Mark Scheme (Results)

Summer 2024

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

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

June 2024
Question Paper Log Number: P75778A
Publications Code: WCH11_01_2406_MS

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	**The only correct answer is C** (1.88×10^{24}) ***A*** *is not correct because this must be multiplied by 5* ***B*** *is not correct because mole calculation inverted and not multiplied by 5* ***D*** *is not correct because mole calculation inverted*	**(1)** **Computer**

Question Number	Answer	Mark
2	**The only correct answer is A** ($6.0\ cm^3$) ***B*** *is not correct because this is double the volume of butane required* ***C*** *is not correct because this is the volume of* CO_2 *released* ***D*** *is not correct because this is the total volume of reacting gases*	**(1)** **Computer**

Question Number	Answer	Mark
3(a)	**The only correct answer is B (**$C_{10}H_{16}$) ***A*** *is not correct because there are 6 too few hydrogen atoms* ***C*** *is not correct because there are 2 extra hydrogen atoms* ***D*** *is not correct because there are 6 extra hydrogen atoms*	**(1)** **Computer**

Question Number	Answer	Mark
3(b)	**The only correct answer is D (**CH_2) ***A** is not correct because the wrong formula of limonene was used* ***B** is not correct because this is the empirical formula of $C_{10}H_{18}$* ***C** is not correct because this is the empirical formula of $C_{10}H_{16}$*	**(1)** **Computer**

Question Number	Answer	Mark
4	**The only correct answer is B** (a compound containing of carbon and hydrogen only) ***A** is not correct because hydrocarbons do not contain oxygen* ***C** is not correct because not all hydrocarbons have only single carbon to carbon bonds* ***D** is not correct because it does not suggest that the hydrogen and carbon atoms are bonded together*	**(1)** **Computer**

Question Number	Answer	Mark
5(a)	**The only correct answer is D (**51.1%) ***A** is not correct because they have worked out the atom economy for 1 mol of carbon dioxide* ***B** is not correct because only allowed for 1 mol of ethanol* ***C** is not correct because they have worked out the atom economy for 2 mol of carbon dioxide*	**(1)** **Computer**

Question Number	Answer	Mark
5(b)	**The only correct answer is D (**100%) ***A*** *is not correct because this is the atom economy based on 1 mol of water and ethanol* ***B*** *is not correct because this is the atom economy based on ethene and ethanol* ***C*** *is not correct because this is the atom economy based on 2 mol of water and ethanol*	**(1)** **Computer**

Question Number	Answer	Mark
6(a)	**The only correct answer is D** ([Ar] $4s^2$) ***A*** *is not correct because this is the electronic configuration for sodium* ***B*** *is not correct because this is the electronic configuration for potassium* ***C*** *is not correct because this is the electronic configuration for magnesium*	**(1)** **Computer**

Question Number	Answer	Mark
6(b)	**The only correct answer is B** ([Ar]$3d^3$) ***A*** *is not correct because the 3 electrons have been removed from the 3d orbitals* ***C*** *is not correct because this is the electronic configuration for* Cr^{2+} ***D*** *is not correct because this is the electronic configuration for* Cr^{+}	**(1)** **Computer**

Question Number	Answer	Mark
7(a)	**The only correct answer is D** (120º) ***A*** *is not correct because the answer is based on a square planar shape* ***B*** *is not correct because this is based on the shape for ammonia* ***C*** *is not correct because the answer is based on a tetrahedral shape*	**(1)** **Computer**

Question Number	Answer	Mark
7(b)	**The only correct answer is D** (109.5º) ***A*** *is not correct because the answer is based on a square planar shape* ***B*** *is not correct because this is based on the shape for water* ***C*** *is not correct because this is based on the shape for ammonia*	**(1)** **Computer**

Question Number	Answer	Mark
7(c)	**The only correct answer is B (**104.5º) ***A*** *is not correct because the answer is based on a square planar shape* ***C*** *is not correct because the answer is based on a tetrahedral shape* ***D*** *is not correct because the answer is based on a linear shape*	**(1)** **Computer**

