Pearson Edexcel

Mark Scheme (Results)

October 2022

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

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October 2022
Question Paper Log Number P71875A
Publications Code WCH11_01_2210_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

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.

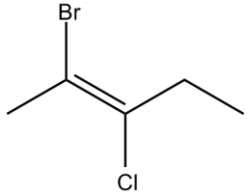
Section A (multiple choice)

Question Number	Correct Answer	Mark
1	**The only correct answer is A** (iron and copper(II) sulfate solution) *B is incorrect because the reaction is a precipitation* *C is incorrect because the reaction is a neutralisation* *D is incorrect because there is no reaction*	**1**

Question Number	Correct Answer	Mark
2	**The only correct answer is D** (silver nitrate solution and potassium bromide solution) *A is incorrect because the reaction is a neutralisation* *B is incorrect because there is no reaction* *C is incorrect because the reaction is a displacement*	**1**

Question Number	Correct Answer	Mark
3	**The only correct answer is C** (7,8,10) *A is incorrect because this is the number of protons, electrons and neutrons in the* $^{15}_{7}N$ *atom* *B is incorrect because this is the number of protons, electrons and neutrons in the* $^{15}_{7}N^{3+}$ *ion* *D is incorrect because it the numbers of protons and neutrons have been reversed*	**1**

Question Number	Correct Answer	Mark
4	**The only correct answer is D** (9) *A is incorrect because it is the number of occupied quantum shells* *B is incorrect because it is the number of occupied subshells* *C is incorrect because the electrons in the 3p subshell have been paired before each orbital is occupied*	**1**

Question Number	Correct Answer	Mark
5	**The only correct answer is A**  *B is incorrect because it is Z-2-bromo-3-chloropent-2-ene* *C is incorrect because it is E-3-bromo-2-chloropent-2-ene* *D is incorrect because it is E-4-bromo-3-chloropent-2-ene*	**1**

Question Number	Correct Answer	Mark
6(a)	**The only correct answer is C** (it is toxic at low concentrations) *A is incorrect because CO does not form an acid in the atmosphere* *B is incorrect because CO does not strongly absorb infrared radiation* *D is incorrect because CO is not the main cause of ozone layer depletion*	**1**

Question Number	Correct Answer	Mark
6(b)	**The only correct answer is D** (120) *A is incorrect because it is the volume of butane that has not reacted* *B is incorrect because it is the total volume of reactants* *C is incorrect because it is the total volume of products*	1

Question Number	Correct Answer	Mark
7(a)	**The only correct answer is A** (to break the Br-Br bond only) *B is incorrect because the energy of ultraviolet radiation is insufficient to break a C−H bond* *C is incorrect because the energy of ultraviolet radiation is insufficient to break a C−C bond* *D is incorrect because the energy of ultraviolet radiation is insufficient to break a C−H bond*	1

Question Number	Correct Answer	Mark
7(b)	**The only correct answer is D** (propagation, homolytic) *A is incorrect because initiation would not have a free radical reactant and heterolytic bond breaking would form ions* *B is incorrect because initiation would not have a free radical reactant* *C is incorrect because heterolytic bond breaking would form ions*	1

Question Number	Correct Answer	Mark
7(c)	**The only correct answer is B** (C_8H_{18} + Br_2 → $C_8H_{17}Br$ + HBr) *A is incorrect because hydrogen is not formed in the reaction* *C is incorrect because the carbon chain does not break in the reaction* *D is incorrect because the carbon chain does not break in the reaction and a C=C double bond does not form*	**1**

Question Number	Correct Answer	Mark
8	**The only correct answer is D** (CH_2Cl_2) *A is incorrect because C_5H_{12} is non-polar* *B is incorrect because although CCl_4 has polar bonds it does not have a dipole moment* *C is incorrect because although BCl_3 has polar bonds it does not have a dipole moment*	**1**

Question Number	Correct Answer	Mark
9	**The only correct answer is D** (54.2) *A is incorrect because the volume has been divided by the density rather than multiplied* *B is incorrect because the volume has been divided by the density, then divided by the atomic number* *C is incorrect because the volume has been divided by the relative atomic mass*	**1**

Question Number	Correct Answer	Mark
10(a)	**The only correct answer is B** (*region* Q) *A is incorrect because region P denotes where ionisation takes place* *C is incorrect because region R denotes where deflection takes place* *D is incorrect because region S denotes where detection takes place*	**1**

Question Number	Correct Answer	Mark
10(b)	**The only correct answer is B** ($^{54}Fe^{2+}$) *A is incorrect because it has the same mass but a smaller charge than* $^{54}Fe^{2+}$ *C is incorrect because it has a larger mass and a smaller charge than* $^{54}Fe^{2+}$ *D is incorrect because it has a larger mass than* $^{54}Fe^{2+}$	**1**

