



Mark Scheme (Provisional)

Summer 2021

Pearson Edexcel International Advanced
Subsidiary Level

In Chemistry (WCH11)

Paper 01: Structure, Bonding and Introduction to
Organic Chemistry

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Summer 2021

Question Paper Log Number P64623A

Publications Code WCH11_01_2106_MS

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (Multiple Choice)

Question number	Answer	Mark
1	<p>The only correct answer is D (Y and Z)</p> <p><i>A is incorrect because W and X both have the same number of neutrons</i></p> <p><i>B is incorrect because W and Y have different numbers of protons so are different elements</i></p> <p><i>C is incorrect because X and Y have different numbers of protons so are different elements</i></p>	1

Question number	Answer	Mark
2	<p>The only correct answer is C (4)</p> <p><i>A is incorrect because the ICl_3^+ ion can have $3 \times {}^{35}\text{Cl}$, $2 \times {}^{35}\text{Cl} + 1 \times {}^{37}\text{Cl}$, $1 \times {}^{35}\text{Cl} + 2 \times {}^{37}\text{Cl}$ or $3 \times {}^{37}\text{Cl}$</i></p> <p><i>B is incorrect because the ICl_3^+ ion can have $3 \times {}^{35}\text{Cl}$, $2 \times {}^{35}\text{Cl} + 1 \times {}^{37}\text{Cl}$, $1 \times {}^{35}\text{Cl} + 2 \times {}^{37}\text{Cl}$ or $3 \times {}^{37}\text{Cl}$</i></p> <p><i>D is incorrect because the ICl_3^+ ion can have $3 \times {}^{35}\text{Cl}$, $2 \times {}^{35}\text{Cl} + 1 \times {}^{37}\text{Cl}$, $1 \times {}^{35}\text{Cl} + 2 \times {}^{37}\text{Cl}$ or $3 \times {}^{37}\text{Cl}$</i></p>	1

Question number	Answer	Mark
3	<p>The only correct answer is C (192.5)</p> <p><i>A is incorrect because this is the relative atomic mass with the abundances reversed</i></p> <p><i>B is incorrect because this would be the relative atomic mass if there were equal amounts of the two isotopes</i></p> <p><i>D is incorrect because this is the relative atomic mass of the most abundant isotope</i></p>	1

Question number	Answer	Mark
4	<p>The only correct answer is B ($\text{Mg}^+(\text{g}) \rightarrow \text{Mg}^{2+}(\text{g}) + \text{e}^-$)</p> <p><i>A is incorrect because this represents the first and second ionisations</i></p> <p><i>C is incorrect because this represents the first and second ionisations and the state symbols are incorrect</i></p> <p><i>D is incorrect because the state symbols are incorrect</i></p>	1

Question number	Answer	Mark
5	<p>The only correct answer is B (3 quantum shells and 5 electrons in the outer shell)</p> <p><i>A is incorrect because the outer five electrons require the least amount of energy to remove</i></p> <p><i>C is incorrect because there are two large jumps between the 3 quantum shells and the outer five electrons require the least amount of energy to remove</i></p> <p><i>D is incorrect because there are two large jumps between the 3 quantum shells</i></p>	1

Question number	Answer	Mark
6	<p>The only correct answer is B (Cl^-)</p> <p><i>A is incorrect because Al^{3+} has electronic configuration $1s^2 2s^2 2p^6$</i></p> <p><i>C is incorrect because N^{3-} has electronic configuration $1s^2 2s^2 2p^6$</i></p> <p><i>D is incorrect because Na^+ has electronic configuration $1s^2 2s^2 2p^6$</i></p>	1

Question number	Answer	Mark
7	<p>The only correct answer is D (286)</p> <p><i>A is incorrect because this is the relative formula mass of anhydrous sodium carbonate, Na₂CO₃</i></p> <p><i>B is incorrect because this is the relative formula mass of Na₂CO₃ + (20 x 1) + 16</i></p> <p><i>C is incorrect because this is the relative formula mass of NaCO₃.10H₂O</i></p>	1

Question number	Answer	Mark
8	<p>The only correct answer is C (O²⁻)</p> <p><i>A is incorrect because Na⁺ has more protons than oxygen and nitrogen but a lower charge than magnesium</i></p> <p><i>B is incorrect because Mg²⁺ is the smallest as it has the most protons and a higher charge than sodium</i></p> <p><i>D is incorrect because F⁻ has one more proton than oxygen and one less electron added to the atom</i></p>	1