Question Number	Answer	Mark
8	**The only correct answer is A** (chlorine) ***B*** *is not correct because the bromide ions are oxidised* ***C*** *is not correct because bromine is a product in the reaction with chlorine* ***D*** *is not correct because the iodide ions are oxidised*	**(1)** **Computer**

Question Number	Answer	Mark
9	**The only correct answer is C** (polar liquid towards the rod and non-polar liquid no deflection) ***A*** *is not correct because non-polar liquids are not deflected* ***B*** *is not correct because polar liquids are not deflected away from the rod* ***D*** *is not correct because non-polar liquids are not deflected*	**(1)** **Computer**

Question Number	Answer	Mark
10	**The only correct answer is B** ($Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{-}$) ***A*** *is not correct because Mg is the first and second ionisation energies combined* ***C*** *is not correct because* Mg^{+} *is a solid* ***D*** *is not correct because this is the first ionisation energy for Mg*	**(1)** **Computer**

Question Number	Answer	Mark
11(a)	**The only correct answer is A** ($Na^{+} > Mg^{2+} > Al^{3+}$) ***B*** *is not correct because the ions are in a random order* ***C*** *is not correct because the ions are in a random order* ***D*** *is not correct because the ions are in reverse order*	**(1)** **Computer**

Question Number	Answer	Mark
11(b)	**The only correct answer is A** ($F^{-} < O^{2-} < N^{3-}$) ***B*** *is not correct because the ions are in a random order* ***C*** *is not correct because the ions are in a random order* ***D*** *is not correct because the ions are in reverse order*	**(1)** **Computer**

Question Number	Answer	Mark
12	**The only correct answer is C** ($Ba(OH)_{2(}aq$) and HCl(aq)) ***A*** *is not correct as AgCl(s) is formed* ***B*** *is not correct as $CaCO_3(s)$ is formed* ***D*** *is not correct as $PbI_2(s)$ is formed*	**(1)** **Computer**

Question Number	Answer	Mark
13	**The only correct answer is C** (green solution and effervescence) ***A*** *is not correct because the solution is not colourless and effervescence is not included* ***B*** *is not correct because a colourless solution is not formed* ***D*** *is not correct because effervescence is not included*	**(1)** **Computer**

Question Number	Answer	Mark
14	**The only correct answer is C** ($H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$) ***A*** *is not correct because it does not show the lowest whole numbers ratio* ***B*** *is not correct because it shows water as aqueous* ***D*** *is not correct because it shows an oxide ion instead of a hydroxide ion*	**(1)** **Computer**

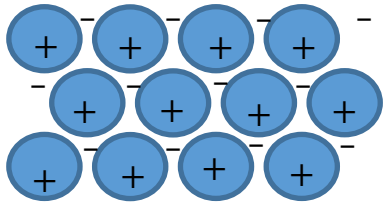
TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
15(a)	An answer that makes reference to the following points: • correctly balanced equation **(1)** • state symbols **(1)**	$2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$ M2 dependent on M1 or near miss e.g. $AgCl_2$ or correct formulae but unbalanced equation	**(2)**

Question Number	Answer	Additional Guidance	Mark
15(b)(i)	An answer that makes reference to the following points: • (colourless to) blue (solution) **(1)** • silver / grey solid **(1)**	Do not award just solution changes colour Accept silver / Ag (layer on the copper) Allow silver / grey / black precipitate Ignore white Ignore powder or solid disappears, temperature change	**(2)**

Question Number	Answer	Additional Guidance	Mark
15(b)(ii)	An answer that makes reference to the following points: • correctly balanced equation **(1)** • state symbols correct **(1)**	$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$ Allow correct ionic equation. $Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$ M2 dependent on reagents or near miss e.g. $CuNO_3$	**(2)**

Question Number	Answer	Additional Guidance	Mark
15(c)(i)	An answer that makes reference to the following points: • At least 12 silver ions arranged in layers with positive charge and at least 10 electrons (e^- or e or -), some within the structure. **(1)** • electrostatic (force of) attraction **(1)** • between positive metal ions / cations and sea of / delocalised electrons **(1)**	Mention of shared electrons or incorrect bonding negates 1 mark  Allow silver ions touching Allow not close packed layers Do not award positively charged nucleus	**(3)**