Question Number	Correct Answer	Mark
10(c)	**The only correct answer is C** (3) *A is incorrect because it assumes that all chlorine molecular ions have the same mass* *B is incorrect because it assumes that all chlorine molecules only form between atoms of the same mass* *D is incorrect because it assumes that* $^{35}Cl-^{37}Cl$ *and* $^{37}Cl-^{35}Cl$ *are not identical*	**1**

Question Number	Correct Answer	Mark
11(a)	**The only correct answer is B** (element V) *A is incorrect because in element U each p orbital contains a single electron* *C is incorrect because in element W two p orbitals contain electron pairs* *D is incorrect because in element X three p orbitals contain electron pairs*	**1**

Question Number	Correct Answer	Mark
11(b)	**The only correct answer is B** (element X) *A is incorrect because element S is in Group 3* *C is incorrect because element Y is in Group 1* *D is incorrect because element Z is in Group 2*	**1**

Question Number	Correct Answer	Mark
11(c)	**The only correct answer is D** (element Y) *A is incorrect because in element S the second electron is not removed from an inner shell* *B is incorrect because in element T the second electron is not removed from an inner shell* *C is incorrect because in element X the second electron is not removed from an inner shell*	**1**

Question Number	Correct Answer	Mark
12	**The only correct answer is C** (0.0654) *A is incorrect because this is the moles of hydrated copper(II) sulfate used* *B is incorrect because this is the moles of anhydrous copper(II) sulfate used* *D is incorrect because the $5H_2O$ are not included in the molar mass*	**1**

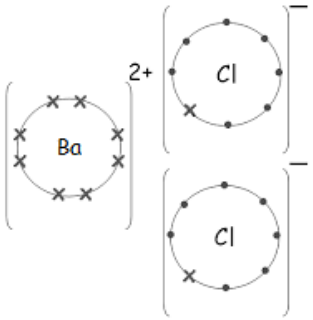
Question Number	Correct Answer	Mark
13	**The only correct answer is A** (5.65) *B is incorrect because the yield of 95% has not been used* *C is incorrect because the 2:1 ratio in the equation has not been used* *D is incorrect because the yield of 95% and the 2:1 ratio in the equation have not been used*	**1**

Total for Section A = 20 marks

Section B

Question Number	Correct Answers	Additional Guidance	Mark
14(a)(i)	$Ba^{2+}(g) \rightarrow Ba^{3+}(g) + e^{(-)}$ OR $Ba^{2+}(g) - e^{(-)} \rightarrow Ba^{3+}(g)$	Allow $e^{(-)}(g)$ / $1e^{(-)}$ Do not award multiples Allow ions shown as $Ba^{+2}(g)$ and $Ba^{+3}(g)$ Allow Ba^{++} / Ba^{+++} Comment – allow lower case 'ba^{2+}' etc	**1**

Question Number	Correct Answers	Additional Guidance	Mark
14(a)(ii)	An answer that makes reference to the following: • there is a **large** increase **(**in ionisation energy) **and** • between the 2nd and 3rd ionisations	 Note – there must be some indication of a significant increase Allow just there is a jump Allow 'after 2 electrons are removed' / between the 2nd and 3rd electrons Ignore comments related to first ionisation energy	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
14(b)(i)	An answer that makes reference to one of the following points: • barium ion shown correctly **(1)** • one chloride ion shown correctly **and** an indication of two chloride ions present **(1)** example of dot-and-cross diagram  	Allow barium ion with no electrons shown Allow lower case 'ba' Ignore any inner shells shown for Ba^{2+} If inner shells shown for Cl^- they must be correct Allow all dots or all crosses Ignore absence of square brackets Ignore any working Do not award covalent diagrams Comment If all charges are omitted, we assume the bonding is covalent so scores zero	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
14(b)(ii)	• calculation of moles of barium chloride **(1)** • calculation of mass of barium chloride to 2 or 3 SF **(1)**	<u>Example of calculation</u> 0.200 × (150 ÷ 1000) = 0.03 (mol) Ignore units in M1 even if incorrect 0.03 × 208.3 = 6.249 = 6.2 / 6.25 (g) Do not award 6.3 Ignore absence of units but if given must be correct in M2 Correct answer with no working scores 2 marks Allow 0.03 x 208 = 6.24 / 6.2 for M2 Allow TE from M1 to M2	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
14(b)(iii)	$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$	Accept $2H_3O^+ + CO_3^{2-} \rightarrow 3H_2O + CO_2$ Allow H_2CO_3 Allow multiples Ignore state symbols even if incorrect Do not award uncancelled chloride ions	**1**

