Mark Scheme (Results)

October 2020

Pearson Edexcel International Advanced Subsidiary Level
In Chemistry (WCH11)
Paper 1 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.

Section A

Question number	Answer	Mark
1	**The only correct answer is B (**C_2H_5**)** ***A*** *is incorrect because this is the molecular formula* ***C*** *is incorrect because this is a ratio based on one atom of carbon* ***D*** *is incorrect because this is the general formula of an alkane*	**(1)**

Question number	Answer	Mark
2 (a)	**The only correct answer is B (**displacement**)** *A is incorrect because addition usually refers to organic reactions* *C is incorrect because no acids or bases are involved* *D is incorrect because substitution usually refers to organic reactions*	**(1)**

Question number	Answer	Mark
2 (b)	**The only correct answer is D (**$Zn \rightarrow Zn^{2+} + 2e^-$**)** *A is incorrect because* Cu^+ *is not formed* *B is incorrect because* Cu^+ *is not a reactant* *C is incorrect because* Zn^+ *is not formed*	**(1)**

Question number	Answer	Mark
3	**The only correct answer is C (**9.46×10^{23}**)** *A is incorrect because the* M_r *has been divided by the mass* *B is incorrect because this would be correct for* CO_2 *D is incorrect because this is the number of atoms*	**(1)**

Question number	Answer	Mark
4	**The only correct answer is C (**C_5H_8O**)** *A is incorrect because the* M_r *is 83* *B is incorrect because the ratio of C and H is not the same* *D is incorrect because this is rounding number of moles to 1 SF*	**(1)**

Question number	Answer	Mark
5	**The only correct answer is B (**barium chloride is a compound**)** *A is incorrect because barium chloride is ionic* *C is incorrect because this is not the simplest ratio* *D is incorrect because the* M_r *is 208.3*	**(1)**

Question number	Answer	Mark
6(a)	**The only correct answer is C** (63.6) *A is incorrect as this is the answer when the abundance of the single charge peaks are used but are divided by 100* *B is incorrect because this is the average of the mass of all the ions with the abundancies not considered* *D is incorrect because this is the A_r when the mass of the two single charge peaks are averaged with the abundancies not considered*	**(1)**

Question number	Answer	Mark
6(b)	**The only correct answer is C** ($^{65}Cu^{2+}$) *A is incorrect because sulphur would not produce the rest of the peaks* *B is incorrect because this is the peak at 31.5* *D is incorrect because this would give a peak at 32.7*	**(1)**

Question number	Answer	Mark
7	**The only correct answer is B** ($C_4H_2O_4$) *A is incorrect because this is the empirical formula* *C is incorrect because there are two extra hydrogens in the formula* *D is incorrect because there are four extra hydrogens in the formula*	**(1)**

Question number	Answer	Mark
8(a)	**The only correct answer is C** ($C_6H_{14}O$) *A is incorrect because this precedes the first molecule in the sequence* *B is incorrect because this is not in this sequence* *D is incorrect because this is the sixth molecule in the sequence*	**(1)**

Question number	Answer	Mark
8(b)	**The only correct answer is B (**homologous series**)** *A is incorrect because this structure is within each of the molecules* *C is incorrect because homolytic is a type of bond breaking* *D is incorrect because this is the type of structure shown*	**(1)**

Question number	Answer	Mark
9	**The only correct answer is C** (Ti^{2+}) *A is incorrect because K^+ has the electronic structure shown* *B is incorrect because Ca^{2+} has the electronic structure shown* *D is incorrect because Sc^{3+} has the electronic structure shown*	**(1)**

Question number	Answer	Mark
10	**The only correct answer is D (**$1s^2\ 2s^2\ 2p^6$**)** *A is incorrect because this would be for losing three electrons* *B is incorrect because this would be for the nitrogen atom* *C is incorrect because this would be for gaining one electron*	**(1)**

Question number	Answer	Mark
11	**The only correct answer is A (**Al^{3+}**) (**53 pm)	**(1)**
	B is incorrect because Ga is below Al in the Periodic Table so has more shells of electrons (62 pm) *C is incorrect because* Mg^{2+} *has fewer protons than* Al^{3+} *(72 pm)* *D is incorrect because* F^- *has fewer protons than* Al^{3+} *(133 pm)*	

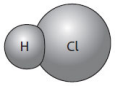
Question number	Answer	Mark
12	**The only correct answer is B** (17.6%) *A is incorrect because the mass of hydrogen has been divided by the total mass of reactants and products* *C is incorrect because the mass of hydrogen has been divided by the mass of carbon monoxide* *D is incorrect because this is the atom economy for carbon monoxide*	**(1)**

Question number	Answer	Mark
13	**The only correct answer is C (**two**)** *A is incorrect because the four unbonded electrons on sulfur form two lone pairs* *B is incorrect because the four unbonded electrons on sulfur form two lone pairs* *D is incorrect because the four unbonded electrons on sulfur form two lone pairs*	**(1)**