Question Number	Answer	Additional Guidance	Mark
15(c)(ii)	An explanation that makes reference to the following points: • the layers / ions / atoms slide less well (over each other) **(1)** • because copper ions / atoms are smaller than silver ions / atoms **(1)**	Do not award layers can not slide (over each other) Allow copper ions and silver ions have different sizes Do not award just copper is smaller than silver Ignore comments about strength of metallic bonds or just copper ions disrupting the lattice	**(2)**

(Total for Question 15 = 11 marks)

Question Number	Answer	Additional Guidance	Mark
16 (a) (i)	An answer that makes reference to the following points: • the (weighted) average/mean mass of atom(s) **(1)** • relative to 1/12th (the mass) of one atom of carbon-12 **(1)**	Allow refer to mole instead of atom in M1 and M2	**(2)**

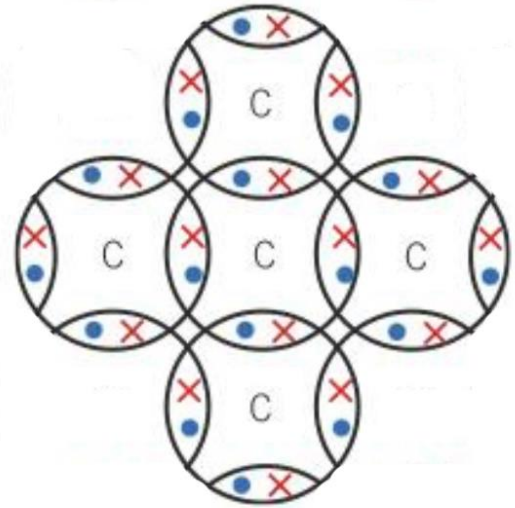
Question Number	Answer	Additional Guidance	Mark
16(a) (ii)	• expression **(1)** • evaluation and answer to 3 SF **(1)**	Example of calculation: $\frac{(28 \times 91.07) + (29 \times 4.62) + (30 \times 3.00) + (32 \times 1.31)}{(100)}$ = 28.1586 = 28.2 (3SF) Allow TE on minor slip if final answer 28 - 32 Correct answer scores 2 Allow g mol^{-1} / g/mol, Do not award any other units for M2	**(2)**

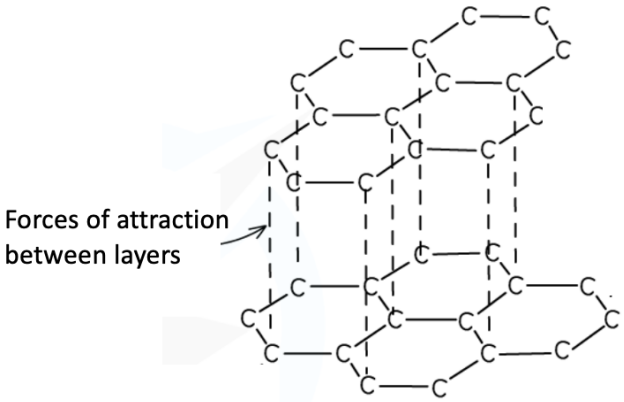
Question Number	Answer	Additional Guidance	Mark
16(a) (iii)	An answer that makes reference to the following point: • $^{28}Si^{2+}$ **(1)**	Allow $^{28}Si^{+2}$ Ignore state symbols	**(1)**

Question Number	Answer	Additional Guidance	Mark
16(b)(i)	An explanation that makes reference to the following points: • (first ionisation energy) increases (for these elements) **(1)** • because the electrons are removed from the same sub-shell **(1)** • and the number of protons has increased (by 1 for each element) **(1)**	Accept 3p (sub-shell) Allow have the same shielding Ignore same shell / same orbital Accept increased nuclear charge	**(3)**