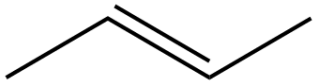
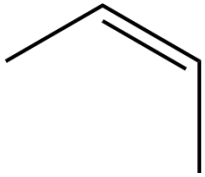
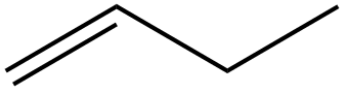
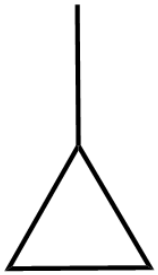
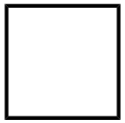
Question Number	Acceptable Answers	Additional Guidance	Mark
14(c)	An answer that makes reference to the following point: • (the) ions are not free to move (and carry charge) / (the) ions are in a fixed position (so cannot carry charge)	Do not award 'electrons are not free to move' Do not award if any statement that $BaCl_2$ is covalent	**1**

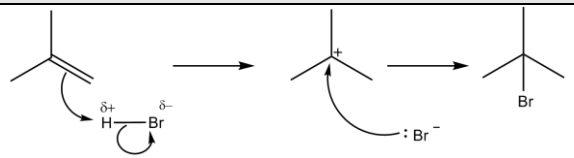
Total for Question 14 = 8 marks

Question Number	Acceptable Answers	Additional Guidance	Mark
15(a)(i)	• 2,2,4-trimethylpentane	Ignore any incorrect or absent commas, hyphens etc Allow 2,2-dimethyl-4-methylpentane Note : ignore minor misspelling of methyl e.g. ‘methly’	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(a)(ii)	• reforming	Allow reformation / reform Do not award cracking / fractional distillation Ignore rearrangement / isomerisation	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(a)(iii)	• prevents knocking / prevents pre-ignition / prevents pinking	Allow smoother combustion / smoother burning / increases octane number / improves octane number / increases RON IGNORE increases the volatility of a fuel / ignites more easily / is a better fuel / burns more cleanly / has a lower boiling temperature / is a safer fuel / burns more efficiently	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(b)	•  **(1)** •  **(1)** •  **(1)** •  or  **(1)**	Penalise use of displayed or structural formulae once only If displayed / semi-displayed formulae used ignore connectivity of CH_3 groups Ignore names even if incorrect	**4**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(c)(i)	• dipole on hydrogen bromide molecule **and** structure of final product **(1)** • curly arrow from C=C to H and curly arrow from H-Br bond to, or just beyond, Br **(1)** • carbocation intermediate **(1)** • lone pair on Br− and curly arrow from lone pair to positive charge **(1)**	 Allow any combination of displayed, structural or skeletal formulae Allow + on bracket around the structure Do not award δ+ on intermediate Do not award δ– on Br in M4 Penalise use of half-arrows once only If minor product is shown then do not award M1 NOTE – incorrect starting alkene can score M2 and M4 only	**4**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(c)(ii)	• the **tertiary** carbocation is (more) stable (than the primary carbocation)	Accept the **3°** carbocation is more stable (than the 1° carbocation) Allow a description of a **3°** carbocation e.g. '3 methyl groups attached to the positive C' Ignore explanations of stability even if incorrect / Ignore references to Markovnikov's law	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(d)(i)	• expression for calculation of moles of C and H **(1)** • deduction of empirical formula **(1)**	<u>Example of calculation</u> Element / C / H Expression to calculate moles / 92.3 / 12 / 7.7 / 1 Moles (mol) / =7.7 (mol) / = 7.7 (mol) Ratio / 1 / 1 Empirical formula = CH / HC No TE from M1 to M2	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(d)(ii)	• conversion of volume to m^3 **(1)** • conversion of temperature to K and pressure to Pa **(1)** • rearrangement of ideal gas equation and calculation of *n* **(1)** • calculation of molar mass **(1)**	<u>Example of calculation</u> 98×10^{-6} (m^3) – if *V* in dm^3 then pressure must be in kPa 358 (K) and 104 000 (Pa) $n = pV \div RT = (104\,000 \times 98 \times 10^{-6}) \div (8.31 \times 358) = 3.4259 \times 10^{-3}$ (mol) Molar mass = $(0.267) \div (3.4259 \times 10^{-3}) = 77.9 / 78$ (g mol^{-1}) Comment Do not penalise grams given as units for molar mass Allow TE throughout M1 and M2 could be subsumed within M3 Answer of 78 with no working scores M4 only	**4**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(d)(iii)	C_6H_6	Standalone mark No TE from di and dii	**1**