Question number	Answer	Mark
9	<p>The only correct answer is D (I⁻)</p> <p><i>A is incorrect because cations cause polarisation of anions and are not polarised themselves</i></p> <p><i>B is incorrect because cations cause polarisation of anions and are not polarised themselves</i></p> <p><i>C is incorrect because a chloride ion is smaller than an iodide ion and large anions are more easily polarised than small anions</i></p>	1

Question number	Answer	Mark
10	<p>The only correct answer is A (diamond)</p> <p><i>B is incorrect because ice consists of H₂O molecules</i></p> <p><i>C is incorrect because poly(ethene) consists of long chain molecules</i></p> <p><i>D is incorrect because sodium chloride consists of a giant lattice of ions</i></p>	1

Question number	Answer	Mark
11	<p>The only correct answer is A (H₂O)</p> <p><i>B is incorrect because the greatest electronegativity difference is between hydrogen and oxygen</i></p> <p><i>C is incorrect because the greatest electronegativity difference is between hydrogen and oxygen</i></p> <p><i>D is incorrect because the greatest electronegativity difference is between hydrogen and oxygen</i></p>	1

Question number	Answer	Mark
12	<p>The only correct answer is B (C₂F₄)</p> <p><i>A is incorrect because CF₄ is tetrahedral</i></p> <p><i>C is incorrect because PF₅ is trigonal bipyramidal</i></p> <p><i>D is incorrect because SF₆ is octahedral</i></p>	1

Question number	Answer	Mark
13	<p>The only correct answer is B (C_7H_{14})</p> <p><i>A is incorrect because this would be correct if ethane was formed instead of ethene</i></p> <p><i>C is incorrect because this would be correct if only one molecule of E was produced and ethane was formed instead of ethene</i></p> <p><i>D is incorrect because this would be correct if only one molecule of E was produced</i></p>	1

Question number	Answer	Mark
14	<p>The only correct answer is C (4,5-dimethylhex-1-ene)</p> <p><i>A is incorrect because the longest chain has 6 carbon atoms</i></p> <p><i>B is incorrect because the double bond starts at the first carbon atom</i></p> <p><i>D is incorrect because the longest chain has 6 carbon atoms</i></p>	1

Question number	Answer	Mark
15	<p>The only correct answer is A (5.25 g)</p> <p><i>B is incorrect because this is 51.2% of 12.5 g</i></p> <p><i>C is incorrect because the M_rs have been reversed</i></p> <p><i>D is incorrect because this is the mass produced if the yield was 100%</i></p>	1

Question number	Answer	Mark
16	<p>The only correct answer is C (11.0 g of carbon dioxide)</p> <p><i>A is incorrect because 6.0 dm³ is occupied by 0.25 mol of gas and 2.0 g is 0.5 mol of helium</i></p> <p><i>B is incorrect because 6.0 dm³ is occupied by 0.25 mol of gas and 4.0 g is 0.125 mol of oxygen gas, O₂</i></p> <p><i>D is incorrect because 6.0 dm³ is occupied by 0.25 mol of gas and 14.0 g is 0.5 mol of nitrogen gas, N₂</i></p>	1

Question number	Answer	Mark
17	<p>The only correct answer is D (Pb₃O₄)</p> <p><i>A is incorrect because PbO contains 92.8% by mass of lead</i></p> <p><i>B is incorrect because PbO₂ contains 86.6% by mass of lead</i></p> <p><i>C is incorrect because Pb₂O₃ contains 89.6% by mass of lead</i></p>	1

Question number	Answer	Mark
18	<p>The only correct answer is B (400 cm³)</p> <p><i>A is incorrect because this is the volume of carbon dioxide produced and there is 100 cm³ of oxygen left</i></p> <p><i>C is incorrect because this is the volume of carbon dioxide and water produced if water was a gas</i></p> <p><i>D is incorrect because this is the volume of carbon dioxide and water produced if water was a gas plus 100 cm³ of oxygen that remains</i></p>	1

