Pearson Edexcel

Mark Scheme (Results)

January 2024

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.

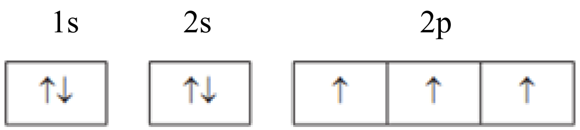
Section A

Question Number	Answer	Mark
1(a)	**The only correct answer is B** (element Q, 1521) ***A*** *is incorrect because it has 7 electrons in its outer shell* ***C*** *is incorrect because it has 1 electron in its outer shell* ***D*** *is incorrect because it has 2 electrons in its outer shell*	**(1)**

Question Number	Answer	Mark
1(b)	**The only correct answer is A** (element P, 1251) ***B*** *is incorrect because it would not form a compound as it is an inert gas.* ***C*** *is incorrect because it would not form a covalent compound* ***D*** *is incorrect because it would not form a covalent compound*	**(1)**

Question Number	Answer	Mark
1(c)	**The only correct answer is D** (element S, 590) ***A*** *is incorrect because it would form a covalent compound* ***B*** *is incorrect because it would not form a compound as it is an inert gas.* ***C*** *is incorrect because it would from a compound with the formula YF*	**(1)**

Question Number	Answer	Mark
1(d)	**The only correct answer is C** (element R, 419) ***A*** *is incorrect because it has a smaller atomic radius* ***B*** *is incorrect because it has a smaller atomic radius* ***D*** *is incorrect because it has a smaller atomic radius*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is C**  ***A*** *is incorrect because the 2s orbital should contain 2 electrons* ***B*** *is incorrect the 2s orbital should contain 2 electrons and each 2p orbital should have one electron before any are doubled up* ***D*** *is incorrect because each 2p orbital should have one electron before any are doubled up*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is A** (a molecule of ethene, $^{12}C_2\,^{1}H_4$) ***B*** *is incorrect because it contains 16 neutrons* ***C*** *is incorrect because it contains 16 neutrons* ***D*** *is incorrect because it contains 16 neutrons*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is D** (16, 20) ***A*** *is incorrect because both elements are in the p block* ***B*** *is incorrect because both elements are in the p block* ***C*** *is incorrect because both elements are in the p block*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is D** (NH_3(g)) ***A*** *is incorrect because it is not a polar molecule* ***B*** *is incorrect because it is not a polar molecule* ***C*** *is incorrect because it is not a polar molecule*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is B**(NO_2) ***A*** *is incorrect because it contains 47% N* ***C*** *is incorrect because it contains 64% N* ***D*** *is incorrect because it contains 37% N*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is B** (2.65 g) ***A*** *is incorrect because they have used the atomic numbers to calculate the* M_r ***C*** *is incorrect because they have used 500* cm^3 *not 250* cm^3. ***D*** *is incorrect because they have used 1000* cm^3 *not 250* cm^3.	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is C** (11.34 g cm^{-3}) ***A*** *is incorrect because they have divided the* A_r *by the number of moles* ***B*** *is incorrect they have used the atomic number not the mass number* ***D*** *is incorrect because this is the number of moles*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is D** (sodium, metallic, giant) ***A*** *is incorrect because copper(II) sulfate is an ionic giant substance* ***B*** *is incorrect because graphene is a covalent giant substance* ***C*** *is incorrect because iodine has covalent bonds*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is A** (1.167 g) ***B*** *is incorrect because they have used a 1:2 ratio not 1:1.* ***C*** *is incorrect because they have used the wrong concentration or volume of the barium chloride* ***D*** *is incorrect because they have used the wrong concentration or volume of the barium chloride and used a 1:2 ratio not 1:1.*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is D** (magnesium iodide) ***A*** *is incorrect because* Na^+ *has a smaller charge than* Mg^{2+} *and* Cl^- *is smaller than* I^- ***B*** *is incorrect because* Na^+ *has a smaller charge than* Mg^{2+} ***C*** *is incorrect because* Cl^- *is smaller than* I^-	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is D** (1.42×10^{21}) ***A*** *is incorrect because they have used iodine molecules not atoms and not multiplied by 10* ***B*** *is incorrect because they have not multiplied by 10* ***C*** *is incorrect because they have used iodine molecules not atoms*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is C** (0.00004%) **A** *is not correct because the answer shows the percentage equal to ppm* **B** *is not correct because the answer shows the ppm divided by 100* **D** *is not correct because the correct answer has been divided by 100*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is C** (5) **A** *is not correct because there are 5 isomers* **B** *is not correct because there are 5 isomers* **D** *is not correct because there are 5 isomers*	**(1)**