Question Number	Answer	Additional Guidance	Mark
16(b)(ii)	An explanation that makes reference to the following points: • sulfur has 4 electrons in the 3p sub-shell **(1)** **and** one 3p orbital is (doubly) filled / has a pair of electrons • so there is a (slight) repulsion between the electrons in the same 3p orbital (resulting in a lower first ionisation energy) **(1)**	Allow shown on a diagram Ignore shielding	**(2)**

(Total for Question 16 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
17 (a)	An answer that makes reference to the following points: • 4 pairs of electrons around central carbon atom **(1)** • 3 more pairs of electrons around each of the 4 outer carbons **(1)**	 Accept all dot, all crosses in any combination Accept the diagram with no circles Allow the electrons not to be paired	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(b)	An answer that makes reference to the following points: • at least two layers of hexagons (with or without Cs) (containing at least 3 hexagons per layer) **(1)** • labelled (electrostatic) forces of attraction between the layers **(1)**	drawing of graphite  Ignore delocalised electrons Allow any form of intermolecular forces	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(c)	An answer that makes reference to the following points: • in diamond all the carbons are bonded to each other, (with no gaps). **(1)** • in graphite there are layers that are further apart than the carbon to carbon bonds in diamond **(1)**	Mention of molecules negates one mark Allow each C bonded to 4 other C atoms, or tetrahedral lattice Allow there is empty space / large distance between the layers in graphite Do not award air is trapped between the layers	**(2)**

(Total for Question 17 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
18(a) (i)	An answer that makes reference to the following point: • **thermal decomposition** (of sodium hydrogencarbonate)	Do not award just decomposition	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(a)(ii)	An answer that makes reference to the following point: • the reactants are dry	Allow the idea that water is needed Allow reverse argument Do not award just solution	**(1)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>18(b) (i)</td><td>• calculate % oxygen (1)

and

mol / mol fraction of K, C, H and O

• (calculate smallest whole number ratio and) give the empirical formula (1)</td><td><u>Example of calculation:</u>

100 – (20.8 + 25.5 + 2.66) = 51.04

<table><tr><td>K</td><td>C</td><td>H</td><td>O</td></tr><tr><td>20.8 ÷ 39.1</td><td>25.5 ÷ 12</td><td>2.66 ÷ 1</td><td>51.04 ÷ 16</td></tr><tr><td>0.532</td><td>2.13</td><td>2.66</td><td>3.19</td></tr><tr><td>0.532 ÷ 0.532</td><td>2.13 ÷ 0.532</td><td>2.66 ÷ 0.532</td><td>3.19 ÷ 0.532</td></tr><tr><td>1</td><td>4</td><td>5</td><td>6</td></tr></table>
$KC_4H_5O_6$; Elements in any order
Correct answer with some working scores (2)
Ignore SF except 1 SF
TE from M1 to M2 or KC_4H_5 (O_2 omitted)</td><td>(2)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
18(b) (ii) **Clip with (b)(iii) and (b)(iv)**	An answer that makes reference to the following points: • correct formulae of reactants **(1)** • correct formulae of products **(1)**	$H^+K^+A^{2-}$ + $NaHCO_3$ → $Na^+K^+A^{2-}$ + H_2O + CO_2 Allow multiples Allow formulae with atoms in any order Accept formulae fully without charges Unbalanced equations scores max 1	**(2)**