Question number	Answer	Mark
19	<p>The only correct answer is C (500 cm³ of 1.0 mol dm⁻³ NaCl)</p> <p><i>A is incorrect because this contains $0.2 \times 1.5 \times 3 = 0.9$ mol of ions but C contains $0.5 \times 1.0 \times 2 = 1.0$ mol of ions</i></p> <p><i>B is incorrect because this contains $0.4 \times 0.8 \times 2 = 0.64$ mol of ions but C contains 1.0 mol of ions</i></p> <p><i>D is incorrect because this contains $1.0 \times 0.25 \times 3 = 0.75$ mol of ions but C contains 1.0 mol of ions</i></p>	1

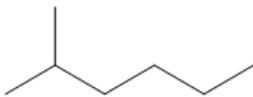
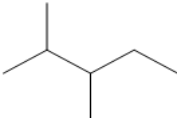

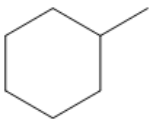
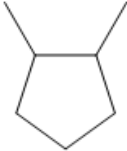
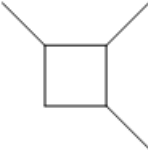

Question number	Answer	Mark
20	<p>The only correct answer is A (2×10^{10})</p> <p><i>B is incorrect because the mass of gold has not been converted into moles</i></p> <p><i>C is incorrect because kg has not been converted into g</i></p> <p><i>D is incorrect because the mass of gold has not been converted into moles and kg has not been converted into g</i></p>	1

Total for Section A = 20 marks

Section B

Question number	Answer	Additional guidance	Mark
21(a)(i)	<ul style="list-style-type: none">limited supply of oxygen / air	Accept not enough oxygen / air Allow lack of oxygen / air Ignore excess fuel / burning in an enclosed space Do not award no oxygen / air	1

Question number	Answer	Additional guidance	Mark
21(a)(ii)	<ul style="list-style-type: none">equation	Examples of equation: $2C_7H_{16} + 15O_2 \rightarrow 14CO + 16H_2O$ $C_7H_{16} + 7\frac{1}{2}O_2 \rightarrow 7CO + 8H_2O$ Allow multiples Ignore state symbols even if incorrect	1

Question number	Answer	Additional guidance	Mark
21(b)(i)	<ul style="list-style-type: none"> <li data-bbox="322 331 663 363">• branched-chain alkane <li data-bbox="322 555 524 587">• cycloalkane 	<p data-bbox="1128 293 1532 325">Examples of skeletal formulae:</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p data-bbox="1128 497 1827 529">Allow any branched-chain alkane with 7 carbon atoms</p> <div style="display: flex; flex-wrap: wrap; justify-content: space-around; align-items: center;">   </div> <div style="display: flex; flex-wrap: wrap; justify-content: space-around; align-items: center; margin-top: 10px;">    </div> <p data-bbox="1128 916 1939 979">Allow any ring with three or more carbon atoms and additional carbons to give a total of 7 carbon atoms</p> <p data-bbox="1128 1027 1886 1123">Allow (1) for a correct branched-chain alkane and a cyclic alkane with 7 carbon atoms using structural or displayed formulae</p> <p data-bbox="1128 1171 1800 1203">Ignore molecular formulae / names even if incorrect</p> <p data-bbox="1128 1225 1939 1331">If no other mark is awarded, allow (1) for correct skeletal formulae of a branched-chain alkane and a cycloalkane that do not have 7 carbon atoms</p>	2

Question number	Answer	Additional guidance	Mark
21(b)(ii)	<ul style="list-style-type: none"> equation 	<p>Example of equation: $C_7H_{16} \rightarrow C_7H_{14} + H_2$</p> <p>Allow multiples</p> <p>Ignore structural / displayed / skeletal formulae Ignore state symbols even if incorrect</p> <p>Do not award equations for cracking into more than one hydrocarbon</p>	1

Question number	Answer	Additional guidance	Mark
21(b)(iii)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> burns more efficiently / smoothly <p>or</p> <ul style="list-style-type: none"> prevents pre-ignition / knocking / pinking 	<p>Allow the octane number would increase Allow research octane number (RON) increases</p> <p>Ignore increases efficiency of the engine / just 'more efficient' / burns more easily / burns better / increase in volatility</p>	1