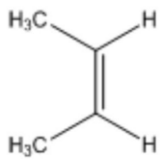
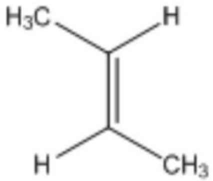
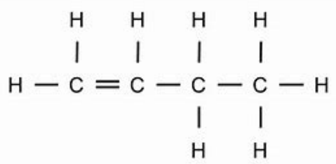
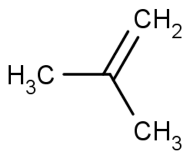
Question Number	Answer	Mark
15	**The only correct answer is B** (it decolourises bromine water) ***A*** *is not correct because it is an addition polymer* ***C*** *is not correct because it is non-biodegradable* ***D*** *is not correct because it has the empirical formula* CH_2	**(1)**

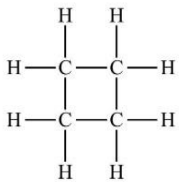
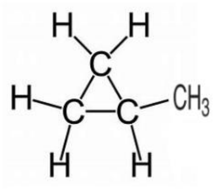
Question Number	Answer	Mark
16	**The only correct answer is A** (butene, pentane and propene) ***B*** *is not correct because there are too many hydrogen atoms in the products* ***C*** *is not correct because there are too few carbon atoms in the products* ***D*** *is not correct because there are too many carbon atoms in the products*	**(1)**

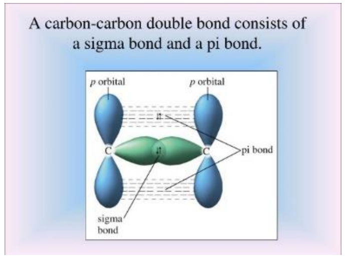
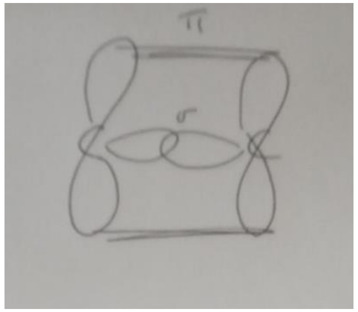
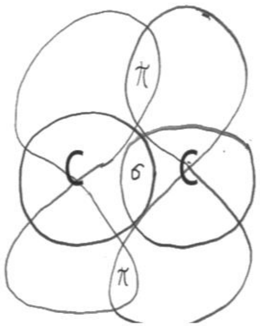
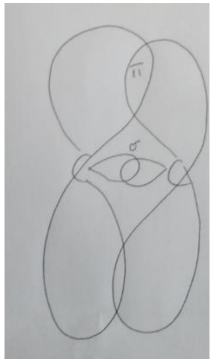
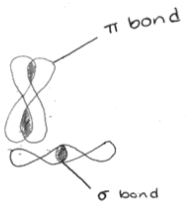
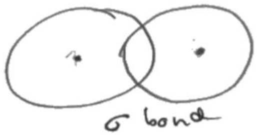
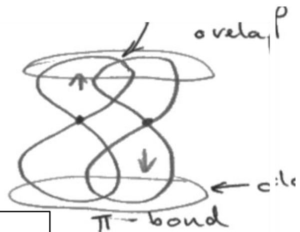
Question Number	Answer	Mark
17	**The only correct answer is C** (water, carbon dioxide and sulfur dioxide) ***A*** *is not correct because no hydrogen can be produced* ***B*** *is not correct because no hydrogen chloride can be produced* ***D*** *is not correct because no hydrogen can be produced*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
18(a)	An answer that makes reference to the following points: • **A**  *cis*- / *Z*- but-2-ene **(1)** • **B**  *trans*- /*E*- but-2-ene **(1)** • **C**  but-1-ene  methylprop-1-ene **(1)**	Allow structural/skeletal/displayed or any combination. Both name and structure required for each mark A and B can be swapped over If both A and B structures are correct but names wrong score 1(and vice versa) Ignore lack of hyphens Either structure allowed Allow $C_2H_5CHCH_2$ Allow 2-methylprop-1-ene, methylpropene	**(4)**