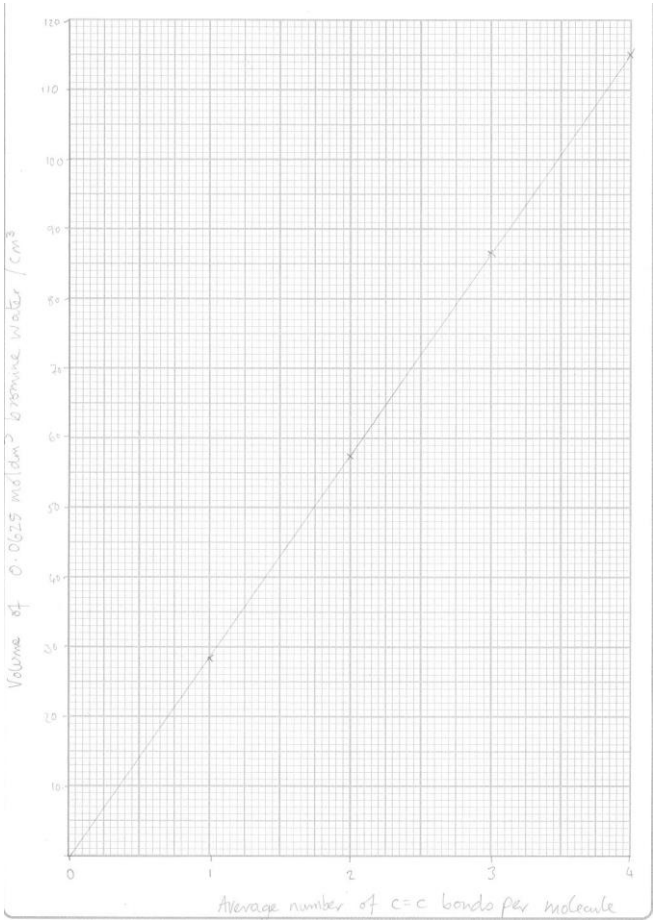
Question Number	Answer		Additional Guidance	Mark
18(b) (iii) **Clip with (b)(ii) and (b)(iv)**	• calculate mass of $NaHCO_3$	**(1)**	Penalise the same conversion error only once in 18 (b) (iii) and (iv) Example of calculation: $5 \times 0.3 = 1.5$ (g)	**(5)**
	• moles of $NaHCO_3$ and hence moles CO_2 using stoichiometry from (b) (i)	**(1)**	$1.5 \div 84 = 0.017857$ (mol) TE on formula of sodium hydrogen carbonate in (b)(ii)	
	• ^{o}C to K and substitution into $pV = nRT$	**(1)**	$190 + 273 = 463$ and $v = \frac{0.017857 \times 8.31 \times 463}{101000}$ $190 + 273 = 463$ and $v = \frac{0.017857 \times R \times 463}{101000}$	
	• evaluation	**(1)**	6.80256×10^{-4} or 8.18593×10^{-5} R ignore units R could be any value except 0	
	• volume converted to cm^3	**(1)**	$V = 680$ (cm^3) or 81.9R Correct answers with working scores 5	

Question Number	Answer		Additional Guidance	Mark
18(b) (iv) **Clip with (b)(ii) and (b)(iii)**	• use of $pV = nRT$ and evaluation and conversion to cm^3	**(1)**	<u>Example of calculation:</u> $V = 293 \times 8.31 \times 0.017857 \div 101000$ $= 4.3 \times 10^{-4}$ (m^3) (= 430 cm^3) TE on incorrect mole calculation for (b)(iii), could be just a value for V Or without use of pV = nRT as V is proportional to temp. $680 \times 293/(273+190) = 430$ (cm^3)	**(2)**
	• calculation of volume reduction	**(1)**	$680 - 430 = 250$ (cm^3) or 2.50×10^{-4} m^3 Ignore SF except 1 SF TE on volume in (b)(iii) provided it is a positive value TE for M2 based on value obtained in M1	

(Total for Question 18 = 13 marks)

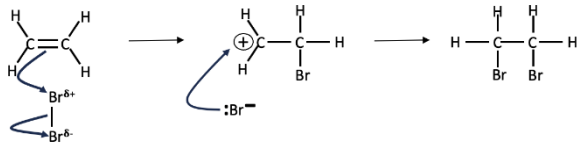
Question Number	Answer	Additional Guidance	Mark
19(a)	An answer that makes reference to the following point: • presence of (at least one) carbon to carbon double bond / C = C	Allow C ≡ C bond Ignore just having a double bond Ignore Hydrocarbon	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(b) (i)	An answer that makes reference to the following point: • addition (reaction) **(1)**	Ignore electrophilic, bromination, hydration, halogenation Do not award nucleophilic, substitution	**(1)**