Question number	Answer	Additional guidance	Mark
21(c)(i)	<ul style="list-style-type: none"> (free) radical (1) substitution (1) 	<p>Allow the words in either order</p> <p>Ignore homolytic /photochemical Do not award heterolytic / nucleophilic / electrophilic</p> <p>Do not award other types of reaction e.g. addition</p>	2

Question number	Answer	Additional guidance	Mark
21(c)(ii)	<ul style="list-style-type: none"> • initiation (step) • equation for initiation step • propagation (step(s)) • one equation for a propagation step • another equation for a propagation step • termination (step) • equation for termination step 	<p>Allow structural / displayed formulae Penalise missing • once only Ignore full curly arrows and curly half-arrows even if incorrect Ignore reference to any conditions e.g. uv / heat</p> <p>(1) Allow initiating (step)</p> <p>(1) $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$ / $\text{Cl}_2 \rightarrow \text{Cl}\cdot + \text{Cl}\cdot$ / $\frac{1}{2}\text{Cl}_2 \rightarrow \text{Cl}\cdot$ or Cl-Cl for Cl_2</p> <p>(1) Allow propagating (step(s))</p> <p>(1) $\text{C}_7\text{H}_{16} + \text{Cl}\cdot \rightarrow \text{C}_7\text{H}_{15}\cdot + \text{HCl}$</p> <p>(1) $\text{C}_7\text{H}_{15}\cdot + \text{Cl}_2 \rightarrow \text{C}_7\text{H}_{15}\text{Cl} + \text{Cl}\cdot$</p> <p>Allow propagation steps in either order</p> <p>(1) Allow terminating (step)</p> <p>(1) $2\text{C}_7\text{H}_{15}\cdot \rightarrow \text{C}_{14}\text{H}_{30}$ / $\text{C}_7\text{H}_{15}\cdot + \text{C}_7\text{H}_{15}\cdot \rightarrow \text{C}_{14}\text{H}_{30}$</p> <p>Ignore additional termination steps - $\text{Cl}\cdot + \text{Cl}\cdot \rightarrow \text{Cl}_2$ / $\text{C}_7\text{H}_{15}\cdot + \text{Cl}\cdot \rightarrow \text{C}_7\text{H}_{15}\text{Cl}$</p> <p>Do not award any other termination steps</p>	7

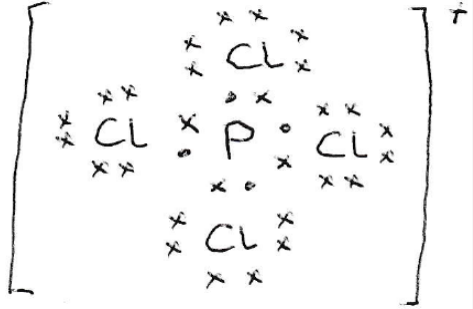
(Total for Question 21 = 15 marks)

Question number	Answer	Additional guidance	Mark
22(a)(i)	<ul style="list-style-type: none"> • axes correct and labelled with atomic radius /nm and atomic number (1) • points plotted correctly (1) 	<p>Example of graph:</p> <p>Allow y axis with 191 etc and label as pm or $\times 10^{-3}$ nm Ignore symbols on x axis Do not award M1 if x axis scale starts at 0</p> <p>The points for Si / atomic number 14 and P / atomic number 15 do not need to be marked</p> <p>Accept graph with or without line drawn</p> <p>Comment If atomic radius is plotted on the x axis, allow (1) for correct graph</p>	2

Question number	Answer	Additional guidance	Mark
22(a)(ii)	<ul style="list-style-type: none"> value in allowed range 	Allow 0.112 to 0.118 (nm) Allow value written in table Ignore any value given for phosphorus	1

Question number	Answer	Additional guidance	Mark
22(a)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> (as the atomic number increases / across the period) the nuclear charge increases / the number of protons (in the nucleus) increases (1) <p>Any two from:</p> <ul style="list-style-type: none"> this is only partially offset by the increased electron (-electron) repulsion as the number of electrons in the (outer) shell increases (1) the electrons are all the same (quantum) shell / experience similar shielding (1) so there is an increase in attractive force between the nucleus and (outer) electrons (1) 	Allow effective nuclear charge increases Allow the same amount of shielding Allow same number of (occupied quantum) shells Do not award electrons in the same subshell / orbital	3

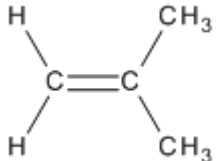
Question number	Answer	Additional guidance	Mark																				
22(b)	<ul style="list-style-type: none"> • giant for structure of sodium chloride (1) • metallic bonding for sodium (1) • ionic bonding for sodium chloride (1) • intermolecular (forces) for chlorine (1) • Na⁺ and electrons / cations and electrons (particles in sodium) (1) • Na⁺ and Cl⁻ /cations and anions (particles in sodium chloride) (1) 	<p>Allow giant ionic / (giant) lattice</p> <p>Ignore metal</p> <p>Ignore ion(s) Ignore electrostatic attractions in M2 and M3</p> <p>Accept London / dispersion (forces) Allow van der Waals' (forces) Ignore weak (forces)</p> <p>Allow positive ions and electrons Allow sodium atoms / ions and electrons</p> <p>Allow positive (sodium) ion and negative (chloride / chlorine) ion Ignore just sodium ions and chloride ions Penalise incorrect charge on an ion once only e.g. Na²⁺</p>	6																				
<p><u>Example of table:</u></p> <table border="1" data-bbox="712 930 1603 1370" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Substance</th> <th>Sodium</th> <th>Sodium chloride</th> <th>Chlorine</th> </tr> </thead> <tbody> <tr> <td>Melting temperature /°C</td> <td>(98)</td> <td>(801)</td> <td>(-101)</td> </tr> <tr> <td>Type of structure</td> <td>(giant)</td> <td>giant</td> <td>(simple molecular)</td> </tr> <tr> <td>Type of bond or force broken on melting</td> <td>metallic</td> <td>ionic</td> <td>intermolecular forces</td> </tr> <tr> <td>Particles involved</td> <td>Na⁺ and electrons / cations and electrons</td> <td>Na⁺ and Cl⁻ /cations and anions</td> <td>(chlorine molecules)</td> </tr> </tbody> </table>				Substance	Sodium	Sodium chloride	Chlorine	Melting temperature /°C	(98)	(801)	(-101)	Type of structure	(giant)	giant	(simple molecular)	Type of bond or force broken on melting	metallic	ionic	intermolecular forces	Particles involved	Na ⁺ and electrons / cations and electrons	Na ⁺ and Cl ⁻ /cations and anions	(chlorine molecules)
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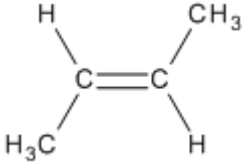
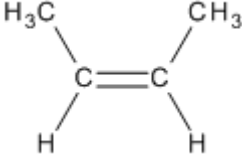
Question number	Answer	Additional guidance	Mark
22(c)(i)	<ul style="list-style-type: none"> correct dot-and-cross diagram 	<p>Example of dot-and-cross diagram:</p>  <p>Allow any combination of dots and crosses, including all dots or all crosses</p> <p>Allow overlapping circles</p> <p>Allow electrons in bonds along the axis of the bond</p> <p>Ignore missing bracket and charge</p> <p>Ignore lines representing covalent bonds e.g. $\frac{x}{\cdot}$</p>	1

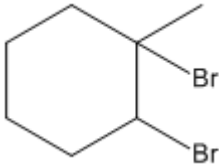
Question number	Answer	Additional guidance	Mark
22(c)(ii)	<ul style="list-style-type: none"> <li data-bbox="383 236 1218 268">• Shape – tetrahedral (1) <li data-bbox="383 363 1218 432">• Justification – (four) bonding pairs /pairs of electrons (around P) (1) <li data-bbox="383 616 1218 647">• (electron pairs) arranged to minimise repulsion (1) 	<p data-bbox="1256 236 1585 316">Stand alone No TE on (c)(i) for shape</p> <p data-bbox="1256 376 1912 552">Allow the number of electron pairs shown in (c)(i) Allow regions of electron density for electron pairs Ignore reference to lone pair-lone pair / lone pair-bond pair repulsion</p> <p data-bbox="1256 596 1845 663">Allow (electron pairs) arranged for maximum separation / as far apart as possible</p> <p data-bbox="1256 708 1697 740">Ignore electron pairs repel equally</p> <p data-bbox="1256 785 1928 841">Penalise use of bonds for electron pairs once only in M2 and M3</p>	3