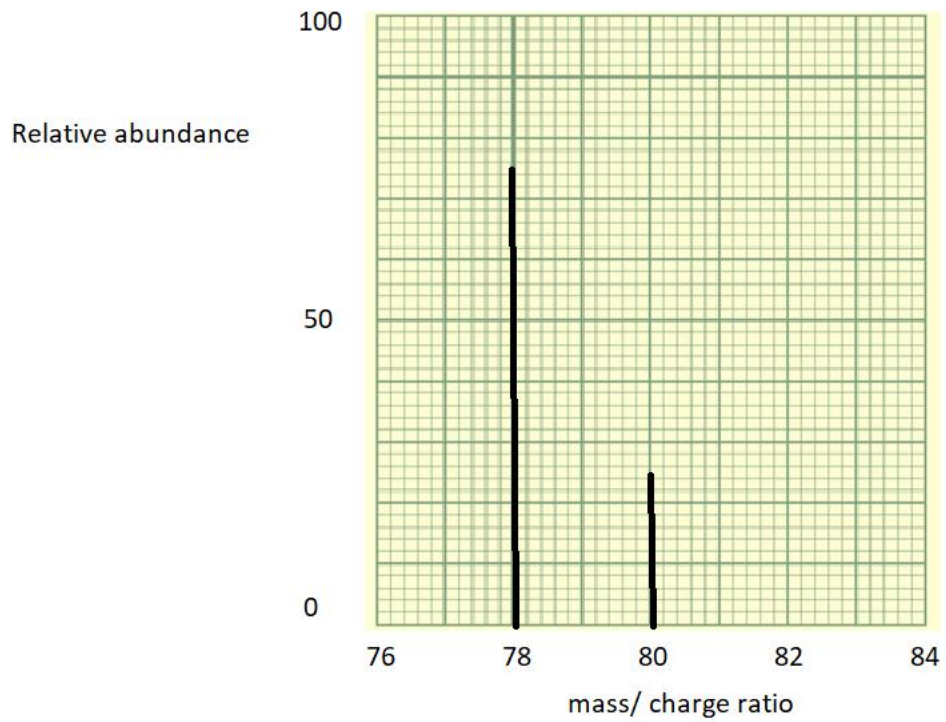
	• **D**  cyclobutane  methylcyclopropane	**(1)**	Either structure allowed If both C and D structures are correct but names wrong score 1(and vice versa) Only penalise missing Hs once if displayed or structural given Allow cyclicbutane If no other mark is awarded score 1 mark for any 2 correct structures or names in correct position	

Question Number	Answer	Additional Guidance	Mark
18(b)	An answer that makes reference to the following points:  • diagram showing electron density of σ bond **(1)** • diagram showing electron density of π bond **(1)**       Both needed	Only one pi bond needs to be labelled Can be shown by 2 separate diagrams All the examples on the left score M1 and M2 If both diagrams are correct but names reversed score 1 Do not award electron rings, single lines or contour lines	**(4)**

	• σ bond head/end on overlap of *(p)* orbitals **(1)** • π bond sideways overlap of *(p)* orbitals **(1)**	Allow overlap along the axis between the atoms/ nuclei Allow axial overlap Allow parallel overlap Allow lateral overlap Ignore above and below/horizontal	

Question Number	Answer	Additional Guidance	Mark
18(c)	An answer that makes reference to the following points: • restricted/ no rotation about the double bond/C=C **(1)** • (two) different groups on each carbon (of the double bond)/the carbon**s** (of the double bond) **(1)**	Allow no or restricted free rotation Ignore lack of twisting/bending/movement Allow different elements/atoms/functional groups Allow an explanation or diagram of the positions of the CH_3 and H. Ignore just the position of the CH_3 Do not award different compounds/molecules	**(2)**

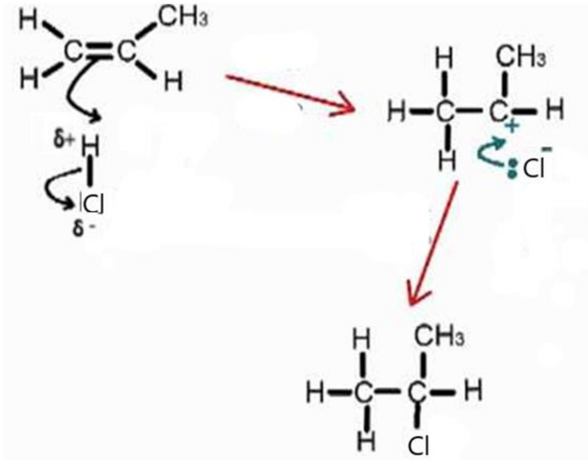
(Total for Question 18 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
19(a)	A description that makes reference to the following points: • two peaks at 78 and 80 **(1)** • peak at 78, 3 x higher than peak at 80 **(1)**  	If there are more than 2 peaks score 0 Allow within 1small square If the peaks are wrong but the lower mass/ charge one is 3x higher than the other, M2 can be scored as a TE. Ignore any labels on the peaks	**(2)**

Question Number	Answer	Additional Guidance	Mark
19(b)(i)	An answer that makes reference to the following points:  • diagram showing curly half-arrows forming 2 free radicals **(1)** • uv (radiation / light) or sunlight **(1)**	Both arrows can come from the same side of the bond Ignore just light	**(2)**

Question Number	Answer	Additional Guidance	Mark
19(b)(ii)	An answer that makes reference to the following points: • homolytic: each atom gets one electron/ the electron pair splits evenly **(1)** • free radical: species with an unpaired electron **(1)**	Allow equal splitting of the electrons (in the bond) Allow atom/ element Allow lone electron Ignore free electron	**(2)**

Question Number	Answer	Additional Guidance	Mark
19(b)(iii)	An answer that makes reference to the following point: • multiple substitutions can occur/ more than one (organic) product	Allow more products formed//more waste products Allow termination products Allow side products/reactions Allow further reactions Ignore chain reaction Ignore poor yield/atom economy Ignore forms impurities Ignore references to HCl being formed/toxic	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(c)(i)	An answer that makes reference to the following points: • 1 dipole on H–Cl • 2 curly arrow from H–Cl bond to Clδ– • 3 curly arrow from double bond to H(δ+) • 4 correct carbocation intermediate • 5 curly arrow from lone pair on Cl • 6 arrow to C+ on intermediate • 7 charge on chloride ion All 7 marking points score 4 marks, 5/6 points score 3 marks, 3/4 points score 2, 2 points score 1 mark	 Arrows must start from the covalent bond or lone pair From the H—Cl bond it must go to the Cl or beyond. From the C=C bond it must go to the H or in the space. From the lone pair on the Cl it must go to the C+ on the intermediate. If wrong alkene used just penalise 1 marking point. If primary carbocation is formed just penalise marking point 4 If half curly arrows used penalise 1 marking point If HBr/HI used penalise 1 marking point	**(4)**

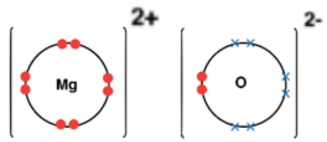
Question Number	Answer		Additional Guidance	Mark
19(c)(ii)	An answer that makes reference to the following points: • (the formation of 1-chloropropane goes via a) primary carbocation • (which is) less stable than the secondary carbocation (formed when of 2-chloropropane is produced)	 (1) (1)	Do not award 1-chloropropane is a primary carbocation or 2-chloropropane is a secondary carbocation but only penalise once, Allow the correct comparison between a tertiary and primary or secondary carbocation for 1 mark Allow reverse argument	(2)

(Total for Question 19 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
20(a)(i)	An answer that makes reference to the following points: • calculation of the % abundance of the third isotope **(1)** • substitute equation **(1)** • calculation of the mass of the 3rd isotope **(1)** • answer to 2 SF only **(1)**	Example of calculation 100- 78.99-10.00 = 11.01(%) $24.32 = \frac{(24 \times 78.99) + (25 \times 10) + (y \times 11.01)}{100}$ $y = \frac{2432 - (24 \times 78.99) - (25 \times 10)}{11.01}$ y = 25.998 mass number = 26 Correct answer with some correct working beyond M1 scores 4	**(4)**