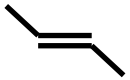
Question Number	Answer	Additional Guidance	Mark
19(b)(ii) **Clip with (b)(iii) and (b)(iv)**	An answer that makes reference to the following points: • x-axis labelled (average) number of C=C (bonds per molecule) **(1)** **and** y-axis labelled **volume (**of 0.0625 mol dm^{-3} bromine water) **/cm^3** • 4 **points** in the table plotted correctly to within half a small square **(1)** **and** plots to cover ½ the grid in both directions with linear scales • straight line of best fit (through all 4 points) **(1)**	 Ignore extrapolation of straight line	**(3)**
Question	**Answer**	**Additional Guidance**	**Mark**

Number			
19(b) (iii) **Clip with (b)(ii) and (b)(iv)**	• calculation of the mean to 3SF	Example of calculation: $\frac{36.9 + 34.1 + 39.3 + 32.5}{4} = 35.7$ (cm^3)	**(1)**

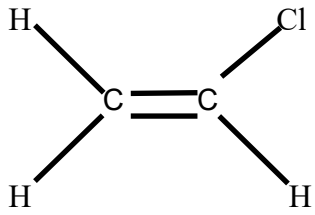
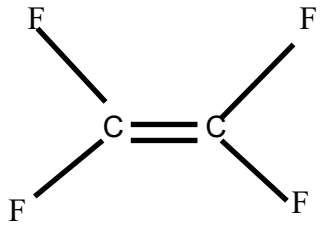
Question Number	Answer	Additional Guidance	Mark
19(b) (iv) **Clip with (b)(ii) and (b)(iii)**	• average number of C=C bonds derived from their graph **and** given to 2SF	Average number of C=C bonds per molecule 1.25 =1.2 or 1.3 Allow TE from an incorrect line of best fit	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(c) (i)	An answer that makes reference to the following points: • dipole on Br−Br • arrow from double bond to delta + bromine • arrow from bromine bond to delta - bromine • carbocation on correct intermediate • lone pair on bromide • negative charge on bromide ion • arrow from lone pair on bromide ion to carbocation • correct formula of final product (1,2-dibromoethane) all 8 points 4 marks, 6 or 7 points 3 marks, 4 or 5 points 2 marks, 2 or 3 points 1 mark	 Point 1 if H-Br used penalise here only Point 4 carbocation intermediate based on any alkene Point 7 given for the arrow from lone pair if given, or anywhere if lone pair not given.	**(4)**

Question Number	Answer	Additional Guidance	Mark
19(c) (ii)	An answer that makes reference to the following point: (E- / trans-) 4-methylhex-2-ene	Do not award hexa	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(d)	An answer that makes reference to the following points: • correct skeletal formula **(1)** • trans means that the (alkyl) groups (methyl or R) are on either side of the double bond **(1)**	 Allow (alkyl) groups point in opposite directions M2 is dependent on the presence of a double bond in M1 or text of M2 Ignore planes as this does not differentiate sufficiently between cis and trans Do not award species or molecules instead of groups	**(2)**

(Total for Question 19 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
20(a)	An answer that makes reference to the following points: • displayed formula of chloroethene **(1)** • displayed formula of tetrafluoroethene **(1)**	  Max 1 for non-displayed formulae or both structures correct but both only missing the double bond Ignore “n” before or after monomer structure Ignore polymer structures	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(b)	An answer that makes reference to the following points: incineration advantages • reduced volume of landfill **(1)** **or** • energy released for generating electricity incineration disadvantage **(1)** • produces toxins recycling advantage **(1)** • saves (precious) resources recycling disadvantage **(1)** • polymers need to be sorted (and this is expensive) **or** • involves the use of energy (to make the new product)	Penalise incorrect chemistry once only Allow less land needed Ignore volume of waste, no landfill Allow heating homes Ignore just useful energy NB a use must be given Allow forms carbon dioxide / greenhouse gas Ignore just causes pollution and incorrect toxins Allow reduces land fill if not already awarded Allow less waste of resources Ignore just expensive Ignore comments about transportation	**(4)**

(Total for Question 20 = 6 marks)

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

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom