Mark Scheme (Results)

Summer 2021

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

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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	**The only correct answer is D** (Y and Z) ***A*** *is incorrect because W and X both have the same number of neutrons* ***B*** *is incorrect because W and Y have different numbers of protons so are different elements* ***C*** *is incorrect because X and Y have different numbers of protons so are different elements*	**1**

Question number	Answer	Mark
2	**The only correct answer is C** (4) ***A*** *is incorrect because the* ICl_3^+ *ion can have 3 x* ^{35}Cl*, 2 x* ^{35}Cl *+ 1 x* ^{37}Cl*, 1 x* ^{35}Cl *+ 2 x* ^{37}Cl *or 3 x* ^{37}Cl ***B*** *is incorrect because the* ICl_3^+ *ion can have 3 x* ^{35}Cl*, 2 x* ^{35}Cl *+ 1 x* ^{37}Cl*, 1 x* ^{35}Cl *+ 2 x* ^{37}Cl *or 3 x* ^{37}Cl ***D*** *is incorrect because the* ICl_3^+ *ion can have 3 x* ^{35}Cl*, 2 x* ^{35}Cl *+ 1 x* ^{37}Cl*, 1 x* ^{35}Cl *+ 2 x* ^{37}Cl *or 3 x* ^{37}Cl	**1**

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

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

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

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

Question number	Answer	Mark
7	**The only correct answer is D** (286) ***A*** *is incorrect because this is the relative formula mass of anhydrous sodium carbonate,* Na_2CO_3 ***B*** *is incorrect because this is the relative formula mass of* $Na_2CO_3 + (20 \times 1) + 16$ ***C*** *is incorrect because this is the relative formula mass of* $NaCO_3.10H_2O$	1

Question number	Answer	Mark
8	**The only correct answer is C** (O^{2-}) ***A*** *is incorrect because* Na^+ *has more protons than oxygen and nitrogen but a lower charge than magnesium* ***B*** *is incorrect because* Mg^{2+} *is the smallest as it has the most protons and a higher charge than sodium* ***D*** *is incorrect because* F^- *has one more proton than oxygen and one less electron added to the atom*	1

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

Question number	Answer	Mark
10	**The only correct answer is A** (diamond) ***B*** *is incorrect because ice consists of H_2O molecules* ***C*** *is incorrect because poly(ethene) consists of long chain molecules* ***D*** *is incorrect because sodium chloride consists of a giant lattice of ions*	1

Question number	Answer	Mark
11	**The only correct answer is A** (H_2O) ***B*** *is incorrect because the greatest electronegativity difference is between hydrogen and oxygen* ***C*** *is incorrect because the greatest electronegativity difference is between hydrogen and oxygen* ***D*** *is incorrect because the greatest electronegativity difference is between hydrogen and oxygen*	1

Question number	Answer	Mark
12	**The only correct answer is B** (C_2F_4) ***A*** *is incorrect because CF_4 is tetrahedral* ***C*** *is incorrect because PF_5 is trigonal bipyramidal* ***D*** *is incorrect because SF_6 is octahedral*	1

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

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

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

Question number	Answer	Mark
16	**The only correct answer is C** (11.0 g of carbon dioxide) ***A*** *is incorrect because 6.0 dm^3 is occupied by 0.25 mol of gas and 2.0 g is 0.5 mol of helium* ***B*** *is incorrect because 6.0 dm^3 is occupied by 0.25 mol of gas and 4.0 g is 0.125 mol of oxygen gas, O_2* ***D*** *is incorrect because 6.0 dm^3 is occupied by 0.25 mol of gas and 14.0 g is 0.5 mol of nitrogen gas, N_2*	**1**

Question number	Answer	Mark
17	**The only correct answer is D** (Pb_3O_4) **A** *is incorrect because PbO contains 92.8% by mass of lead* ***B*** *is incorrect because PbO_2 contains 86.6% by mass of lead* ***C*** *is incorrect because Pb_2O_3 contains 89.6% by mass of lead*	**1**

Question number	Answer	Mark
18	**The only correct answer is B** (400 cm^3) ***A*** *is incorrect because this is the volume of carbon dioxide produced and there is 100 cm^3 of oxygen left* ***C*** *is incorrect because this is the volume of carbon dioxide and water produced if water was a gas* ***D*** *is incorrect because this is the volume of carbon dioxide and water produced if water was a gas plus 100 cm^3 of oxygen that remains*	**1**

Question number	Answer	Mark
19	**The only correct answer is C** (500 cm^3 of 1.0 mol dm^{-3} NaCl) ***A*** *is incorrect because this contains 0.2 x 1.5 x 3 = 0.9 mol of ions but **C** contains 0.5 x 1.0 x 2 = 1.0 mol of ions* ***B*** *is incorrect because this contains 0.4 x 0.8 x 2 = 0.64 mol of ions but **C** contains 1.0 mol of ions* ***D*** *is incorrect because this contains 1.0 x 0.25 x 3 = 0.75 mol of ions but **C** contains 1.0 mol of ions*	1

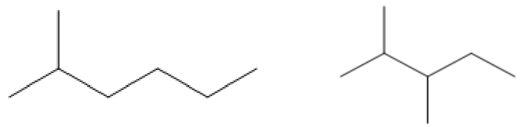
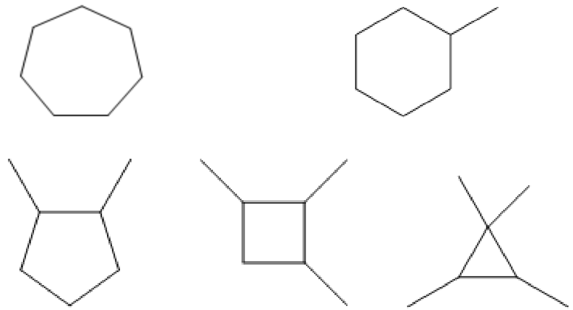
Question number	Answer	Mark
20	**The only correct answer is A** (2 x 10^{10}) ***B*** *is incorrect because the mass of gold has not been converted into moles* ***C*** *is incorrect because kg has not been converted into g* ***D*** *is incorrect because the mass of gold has not been converted into moles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

Total for Section A = 20 marks

Section B

Question number	Answer	Additional guidance	Mark
21(a)(i)	• 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)	• 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)	• branched-chain alkane **(1)** • cycloalkane **(1)**	Examples of skeletal formulae:  Allow any branched-chain alkane with 7 carbon atoms  Allow any ring with three or more carbon atoms and additional carbons to give a total of 7 carbon atoms Allow (1) for a correct branched-chain alkane **and** a cyclic alkane with 7 carbon atoms using structural or displayed formulae Ignore molecular formulae / names even if incorrect 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	**2**

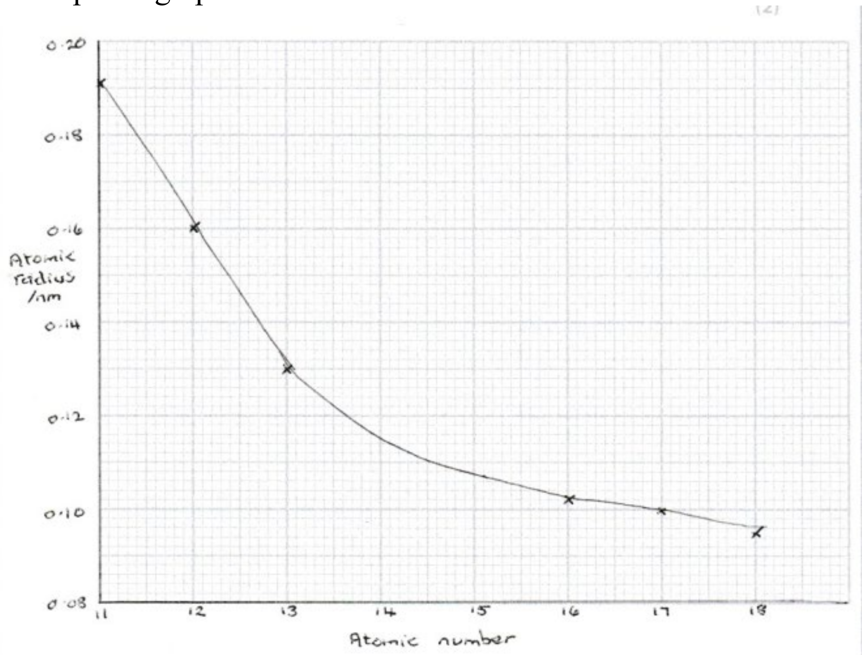
Question number	Answer	Additional guidance	Mark
21(b)(ii)	• equation	Example of equation: $C_7H_{16} \rightarrow C_7H_{14} + H_2$ Allow multiples Ignore structural / displayed / skeletal formulae Ignore state symbols even if incorrect Do not award equations for cracking into more than one hydrocarbon	**1**