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	An answer that makes reference to the following points: • same number of protons **and** different number of neutrons	Allow same atomic number/ same number of electrons/ same electronic configuration/ same reactivity/chemical properties Ignore they are the same element **and** Allow different number of nucleons/ different mass number/different (atomic) mass Do not award relative atomic mass	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(a)(iii)	An answer that makes reference to the following point: • ^{24}Mg **and** lowest mass or lowest m/z ratio (so deflected more by the magnetic field)	Allow ^{24}Mg is lightest Allow $^{24}Mg^{+}$ Ignore just the lowest mass	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following points: • correct structure of Mg ion and charge **(1)** • correct structure of O ion and charge **(1)**	Example of diagrams Allow any combination/position of dots and crosses or just dots or just crosses.  Accept Mg with charge but no electrons and/or no circle Penalise lack of charges once only	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	An answer that makes reference to the following points: • oxide/ O^{2-} smaller than sulfate/ SO_4^{2-} **(1)** • stronger (electrostatic) attraction between the (Mg^{2+} and O^{2-}) **ions** **(1)**	Allow just the oxide is smaller or vice versa Do not award comparison with sulfur or sulfide Allow stronger **ionic** bond Allow more energy required to break the **ionic** bond Allow reverse argument Ignore reference to lattice energy Ignore reference to distortion/polarisation Any reference to intermolecular forces /covalent bond/molecular structure score 0	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(c)	An answer that makes reference to the following points: • Mg: has delocalised electrons (that are free to move) when solid **and** liquid **(1)** • MgO: ions are only free to move when liquid **(1)**	Allow has electrons that are free to move Allow ions are not free to move when solid Ignore ions/electrons carrying charge	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(d)(i)	Example of equation $Mg(s) + H_2SO_4(aq) \longrightarrow MgSO_4(aq) + H_2(g)$ • correct balanced equation **(1)** • correct state symbols **(1)**	$Mg(s) + 2H^+(aq) \longrightarrow Mg^{2+}(aq) + H_2(g)$ Allow multiples Allow ionic equation M2 dependent on M1 or having the correct species in an unbalanced equation	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(d)(ii)	An answer that makes reference to the following points: • bubbles (of gas)/ fizzing/ effervescence **(1)** • Mg disappears/ disintegrates /gets smaller /dissolves **(1)** OR mixture gets warmer/ temperature increase	Ignore just hydrogen/gas produced Allow solid disappears Ignore Mg floats Ignore just exothermic/ temperature changes Do not award white ppt	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(e)(i)	• number of moles of sulfuric acid	Example of calculation $30 \times 0.5 \div 1000 = 0.015/ 1.5 \times 10^{-2}$ (mol) Do not award 1 SF.	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(e)(ii)	• mass of Mg	Example of calculation $0.015/\ 1.5 \times 10^{-2} \times 24.3 = 0.3645$ (g) Ignore SF except 1SF TE on (e)(i).	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(e)(iii)	An answer that makes reference to the following point: • to ensure all the sulfuric acid is used up/ sulfuric acid is limiting	Allow all the sulfuric acid is neutralised Allow Mg is easy to remove from the reaction mixture. Ignore so that the Mg is in excess	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(e)(iv)	An answer that refers to the following point: • (gravity) filtration	Ignore any heating after filtration	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(e)(v)	• maximum mass of $MgSO_4{\cdot}7H_2O$ **(1)** • calculation of % yield **(1)** • moles of of $MgSO_4{\cdot}7H_2O$ **(1)** • calculation of % yield **(1)**	<u>Example of calculation</u> 0.015/ 1.5×10^{-2} (mol) × 246.4 = 3.696 g 2.78 ÷ 3.696 × 100 = 75.216 % Ignore SF except 1SF TE on (e)(i) OR 2.78 ÷ 246.4 = 0.011282 (mol) 0.011282 /0.015 × 100 = 75.216 % Ignore SF except 1SF TE on (e)(i) TE on calculated molar mass of $MgSO_4{\cdot}7H_2O$ as long as the % is less than 100% Correct answer with some working scores 2	**(2)**

(Total for Question 20 = 22 marks)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>21(a)</td>
<td>

M1 % (of hydrogen) (1)
M2 calculation of moles (1)
M3 divide by the lowest number of moles to get empirical formula (1)
M4 calculation of M_r of empirical formula (1)

M1 % (of hydrogen) (1)
M2 multiplication of % by M_r (row 2) (1)
M3 calculation of ratio number (row 3) (1)
M4 divide by the lowest number to get empirical formula (row 4) (1)

</td>
<td>
<u>Example of calculation</u>

100 − 17.48 – 77.67 = 4.85 (%)

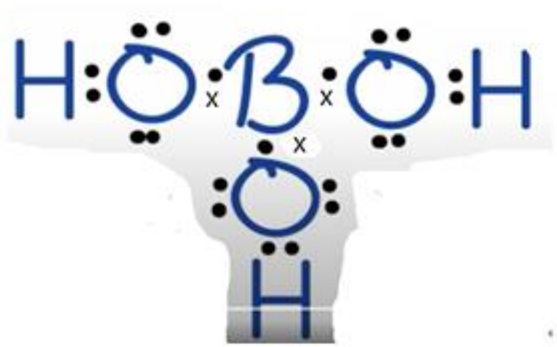
<table>
<tr><th>B</th><th>O</th><th>H</th></tr>
<tr><td>17.48/10.8</td><td>77.67/16</td><td>4.85/1</td></tr>
<tr><td>1.6185</td><td>4.854</td><td>4.85</td></tr>
<tr><td>1.6185/1.6185 = 1</td><td>4.85/1.6185 = 2.996</td><td>4.85/1.6185 = 2.996</td></tr>
</table>

1 x 10.8 + 3 x 16 + 3 x 1 = 61.8 (g mol^{-1})

If they only use 2 elements, they can score one mark for M2 and M3 being correct for both B and O

Or

<table>
<tr><th>B</th><th>O</th><th>H</th></tr>
<tr><td>17.48 × 61.8/100</td><td>77.67 × 61.8/100</td><td>4.85 × 61.8/100</td></tr>
<tr><td>= 10.8</td><td>= 48</td><td>= 3</td></tr>
<tr><td>10.8/10.8 = 1</td><td>48/16 = 3</td><td>3/1 = 3</td></tr>
</table>
</td>
<td>(4)</td>
</tr>
</table>

Question Number	Answer	Additional Guidance	Mark
21(b)(i)	An answer that makes reference to the following points: • correct electrons around B **(1)** • correct electrons around the oxygens **(1)** • correct electrons round the hydrogens **(1)**	Example of diagram Allow any combination of dots and crosses or just dots or just crosses.  Ignore how the lone pair electrons are arranged in oxygen. The marks are only awarded if the bond and number of bonds is correct between the correct two atoms. Anything ionic score 0	**(3)**

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	An answer that makes reference to the following points: • bond angle 120° **(1)** • 3 (bonding) pairs of electrons (round B) adopt a position of minimum repulsion **(1)**	Ignore trigonal planar/any shape even if incorrect Allow maximum separation of 3 electron pairs No TE on incorrect bond angle for M2 Do not award bonds for electrons Ignore electron pairs have equal repulsion Allow TE on structure in (b)(i) If structure in (b)(i) has 3 bonding and 1 lone pair of electrons M1 bond angle of 107^{o} (allow 106-108) M2 lone pairs repel more than bonding pairs (and adopt a position of minimum repulsion/maximum separation) Any ionic structure from (b)(i) will score 0	**(2)**

(Total for Question 21 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
22(a)	• conversion of dm^3 to m^3 **(1)** • conversion of temperature to K **(1)** • rearrangement of ideal gas equation **(1)** • evaluation to give number of moles **(1)** • calculation of molar mass **(1)**	Example of calculation $1 \div 1000 = 0.0010$ / 1.0×10^{-3} (m^3) $273 + 20 = 293$ $n = \frac{pV}{RT}$ $\frac{101000 \times 1.0 \times 10^{-3}}{8.31 \times 293} = 0.04148$ / 4.148×10^{-2} (mol) $\frac{0.656}{0.04148} = 15.81 = 16$ (g mol^{-1}) Ignore SF except 1SF Allow TE throughout Allow conversion of Pa to kPa and use of dm^3 Do not award a TE on a molar mass less than 2 Correct answer with some working scores 5	**(5)**

	Alternative method • conversion of any volume in dm^3 to m^3 by dividing by 1000 (e.g. 24 in this case) • conversion of temperature to K • rearrangement of ideal gas equation • evaluation to give number of moles • calculation of mass in volume chosen in M1 (eg 24 dm^3 as shown) **and** calculation of molar mass	$24 \div 1000 = 0.024$ (m^3) $273 + 20 = 293$ $n = \frac{pV}{RT}$ $\frac{101000 \times 0.024}{8.31 \times 293} = 0.99556$ (mol) $0.656 \times 24 = 15.744$ (g) **and** $15.744 \div 0.99556$ (mol) $= 15.81$(g mol^{-1})	

Question Number	Answer	Additional Guidance	Mark
22(b)	An answer that makes reference to the following point: • methane/CH_4	TE on a hydrocarbon that fits the molar mass from (a)	**(1)**

(Total for Question 22 = 6 marks)

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

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