explanation that makes reference to the following points:</p>  <ul style="list-style-type: none"> <li data-bbox="439 799 1043 826">• dipole on HBr and two correct curly arrows <li data-bbox="439 986 741 1013">• correct intermediate <li data-bbox="439 1098 1312 1161">• curly arrow from lone pair on Br⁻ to C⁺ or the space between the Br⁻ to C⁺ 	<p data-bbox="1402 807 1989 986">(1) Arrows must start from the covalent bond. From the H—Br bond it must go to the Br or beyond. From the C=C bond it must go to the H or in the space.</p> <p data-bbox="1402 994 1442 1021">(1)</p> <p data-bbox="1402 1102 1984 1430">(1) If Br₂ is added M2 and M3 can be scored If 1-bromopropane is the product the intermediate mark cannot be scored so Max 2 Penalise half curly arrows once only If wrong alkene Allow M1 and M3 only. Ignore the product even if incorrect</p>	(3)

Question Number	Answer	Additional Guidance	Mark
21(c)(i)	<ul style="list-style-type: none"> $C_{10}H_{16}$ 	$H_{16}C_{10}$ Ignore working and any names	(1)

Question Number	Answer	Additional Guidance	Mark
21(c)(ii)	 <p>or</p>	Allow any circle that includes the correct double bond and does not extend beyond the OR answer.	(1)

Question Number	Answer	Additional Guidance	Mark
21(c)(iii)	<ul style="list-style-type: none">• correct skeletal formula	<p>Example of formula:</p>  <p>Ignore angles and lengths of bonds</p>	(1)

Question Number	Answer	Additional Guidance	Mark
21(c)(iv)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • moles of hydrogen / H₂ • ratio of moles hydrogen / H₂ to alpha-ocimene = number of C=C that react • Correct structure  <p>If there is no calculation or calculation says H₂ is in excess M3 can be awarded.</p>	<p><u>Example of calculation</u></p> <p>(1) 3.6 ÷ 24 = 0.15 (mol)</p> <p>(1) 0.15 ÷ 0.05 = 3</p> <p>Allow TE incorrect moles of H₂</p> <p>(1)</p> <p>Allow TE on incorrect ratio of 1 or 2.</p> <p>Ignore length of bonds/bond angles</p> <p>Allow structural or displayed formulae</p>	(3)

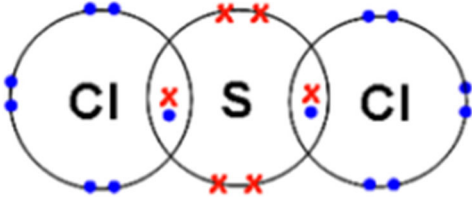
(Total for Question 21 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
22(a)(i)	<ul style="list-style-type: none"> (metallic bonding is) the attraction between positive ions/cations and delocalised electrons 	<p>Can be shown as a labelled diagram including the word attraction.</p> <p>Allow electrostatic forces as an alternative to attraction</p> <p>Allow attraction between metal ions and delocalised electrons</p> <p>Allow attraction between (positive) nuclei and delocalised electrons</p> <p>Ignore just 'ions'</p> <p>Ignore free moving electrons/ sea of electrons</p>	(1)

Question Number	Answer	Additional Guidance	Mark
22(a)(ii)	<p>An explanation that makes reference to three of the following points</p> <ul style="list-style-type: none"> • M1 Mg has more delocalised electrons • M2 Mg²⁺ is smaller (than Na⁺) • M3 Mg²⁺ has a higher charge (than Na⁺) • M4 Greater attraction between the delocalised electrons and the Mg²⁺ ions/ Mg²⁺ nuclei 	<p>(1) Allow Mg loses two electrons and Na one to form delocalised electrons Ignore free moving electrons</p> <p>(1) Allow Mg ion is smaller (than Na⁺) Allow Mg smaller ionic radius Do not award atomic radius</p> <p>(1) Allow Mg ion has a higher charge (than Na⁺) Ignore the number of protons</p> <p>Just Mg²⁺ ‘has a greater charge density’ scores (1) for M2 & M3</p> <p>(1) Allow greater attraction between the delocalised electrons and Mg Ignore attraction to the protons Ignore outer shell electrons</p> <p>Allow reverse argument for all points</p>	(3)

Question Number	Answer	Additional Guidance	Mark
22(b)(i)	<ul style="list-style-type: none"> (the electrostatic attraction between) the shared (pair of) electrons and the (two) nuclei (of the bonded atoms) 	Allow single nucleus	(1)

Question Number	Answer	Additional Guidance	Mark
22(b)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> phosphorus (P) simple molecular silicon (Si) giant (covalent/molecular) structure when phosphorus melts weak London forces are broken and when silicon melts strong covalent bonds are broken 	<p>(1) Allow (small) molecules/ P₄/ just 'molecular'/simple covalent</p> <p>(1) Allow lattice instead of giant Ignore macromolecular Do not award giant metallic/ionic</p> <p>(1) Allow / dispersion /van der Waals forces/ instantaneous dipole-induced dipole/intermolecular forces Do not award if any mention of intermolecular forces for silicon.</p>	(3)

Question Number	Answer	Additional Guidance	Mark
22(c)(i)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • dot-and-cross diagram showing two shared pairs of electrons between S and Cls • rest of diagram correct 	<p>Example of dot-and-cross diagram</p>  <p>(1)</p> <p>(1)</p> <p>Allow all dots/all crosses/dots crosses the wrong way round</p> <p>Allow the non-bonded pairs of electrons on S and Cl anywhere and allow non-bonding electrons unpaired.</p> <p>Ignore inner shells</p> <p>Charged species/ions scores 0</p>	(2)

Question Number	Answer	Additional Guidance	Mark
22(c)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • bond angle 104.5(°) (1) • four pairs of electrons/ 2 bonding pairs and 2 lone pairs occupy a position of minimum repulsion (1) • (2)lone pairs repel more than bonding pairs (so the angle is reduced from 109.5 (°)) (1) 	<p>Allow 102-105 (actual answer 103°)</p> <p>Allow just electron pairs occupying a position of minimum repulsion and do not penalise for an incorrect number of electron pairs if quoted. Allow maximum separation Ignore bonds/ areas of electron density/atoms</p> <p>Ignore any reference to shapes e.g. angular, V-shaped</p>	(3)

(Total for Question 22 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
23(a)(i)	<ul style="list-style-type: none"> $\text{Li(g)} \rightarrow \text{Li}^{\text{+}}(\text{g}) + \text{e}^{(-)}$ 	<p>Both species and states must be correct</p> <p>Allow</p> <p>$\text{Li(g)} - \text{e}^{(-)} \rightarrow \text{Li}^{\text{+}}(\text{g})$</p> <p>Ignore state symbol on e^{-}</p>	(1)

Question Number	Answer	Additional Guidance	Mark
23(a)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> (on moving across the period) there is an increase in the number of protons/atomic number/nuclear charge (1) (The electrons are in the same shell so there is a) greater attraction between the nucleus and electron(s) (1) 	<p>Allow effective nuclear charge</p> <p>Allow smaller atomic radius</p> <p>Allow same/similar shielding</p> <p>Allow attraction between protons and electrons</p>	(2)

Question Number	Answer	Additional Guidance	Mark
23(a)(iii)	<p>An explanation that makes reference to the following points:</p> <p>Oxygen (even though it has one more proton)</p> <ul style="list-style-type: none"> • M1 the electron is being removed from a (2)p orbital that is paired / full (1) • M2 less energy is needed to remove a paired electron / there is repulsion between the paired electrons (1) <p>OR</p> <p>Nitrogen (even though it has one fewer proton)</p> <ul style="list-style-type: none"> • M1 the electron is being removed from a (2)p orbital that is unpaired (1) • M2 more energy is needed to remove an unpaired electron (1) 	<p>Allow the electron is being removed from the pair of electrons in the (2)p sub-shell Allow the p orbital contains two electrons Do not award p shell Do not award 3p</p> <p>Allow there is spin-pair repulsion Allow easier to remove a paired electron Allow there is repulsion between the electrons if pairing or 2 electrons of full orbital is mentioned in M1</p> <p>Allow the electron is being removed from a half-filled (2)p sub-shell Allow the electron is being removed from a (2)p orbital that only contains one electron. Do not award p shell Do not award 3p</p> <p>Allow more energy is required to remove this electron if unpaired is mentioned in M1 Allow this arrangement is stable, so more energy is needed to remove the electron</p> <p>M1 can be scored with a diagram</p> <p>Ignore reference to shielding/lone pairs</p>	(2)

Question Number	Answer	Additional Guidance	Mark
23(b)	<p>An answer that makes reference to two of the following points:</p> <ul style="list-style-type: none"> <li data-bbox="495 794 1240 991">○ M1 (General increase because there is the same positive charge) but fewer electrons/ less repulsion between electrons/ electrons getting closer to the nucleus/ ion becoming increasingly more positive/increase in effective nuclear charge (1) <li data-bbox="495 1031 1240 1161">○ M2 there is a big jump between 5th-6th ionisation energies as the 6th electron is removed from a new shell/ quantum shell/ energy level (closer to the nucleus) (1) <li data-bbox="495 1334 1240 1433">○ M3 there is a jump between 3rd - 4th ionisation energies as the 4th electron is removed from a new sub shell/2s (closer to the nucleus) (1) 	<p>Allow there is a big jump between 5th-6th ionisation energies as nitrogen has 5 electrons in its outer shell Ignore it is in group 5 Allow there is a big jump between 5th-6th ionisation energies as the inner electrons have no shielding</p>	(2)

(Total for Question 23 = 7 marks)

Question Number	Answer	Additional Guidance	Mark
24(a)	<ul style="list-style-type: none"> <li data-bbox="416 416 1240 448">• M1 conversion of volume to m³ (1) <li data-bbox="416 488 1240 520">• M2 rearrangement of Ideal Gas Equation (1) <li data-bbox="416 592 1240 655">• M3 conversion of pressure and evaluation to give number of moles (1) <li data-bbox="416 759 1240 791">• M4 calculation of molar mass (1) 	<p data-bbox="1296 349 1570 381"><u>Example of calculation</u></p> <p data-bbox="1296 413 1816 445">$72.5 \times 10^{-6} = 7.25 \times 10^{-5} / 0.0000725 \text{ (m}^3\text{)}$</p> <p data-bbox="1296 485 1375 549">$n = \frac{pV}{RT}$</p> <p data-bbox="1296 580 1980 644">$\frac{100000 \times 7.25 \times 10^{-5}}{8.31 \times 358} = 2.4370 \times 10^{-3} / 0.002437 \text{ (mol)}$</p> <p data-bbox="1296 692 1666 724">Allow TE on volume from M1</p> <p data-bbox="1296 756 1789 820">$\frac{0.210}{2.4370 \times 10^{-3}} = 86.172 = 86 \text{ (g mol}^{-1}\text{)}$</p> <p data-bbox="1296 860 1644 892">Allow TE on moles from M3</p> <p data-bbox="1296 932 1644 995">Ignore SF except 1SF Ignore units even if incorrect</p>	(4)

Question Number	Answer	Additional Guidance	Mark
24(b)	<ul style="list-style-type: none"> hexane or any alkane with the molecular formula of C₆H₁₄ 	Allow name or structural/displayed/skeletal formula Allow TE on sensible mass from (a) If no mass allow hexane If both name and formula/structure given they must match The name or formula must match the mass in (a)	(1)

(Total for Question 24 = 5 marks)
(Total for Section B = 60 marks)
TOTAL FOR PAPER = 80 MARKS