(Total for Question 22 = 16 marks)

Question number	Answer	Additional guidance	Mark
23(a)	<ul style="list-style-type: none"> (alkene is) C₈H₁₆ 	Allow H ₁₆ C ₈ Allow large numbers e.g. C8H16 Do not award C ⁸ H ¹⁶	1

Question number	Answer	Additional guidance	Mark
23(b)(i)	<ul style="list-style-type: none"> structure of C₄H₈ branched alkene 	Example of structure:  Allow any unambiguous structure e.g. structural or displayed formula or any combination of these / skeletal formula Ignore name even if incorrect	1

Question number	Answer	Additional guidance	Mark
23(b)(ii)	<ul style="list-style-type: none"> • structure of one geometric isomer and name (1) • structure of the other geometric isomer and name (1) 	<p>Examples of structures and names:</p> <div style="text-align: center;">  </div> <p>and <i>trans</i>-but-2-ene / <i>E</i>-but-2-ene</p> <div style="text-align: center;">  </div> <p>and <i>cis</i>-but-2-ene / <i>Z</i>-but-2-ene</p> <p>Allow isomers in either order</p> <p>Allow 2-butene for but-2-ene</p> <p>Allow any unambiguous structures e.g. displayed formulae or skeletal formulae</p> <p>Ignore missing hyphens</p> <p>If no other mark is scored, allow (1) for two correct structures or two correct names</p>	2

Question number	Answer	Additional guidance	Mark
23(c)(i)	<ul style="list-style-type: none"> skeletal formula of product 	Example of skeletal formula:  Ignore structural / displayed formula	1

Question number	Answer	Additional guidance	Mark
23(c)(ii)	An answer that makes reference to one of the following pairs: Either <ul style="list-style-type: none"> steam / H₂O(g) (1) phosphoric(V) acid (catalyst) / H₃PO₄ (1) Or <ul style="list-style-type: none"> (concentrated) sulfuric acid / H₂SO₄ (1) followed by water / H₂O (1) 	Allow reagent and condition written on either dotted line for the steam and phosphoric acid answer Allow water / H ₂ O and heat / any temperature above 100°C Ignore pressure If oxidation number is given, it must be correct Allow just 'acid catalyst' Ignore hydrochloric acid / just 'H ⁺ ' Ignore specified temperature / heat / reflux Do not award H ₂ O(g)	2

Question number	Answer	Additional guidance	Mark
23(d)	<ul style="list-style-type: none"> curly arrow from C=C bond to / towards $I^{\delta+}$ and curly arrow from I-Cl bond to, or just beyond Cl (1) intermediate (1) lone pair on Cl^- and curly arrow from lone pair to carbon with positive charge (1) structure of major product (1) 	<p>Example of mechanism:</p> <p>Do not award $\delta+$ charge on intermediate</p> <p>Do not award $\delta-$ charge on chloride ion</p> <p>Allow curly arrow from lone pair to positive charge</p> <p>Note Mechanism for the formation of the minor product can score M1, M3 and M4</p>	4

Question number	Answer	Additional guidance	Mark
23(e)	<ul style="list-style-type: none"> pent-2-ene 	<p>Allow 2-pentene Ignore <i>E</i> / <i>Z</i> / <i>cis</i> / <i>trans</i> Do not award just 'pentene'</p>	1

Question number	Answer	Additional guidance	Mark
23(f)	<ul style="list-style-type: none"> • conversion of volume to m³ • rearrangement of ideal gas equation • evaluation to give n • deduction of number of double bonds 	<p>(1) Example of calculation: volume of H₂ = $\frac{600}{1 \times 10^6} = 6 \times 10^{-4} / 0.0006 \text{ m}^3$</p> <p>(1) $n = \frac{pV}{RT}$ or $n = \frac{1.24 \times 10^5 \times 6 \times 10^{-4}}{8.31 \times 298}$</p> <p>TE on volume</p> <p>(1) $n = 0.03004 / 0.0300 / 0.030 / 0.03$ TE on volume</p> <p>(1) ratio alkene : H₂ = 0.01 : 0.03 / 1 : 3 and so there are 3 double bonds</p> <p>TE on volume</p> <p>Final answer with no working scores (1)</p> <p>Ignore SF including 1SF</p>	4

(Total for Question 23 = 16 marks)

Question number	Answer	Additional guidance	Mark						
24(a)	<ul style="list-style-type: none"> all three numbers correct 	Example of table: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Number of protons</th> <th>Number of neutrons</th> <th>Number of electrons</th> </tr> </thead> <tbody> <tr> <td>26</td> <td>30</td> <td>24</td> </tr> </tbody> </table>	Number of protons	Number of neutrons	Number of electrons	26	30	24	1
Number of protons	Number of neutrons	Number of electrons							
26	30	24							

Question number	Answer	Additional guidance	Mark
24(b)	<ul style="list-style-type: none"> expression to calculate relative atomic mass correct answer to 3SF 	Example of calculation: $\frac{(54 \times 5.84) + (56 \times 91.68) + (57 \times 2.17) + (58 \times 0.31)}{100}$ Relative atomic mass (= 55.911) = 55.9 TE on incorrect numbers in correct expression Ignore units of g mol^{-1} or g mol^{-} Do not award other incorrect units e.g. g or % Correct answer with some working scores (2)	2

Question number	Answer	Additional guidance	Mark
24(c)	<ul style="list-style-type: none"> <li data-bbox="383 292 613 323">• ionic equation <li data-bbox="383 443 645 475">• all state symbols 	<p data-bbox="1227 217 1509 248">Example of equation:</p> <p data-bbox="1144 288 1715 320">(1) $\text{Mg(s)} + \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Fe(s)} + \text{Mg}^{2+}(\text{aq})$</p> <p data-bbox="1227 363 1440 395">Allow multiples</p> <p data-bbox="1144 440 1816 472">(1) State symbols conditional on correct equation</p> <p data-bbox="1227 491 1921 560">Allow state symbols if equation includes correct metals combined with ions with incorrect charges e.g.</p> <p data-bbox="1227 579 1783 611">$3\text{Mg(s)} + 2\text{Fe}^{3+}(\text{aq}) \rightarrow 2\text{Fe(s)} + 3\text{Mg}^{2+}(\text{aq})$</p> <p data-bbox="1227 619 1267 651">Or</p> <p data-bbox="1227 670 1738 702">$2\text{Mg(s)} + \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Fe(s)} + 2\text{Mg}^{+}(\text{aq})$</p> <p data-bbox="1227 746 1910 778">Allow state symbols for balanced non-ionic equation</p> <p data-bbox="1227 786 1771 818">$\text{Mg(s)} + \text{FeSO}_4 \rightarrow \text{Fe(s)} + \text{MgSO}_4(\text{aq})$</p> <p data-bbox="1227 826 1384 858">or multiples</p>	2

Question number	Answer	Additional guidance	Mark																														
24(d)	<ul style="list-style-type: none"> • calculation of mass of oxygen and working to find mol • calculation of mol of Fe, S and O • calculation of simplest whole number ratio and deduction of empirical formula 	<p>Example of calculation: mass of oxygen = 25.00 – 6.98 – 6.03 = 11.99 (g)</p> <table style="margin-left: 40px;"> <tr> <td></td> <td style="text-align: center;">Fe</td> <td style="text-align: center;">:</td> <td style="text-align: center;">S</td> <td style="text-align: center;">:</td> <td style="text-align: center;">O</td> </tr> <tr> <td style="text-align: right;">mol</td> <td style="text-align: center;"><u>6.98</u></td> <td style="text-align: center;">:</td> <td style="text-align: center;"><u>6.03</u></td> <td style="text-align: center;">:</td> <td style="text-align: center;"><u>11.99</u></td> </tr> <tr> <td></td> <td style="text-align: center;">55.8</td> <td></td> <td style="text-align: center;">32.1</td> <td></td> <td style="text-align: center;">16.0</td> </tr> </table> <p style="margin-left: 40px;">= 0.12509 : 0.18785 : 0.74938</p> <p>Ignore SF except 1 SF in M2</p> <table style="margin-left: 40px;"> <tr> <td style="text-align: right;">ratio</td> <td style="text-align: center;">1</td> <td style="text-align: center;">:</td> <td style="text-align: center;">1.5</td> <td style="text-align: center;">:</td> <td style="text-align: center;">6</td> </tr> <tr> <td style="text-align: right;">=</td> <td style="text-align: center;">2</td> <td style="text-align: center;">:</td> <td style="text-align: center;">3</td> <td style="text-align: center;">:</td> <td style="text-align: center;">12</td> </tr> </table> <p>and</p> <p>empirical formula is Fe₂S₃O₁₂ TE on mol Fe, S and O</p> <p>Allow symbols in any order</p> <p>Correct empirical formula with no working scores (3)</p> <p>Penalise incorrect rounding / truncation of numbers once only in M2 e.g. 0.12 / 0.18 / 0.74</p> <p>Note Allow (3) for correct working with Fe₂(SO₄)₃ but Fe₂(SO₄)₃ with no working scores (0)</p>		Fe	:	S	:	O	mol	<u>6.98</u>	:	<u>6.03</u>	:	<u>11.99</u>		55.8		32.1		16.0	ratio	1	:	1.5	:	6	=	2	:	3	:	12	3
	Fe	:	S	:	O																												
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ratio	1	:	1.5	:	6																												
=	2	:	3	:	12																												