Total for Question 15 = 19 marks

Question Number	Acceptable Answers	Additional Guidance	Mark
16(a)	An explanation that makes reference to the following points: • **atoms** (of the same element) with the same number of protons / **atoms** with same atomic number / **atoms** with same proton number **(1)** • with a different number of neutrons / neutron number / mass number **(1)**	NOTE answers with no reference to atoms can score 1 max for correct statements about the number of protons and neutrons or atomic number and mass number e.g. 'elements with same number of protons but different number of neutrons' scores 1 mark e.g. 'isotopes have the same atomic number and different mass number' scores 1 mark Ignore references to same number of electrons Ignore references to relative atomic mass	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(b)	• numerator of weighted mean expression **(1)** • calculation of relative atomic mass **(1)**	Example of calculation $(70 \times 20.6) + (72 \times 27.4) + (73 \times 7.7) + (74 \times 36.7) + (76 \times 7.6)$ $\frac{(70 \times 20.6) + (72 \times 27.4) + (73 \times 7.7) + (74 \times 36.7) + (76 \times 7.6)}{100}$ = 72.703 / 72.70 / 72.7 TE on one transcription error Final answer must be to at least 1 decimal place Correct answer with no working scores 2 Ignore units	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(c)	• $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2$	Allow [Ar] $3d^{10} 4s^2 4p^2$ Allow $4s^2$ immediately before $3d^{10}$ Allow $3p_x^2 3p_y^2 3p_z^2$ Allow numbers of electrons not shown as superscripts Allow upper case letters for ‘S’, ‘P’ and ‘D’	**1**

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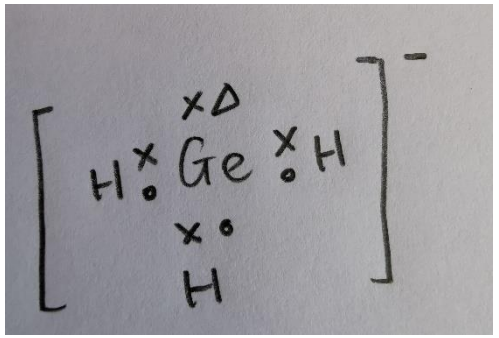
Question Number	Acceptable Answers	Additional Guidance	Mark
16(d)(i)	• calculation of $\sum M_r$ (all reactants) / $\sum M_r$ (all products) **(1)** • calculation of atom economy as a percentage **(1)**	<u>Example of calculation</u> 46+72.6 +48+23+10.8+4+18 = 222.4 / 72.6+4+80+23+10.8+32) = 222.4 (76.6 ÷ 222.4) × 100 = 34.442% Allow TE in M2 from M1 provided atom economy is less than 100% Allow use of A_r = 72.7 for Ge calculated in (b) which gives the answer 34.472% Ignore SF except 1 SF	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(d)(ii)	An explanation that makes reference to the following points: • **3** bond pairs between Ge atom and **three** H atoms **(1)** • lone pair on Ge atom (and charge on ion) **(1)**	 Allow any combination of dots and / or crosses Ignore missing charge on ion Ignore lines showing covalent bonds	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(d)(iii)	An answer that makes reference to the following points: • trigonal pyramid(al) **(1)** • angle between 106 and 108° **(1)**	Allow pyramidal Comment – the correct shape and angle are standalone marks. However allow trigonal planar and 120° for 2 marks if (d)(ii) shows only 3 bond pairs.	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(d)(iv)	• calculation of maximum mass of germane in laboratory in mg **(1)** • conversion of mass from mg to g **(1)** • calculation of moles of germane **(1)** • calculation of maximum number of germane molecules in laboratory **(1)** NOTE – do not award M1 and M2 if there is evidence that candidates believe the values 147.84 / 0.14784 are moles. Such answers are likely to only be able to access M4	<u>Example of calculation</u> $0.640 \times 231 = 147.84$ (mg) $147.84 \div 1000 = 0.14784$ (g) Allow TE from M1 to M2 $= 0.14784 \div 76.6 = 1.9300 \times 10^{-3}$ (mol) Allow TE from M2 to M3 $1.9300 \times 10^{-3} \times 6.02 \times 10^{23}$ $= 1.1619 \times 10^{21}$ (molecules) Allow TE from M3 to M4 Allow use of 76.7 for 76.6 giving 1.1604×10^{21} Correct answer with no working scores 4 marks Ignore SF except 1 SF	**4**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(e)(i)	• calculation of moles of carbon dioxide	(335.5 ÷ 24000) = 0.013979 / 1.3979 × 10^{-2} (mol) Ignore SF except 1 SF	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(e)(ii)	• answer to (i) × 2	(0.013979 × 2) = 0.027958 / 2.7958 × 10^{-2} (mol) Ignore SF except 1 SF Allow TE from (i)	**1**