Question number	Answer	Additional guidance	Mark
21(b)(iii)	An answer that makes reference to the following point: • burns more efficiently / smoothly **or** prevents pre-ignition / knocking / pinking	Allow the octane number would increase Allow research octane number (RON) increases Ignore increases efficiency of the engine / just ‘more efficient’ / burns more easily / burns better / increase in volatility	**1**

Question number	Answer	Additional guidance	Mark
21(c)(i)	• (free) radical **(1)** • substitution **(1)**	Allow the words in either order Ignore homolytic /photochemical Do not award heterolytic / nucleophilic / electrophilic Do not award other types of reaction e.g. addition	**2**

Question number	Answer	Additional guidance	Mark
21(c)(ii)		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	**7**
	• initiation (step) **(1)**	Allow initiating (step)	
	• equation for initiation step **(1)**	$Cl_2 \rightarrow 2Cl•$ / $Cl_2 \rightarrow Cl• + Cl•$ / $½Cl_2 \rightarrow Cl•$ or Cl-Cl for Cl_2	
	• propagation (step(s)) **(1)**	Allow propagating (step(s))	
	• one equation for a propagation step **(1)** • another equation for a propagation step **(1)**	$C_7H_{16} + Cl• \rightarrow C_7H_{15}• + HCl$ $C_7H_{15}• + Cl_2 \rightarrow C_7H_{15}Cl + Cl•$ Allow propagation steps in either order	
	• termination (step) **(1)**	Allow terminating (step)	
	• equation for termination step **(1)**	$2C_7H_{15}• \rightarrow C_{14}H_{30}$ / $C_7H_{15}• + C_7H_{15}• \rightarrow C_{14}H_{30}$ Ignore additional termination steps - $Cl• + Cl• \rightarrow Cl_2$ / $C_7H_{15}• + Cl• \rightarrow C_7H_{15}Cl$ Do not award any other termination steps	

(Total for Question 21 = 15 marks)

Question number	Answer	Additional guidance	Mark
22(a)(i)	• axes correct and labelled with atomic radius /nm and atomic number **(1)** • points plotted correctly **(1)**	Example of graph:  Allow y axis with 191 etc and label as pm or x 10^{-3} nm Ignore symbols on x axis Do not award M1 if x axis scale starts at 0 The points for Si / atomic number 14 and P / atomic number 15 do not need to be marked Accept graph with or without line drawn **Comment** If atomic radius is plotted on the x axis, allow (1) for correct graph	2

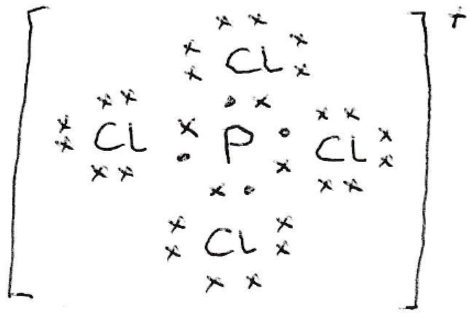
Question number	Answer	Additional guidance	Mark
22(a)(ii)	• value in allowed range	Allow 0.112 to 0.118 (nm) Allow value written in table Ignore any value given for phosphorus	**1**

Question number	Answer	Additional guidance	Mark
22(a)(iii)	An explanation that makes reference to the following points: • (as the atomic number increases / across the period) the nuclear charge increases / the number of protons (in the nucleus) increases **(1)** **Any two from:** • 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)	• giant for structure of sodium chloride **(1)**	Allow giant ionic / (giant) lattice	6
	• metallic bonding for sodium **(1)**	Ignore metal	
	• ionic bonding for sodium chloride **(1)**	Ignore ion(s) Ignore electrostatic attractions in M2 and M3	
	• intermolecular (forces) for chlorine **(1)**	Accept London / dispersion (forces) Allow van der Waals' (forces) Ignore weak (forces)	
	• Na^+ **and** electrons / cations **and** electrons (particles in sodium) **(1)**	Allow positive ions **and** electrons Allow sodium atoms / ions **and** electrons	
	• Na^+ **and** Cl^- /cations **and** anions (particles in sodium chloride) **(1)**	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. Na^{2+}	

<u>Example of table:</u>

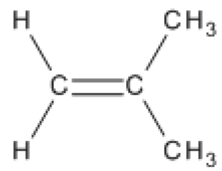
Substance	Sodium	Sodium chloride	Chlorine
Melting temperature /°C	(98)	(801)	(−101)
Type of structure	(giant)	giant	(simple molecular)
Type of bond or force broken on melting	metallic	ionic	intermolecular forces
Particles involved	Na^+ **and** electrons / cations **and** electrons	Na^+ **and** Cl^- /cations **and** anions	(chlorine molecules)

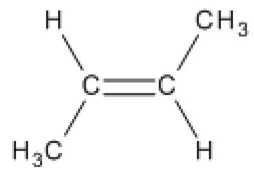
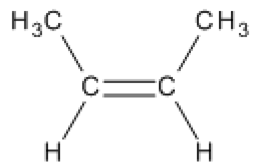
Question number	Answer	Additional guidance	Mark
22(c)(i)	• correct dot-and-cross diagram	Example of dot-and-cross diagram:  Allow any combination of dots and crosses, including all dots or all crosses Allow overlapping circles Allow electrons in bonds along the axis of the bond Ignore missing bracket and charge Ignore lines representing covalent bonds e.g. $\frac{\text{x}}{\bullet}$	1

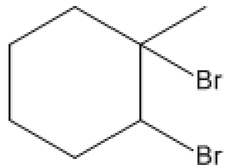
Question number	Answer	Additional guidance	Mark
22(c)(ii)	• Shape – tetrahedral **(1)** • Justification – (four) bonding pairs /pairs of electrons (around P) **(1)** • (electron pairs) arranged to minimise repulsion **(1)**	Stand alone No TE on (c)(i) for shape Allow the number of electron pairs shown in (c)(i) Allow regions of electron density for electron pairs Ignore reference to lone pair-lone pair / lone pair-bond pair repulsion Allow (electron pairs) arranged for maximum separation / as far apart as possible Ignore electron pairs repel equally Penalise use of bonds for electron pairs once only in M2 and M3	**3**

(Total for Question 22 = 16 marks)

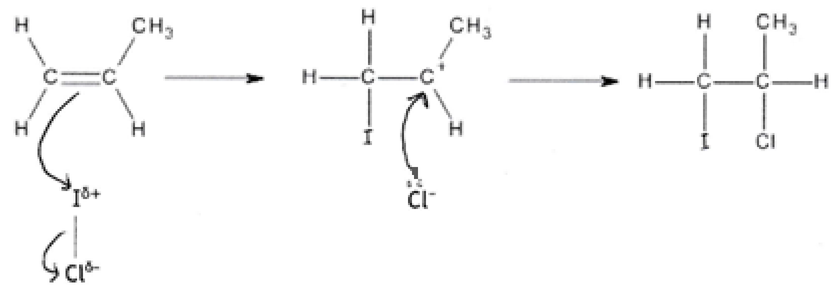
Question number	Answer	Additional guidance	Mark
23(a)	• (alkene is) C_8H_{16}	Allow $H_{16}C_8$ Allow large numbers e.g. C8H16 Do not award C^8H^{16}	**1**

Question number	Answer	Additional guidance	Mark
23(b)(i)	• structure of C_4H_8 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)	• structure of one geometric isomer **and** name **(1)** • structure of the other geometric isomer **and** name **(1)**	Examples of structures and names:  **and** *trans*-but-2-ene / *E*-but-2-ene  **and** *cis*-but-2-ene / *Z*-but-2-ene Allow isomers in either order Allow 2-butene for but-2-ene Allow any unambiguous structures e.g. displayed formulae or skeletal formulae Ignore missing hyphens If no other mark is scored, allow (1) for two correct structures **or** two correct names	**2**

Question number	Answer	Additional guidance	Mark
23(c)(i)	• 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** • steam / $H_2O(g)$ **(1)** • phosphoric((V)) acid (catalyst) / H_3PO_4 **(1)** **Or** • (concentrated) sulfuric acid / H_2SO_4 **(1)** • **followed by** water / H_2O **(1)**	Allow reagent and condition written on either dotted line for the steam and phosphoric acid answer Allow water / H_2O **and** heat / any temperature above 100ºC 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 $H_2O(g)$	2

Question number	Answer	Additional guidance	Mark
23(d)	• 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)**	Example of mechanism:  Do not award δ+ charge on intermediate Do not award δ− charge on chloride ion Allow curly arrow from lone pair to positive charge **Note** Mechanism for the formation of the minor product can score M1, M3 and M4	4

Question number	Answer	Additional guidance	Mark
23(e)	• pent-2-ene	Allow 2-pentene Ignore *E* / *Z* / *cis* / *trans* Do not award just 'pentene'	1

Question number	Answer	Additional guidance	Mark
23(f)	• conversion of volume to m^3 **(1)** • rearrangement of ideal gas equation **(1)** • evaluation to give n **(1)** • deduction of number of double bonds **(1)**	Example of calculation: volume of $H_2 = \frac{600}{1 \times 10^6} = 6 \times 10^{-4}$ / 0.0006 m^3 $n = \frac{pV}{RT}$ **or** $n = \frac{1.24 \times 10^5 \times 6 \times 10^{-4}}{8.31 \times 298}$ TE on volume n = 0.03004 / 0.0300 / 0.030 / 0.03 TE on volume ratio alkene : H_2 = 0.01 : 0.03 / 1 : 3 **and** so there are 3 double bonds TE on volume Final answer with no working scores (1) Ignore SF including 1SF	**4**

(Total for Question 23 = 16 marks)

Question number	Answer	Additional guidance	Mark
24(a)	• all three numbers correct	Example of table: <table><tr><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th></tr><tr><td>26</td><td>30</td><td>24</td></tr></table>	**1**

Question number	Answer	Additional guidance	Mark
24(b)	• expression to calculate relative atomic mass **(1)** • correct answer to 3SF **(1)**	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)	• ionic equation **(1)** • all state symbols **(1)**	Example of equation: $Mg(s) + Fe^{2+}(aq) \rightarrow Fe(s) + Mg^{2+}(aq)$ Allow multiples State symbols conditional on correct equation Allow state symbols if equation includes correct metals combined with ions with incorrect charges e.g. $3Mg(s) + 2Fe^{3+}(aq) \rightarrow 2Fe(s) + 3Mg^{2+}(aq)$ Or $2Mg(s) + Fe^{2+}(aq) \rightarrow Fe(s) + 2Mg^{+}(aq)$ Allow state symbols for balanced non-ionic equation $Mg(s) + FeSO_4 \rightarrow Fe(s) + MgSO_4(aq)$ or multiples	**2**

Question number	Answer	Additional guidance	Mark
24(d)	• calculation of mass of oxygen **and** working to find mol **(1)** • calculation of mol of Fe, S and O **(1)** • calculation of simplest whole number ratio **and** deduction of empirical formula **(1)**	Example of calculation: mass of oxygen = 25.00 – 6.98 – 6.03 = 11.99 (g) Fe : S : O mol $\frac{6.98}{55.8} : \frac{6.03}{32.1} : \frac{11.99}{16.0}$ = 0.12509 : 0.18785 : 0.74938 Ignore SF except 1 SF in M2 ratio 1 : 1.5 : 6 = 2 : 3 : 12 **and** empirical formula is $Fe_2S_3O_{12}$ TE on mol Fe, S and O Allow symbols in any order Correct empirical formula with no working scores (3) Penalise incorrect rounding / truncation of numbers once only in M2 e.g. 0.12 / 0.18 / 0.74 **Note** Allow (3) for correct working with $Fe_2(SO_4)_3$ but $Fe_2(SO_4)_3$ with no working scores (0)	3

Question number	Answer	Additional guidance	Mark
24(e)	• calculation of mol of iron(III) oxide **(1)** • calculation of mol of sulfur dioxide **and** mol of sulfur trioxide **(1)** • calculation of mass **and** mol of H_2O **(1)** • calculation of value of x **(1)** • balanced equation **(1)**	Example of calculation: mol $Fe_2O_3 = \frac{2.00}{159.6} = 0.012531$ / 1.2531×10^{-2} mol $SO_2 = \frac{0.80}{64.1} = 0.0124805$ / 1.24805×10^{-2} **and** mol $SO_3 = \frac{1.00}{80.1} = 0.012484$ / 1.2484×10^{-2} mass of $H_2O = 6.95 - (2.00 + 0.80 + 1.00)$ $= 3.15$ (g) **and** mol of $H_2O = \frac{3.15}{18} = 0.175$ (mol) Ratio $SO_2 : SO_3 : H_2O = 1 : 1 : 14$ There must be $2FeSO_4$ to produce SO_2 and SO_3 So x = 7 TE on M1, M2, and M3 This mark may be awarded in M5 Example of equation: $2FeSO_4.7H_2O \rightarrow Fe_2O_3 + SO_2 + SO_3 + 14H_2O$ Stand alone mark 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:	**5**

		Method 1 mol $FeSO_4$ = 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) **Method 2** mass of water = 6.95 – (2.00 + 0.80 + 1.00) = 3.15 (g) **and** mass of $FeSO_4$ = 3.8(0) (g) (1) $FeSO_4$ / H_2O mol $FeSO_4$ and water $\frac{3.80}{151.9}$ $\frac{3.15}{18}$ = 0.025 0.175 simplest ratio 1 7 (1)	

(Total for Question 24 = 13 marks)

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