Question number	Answer	Additional guidance	Mark
24(e)	<ul style="list-style-type: none"> • calculation of mol of iron(III) oxide • calculation of mol of sulfur dioxide and mol of sulfur trioxide • calculation of mass and mol of H₂O • calculation of value of x • balanced equation 	<p>(1) Example of calculation: $\text{mol Fe}_2\text{O}_3 = \frac{2.00}{159.6} = 0.012531 / 1.2531 \times 10^{-2}$</p> <p>(1) and $\text{mol SO}_2 = \frac{0.80}{64.1} = 0.0124805 / 1.24805 \times 10^{-2}$</p> <p>(1) and $\text{mol SO}_3 = \frac{1.00}{80.1} = 0.012484 / 1.2484 \times 10^{-2}$</p> <p>(1) mass of H₂O = 6.95 – (2.00 + 0.80 + 1.00) = 3.15 (g)</p> <p>and $\text{mol of H}_2\text{O} = \frac{3.15}{18} = 0.175 \text{ (mol)}$</p> <p>(1) Ratio SO₂ : SO₃ : H₂O = 1 : 1 : 14 There must be 2FeSO₄ to produce SO₂ and SO₃ So x = 7 TE on M1, M2, and M3 This mark may be awarded in M5</p> <p>(1) Example of equation: $2\text{FeSO}_4 \cdot 7\text{H}_2\text{O} \rightarrow \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3 + 14\text{H}_2\text{O}$ Stand alone mark</p> <p>Allow multiples Allow fractions for numbers of moles TE on value of x in M4 provided equation is balanced Ignore state symbols even if incorrect See next page for alternative methods Alternative methods for M3 and M4:</p>	5

		<p>Method 1 mol FeSO₄ = 2 x 1.2531 x 10⁻² = 0.025062 (1) M_r of hydrate = 6.95 / 0.025062 = 277.305 and mass of water = 265.34 – 151.9 = 125.405 (g) and mol water = 125.405/18 = 6.9669 = 7 (1)</p> <p>Method 2 mass of water = 6.95 – (2.00 + 0.80 + 1.00) = 3.15 (g) and mass of FeSO₄ = 3.8(0) (g) (1)</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td style="text-align: center;">FeSO₄</td> <td style="text-align: center;">H₂O</td> </tr> <tr> <td style="text-align: right;">mol FeSO₄ and water</td> <td style="text-align: center;"><u>3.80</u></td> <td style="text-align: center;"><u>3.15</u></td> </tr> <tr> <td></td> <td style="text-align: center;">151.9</td> <td style="text-align: center;">18</td> </tr> <tr> <td></td> <td style="text-align: center;">= 0.025</td> <td style="text-align: center;">0.175</td> </tr> <tr> <td style="text-align: right;">simplest ratio</td> <td style="text-align: center;">1</td> <td style="text-align: center;">7 (1)</td> </tr> </table>		FeSO ₄	H ₂ O	mol FeSO ₄ and water	<u>3.80</u>	<u>3.15</u>		151.9	18		= 0.025	0.175	simplest ratio	1	7 (1)	
	FeSO ₄	H ₂ O																
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(Total for Question 24 = 13 marks)