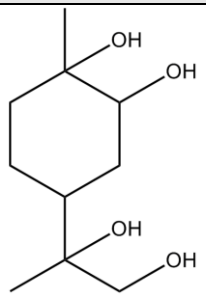
Question Number	Acceptable Answers	Additional Guidance	Mark	
16(e)(iii)	• answer to (ii) ÷ 4	(0.027958 ÷ 4) = 0.0069896 / 6.9896 × 10^{-3} (mol) Ignore SF except 1 SF Allow TE from (ii)	**1**	

Question Number	Acceptable Answers		Additional Guidance	Mark
16(e)(iv)	• 1.50 ÷ (answer to (iii)) • identification of X	**(1)** **(1)**	1.50 ÷ 6.9897 × 10^{-3} = 214.6 (g mol^{-1}) 214.6 – 72.6 = 142.01 142.01 ÷ 4 = 35.501 ; so X = Cl Allow TE from (iii) Must be some correct working to score M2	**2**

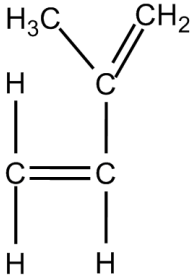
Total for Question 16 = 20 marks

Question Number	Acceptable Answers	Additional Guidance	Mark
17(a)	An answer that makes reference to the following points: • C_{10} **(1)** • H_{16} **(1)**	 Allow in either order Allow numerical values not shown as subscripts e.g. C10H16 scores both marks	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
17(b)(i)	An answer that makes reference to the following points: • from purple to colourless	Do not award other colours Allow (pale) pink to colourless Ignore references to clear Ignore adjectives before purple e.g. deep purple	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
17(b)(ii)		Allow displayed formula Ignore connectivity of OH group unless bond shown horizontally, and H connected directly to bond Ignore orientation of OH group	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
17(b)(iii)	• oxidation	Allow electrophilic addition	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
17(c)		Allow skeletal, structural or displayed or any combination Ignore 'n' before or after structure Ignore connectivity of CH_3 and CH_2 groups	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
17(d)	An answer that makes reference to any **two** of the following points: • (help develop) biodegradable polymers / polymers from plant material / (polymers that can be) re-used / (polymers that can be easily) recycled **(1)** • remove (toxic) gases produced by incineration (of polymers) **(1)** • (develop processes to) convert polymers back into feedstock (for use in chemical industry) **(1)** • use of IR (spectroscopy) to separate polymers (for recycling) **(1)**	Allow the term 'plastic' for polymers Ignore biopolymers Ignore reduce use of polymers Allow monomers / smaller molecules / more reactive molecules / more useful molecules for 'feedstock'	**2**

	Acceptable Answers	Additional Guidance	Mark
17(e)(i)	An answer that makes reference to the following points: advantage of liquid CO_2 • non-flammable / non-toxic / readily available / CO_2 can be reused **(1)** disadvantage of liquid CO_2 • energy needed to generate (high) pressure / (high) pressure is expensive / risk of explosion under pressure / **(1)**	Allow reverse arguments for hexane Allow can be separated (from limonene) easily Allow hexane is non-renewable / finite Ignore 'removes CO_2 from atmosphere' Allow energy needed to maintain pressure Allow strength of vessel needed to withstand (high) pressure Ignore references to temperature Ignore just 'expensive' Do not award greenhouse gas / global warming	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
17(e)(ii)	• calculation of mass of limonene required in 30 cm^3 of cleaning product **(1)** • calculation of mass of orange peel needed to produce 1 g of limonene **(1)** • calculation of mass of orange peel needed to produce enough limonene to make 30 cm^3 of cleaning product, in kg **(1)**	<u>Example of calculation</u> 0.841 × 30 = 25.23 (g) Ignore units in M1 1 g limonene needs (100 ÷ 1.63) g of peel = 61.3497 (g) (100 ÷ 1.63) × 25.23 = 1547.9 (g) = 1.55 (kg) Allow final answer in grams if units quoted Allow TE throughout M2 could be subsumed in M3 Ignore SF except 1 SF Correct answer with no working scores 3 NOTE : if ratio in M2 is inverted mass = 4.11×10^{-4} (kg) and scores M1 and M3	**3**

Total for Question 17 = 13 marks
Total for Section B = 60 marks
Total for Paper = 80 marks

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