Question number	Answer	Mark
14	**The only correct answer is A (**$J^{2+}(g) \rightarrow J^{3+}(g) + e^-$**)** *B is incorrect because this is the fourth ionisation energy* *C is incorrect because the equation is unbalanced and begins with the uncharged atom* *D is incorrect because it begins with the uncharged atom*	**(1)**

Question number	Answer	Mark
15	**The only correct answer is A (**$BeCl_2 > BCl_3 > CH_4$**)** *B is incorrect because the bond angle in methane is larger than that in ammonia* *C is incorrect because this is the order of increasing bond angle* *D is incorrect because the bond angle in beryllium chloride is bigger than that in ammonia*	**(1)**

Question number	Answer	Mark
16	**The only correct answer is A** (Li^+ and I^-) *B* *is incorrect because the positive ion is larger and the negative ion is smaller than* LiI *C* *is incorrect because the positive ion is larger and the negative ion is smaller than* LiI *D* *is incorrect because the positive ion is larger and the negative ion is smaller than* LiI	**(1)**

Question number	Answer	Mark
17	**The only correct answer is D** () *A* *is incorrect because the bonding is not ionic* *B* *is incorrect because the electron density would not form this shape* *C* *is incorrect because the molecule is not symmetrical*	**(1)**

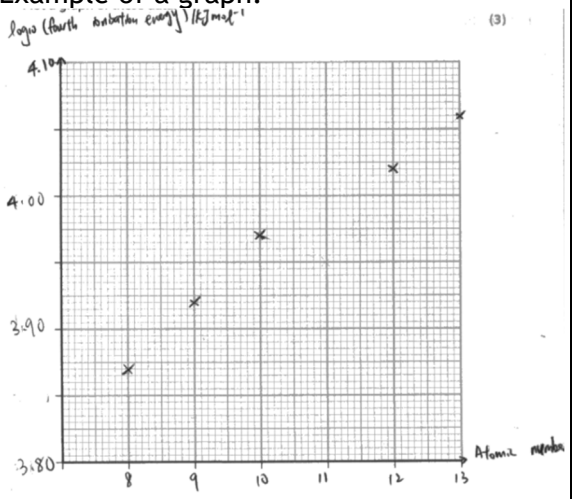
Total for Section A = 20 marks

Section B

Question Number	Answer	Additional guidance	Mark
18(a)	A statement that makes reference to the following points: • a region within an atom (1) • can hold (up to) **two** electrons (with opposing spins) **or** where there is a **high** probability of finding an electron (1)	Allow A region around the nucleus Allow area/place/space for region Ignore path/track/orbiting Do not award in the nucleus Allow a percentage between 90 and 95 Allow a **greater** chance of finding / **most** likely to find Do not award just likely Marks are standalone	**(2)**

Question Number	Answer	Additional guidance	Mark
18(b)	• s-orbitals are spherical / ball shaped **and** p-orbitals are dumbbell shaped	IGNORE the words circular or figure of eight or pear shaped Accept labelled diagrams e.g.  s-orbital p-orbital Accept a p-orbital on any axis Allow correct unlabelled diagrams or descriptions in the correct order Allow 3 p-orbitals overlapping if they are specifically labelled as 3 p-orbitals Ignore references to numbers of electrons Ignore has two lobes for p-orbital	**(1)**

Question Number	Answer	Additional guidance	Mark
18(c)	A description that makes reference to: • three (quantum) shells (1) • 2, 8, 1 (1) • Indication of which electrons are in which (quantum) shell (1)	Accept energy levels Accept the numbers in the reverse order Allow descriptions of the large jumps between IE1 & IE2 **and** IE9 & IE10 e.g. • It has one electron in its outermost shell or • First electron removed is in the third shell / 3s or • 8 electrons in 2nd quantum shell or • Two electrons are on the innermost shell Allow one electron in valence shell Ignore one valence electron Ignore spd notation	**(3)**

Question Number	Answer	Additional guidance	Mark
18(d)(i)	• axes correct way round and both suitably labelled (1) • suitable choice of linear scale so that the points cover at least 50% of the grid in both directions (1) • all 5 points plotted correctly (1)	Example of a graph:  Do not award log as an axis label Ignore units and brackets on the y-axis Accept atomic numbers on the x-axis **Allow element symbols Al to O** Allow MP3 for bar charts Allow half square tolerance on plotted points Ignore any lines joining the points	**(3)**

Question Number	Answer	Additional guidance	Mark
18(d)(ii)	• $(10^{(3.99)}=)$ 9772 (kJ mol^{-1})	Accept answers given in standard form Accept answers given in the grid for (d)(i) Allow 9544 – 10000 (kJ mol^{-1}) TE from graph in 18(d)(i) Allow any SF Ignore units even if incorrect	**(1)**

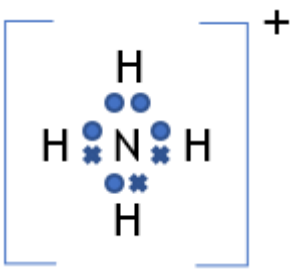
Question Number	Answer	Additional guidance	Mark
18(d)(iii)	The fourth electron is removed from the same / second (quantum) shell	Allow both electrons are removed from 2p orbitals / the 2p subshell Allow same energy level Do not award same electronic structure / same orbital in place of same shell Ignore shielding Ignore nuclear charge Ignore references to electron pairs repelling	**(1)**

(Total for Question 18 = 11 marks)

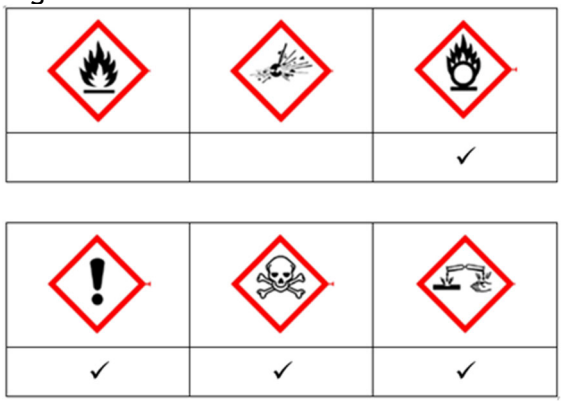
Question Number	Answer	Additional guidance	Mark
19(a)(i)	• $(NH_4)_2Cr_2O_7 \rightarrow N_2 + 4H_2O + Cr_2O_3$	1 mark for Cr_2O_3 1 mark for all the rest being correct Allow multiples Marks are standalone	**(2)**

Question Number	Answer	Additional guidance	Mark
19(a)(ii)	• (thermal) decomposition **or** redox	Ignore oxidation or reduction on their own	**(1)**

Question Number	Answer		Additional guidance	Mark
19(b)	• conversion of units for *P* and *V*	(1)	Example of calculation: $P = 101000 / 1.01 \times 10^5$ Pa $V = 0.0000252 / 2.52 \times 10^{-5}$ m^3 Allow incorrect use standard form e.g. 10.1×10^4 Pa	**(4)**
	• substitution in equation and rearrange	(1)	$T = \frac{101000 \times 0.0000252}{0.001 \times 8.31}$	
	• answer in **K**	(1)	T = 306.28 (K)	
	• convert to °C	(1)	T = 33.3(°C) (33.1°C if 273.15 is used for conversion of kelvin to Celsius) Ignore SF except 1 SF on final answer TE throughout but only award for MP4 if final answer in °C is between 0 and 50°C Units if given must be correct *Comment:* *Correct answer with no working scores 4* *306.28(K) scores 3* *30.85℃ scores 3* *33.7℃ scores 3 as they have used R as 8.3* *33.55℃ scores 3 using 8.3 and 273.15* *306.7K scores 2 as they have used R as 8.3*	

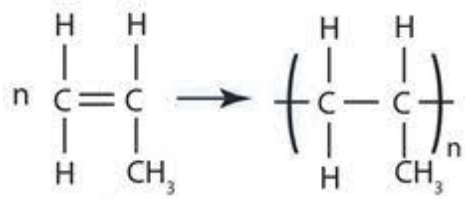
Question Number	Answer	Additional guidance	Mark
19(c)(i)	A drawing that shows: • four pairs of electrons and 4 hydrogen atoms around nitrogen (1) • one dative covalent bond **and** plus sign (1)	 Allow answers without brackets Allow use of any symbol for the electrons as long as it is clear which is the dative covalent bond (e.g. by use of an arrow) Ignore placement of positive sign	**(2)**

Question Number	Answer	Additional guidance	Mark
19(c)(ii)	An explanation that makes reference to: • tetrahedral / tetrahedron (1) • (four) **pairs of electrons** arranged in position of minimum repulsion / maximum separation (1)	MP1 may be scored with a 3D diagram or an answer given in 19(c)(i) Allow phonetic spelling Allow equal repulsion of electron-pairs Allow reference to bonding pairs Ignore reference to bonds Ignore all bond angles Do not award references to lone pairs Marks are standalone	**(2)**

Question Number	Answer	Additional guidance	Mark
19(d)(i)	Four correct ticks scores 2 marks, Three correct ticks scores 1 mark Four correct ticks and one incorrect tick scores 1 mark	e.g.  	**(2)**

Question Number	Answer	Additional guidance	Mark
19(d)(ii)	An answer containing an appropriate suggestion: • dichromate/oxidising agents promote(s) combustion/burning of alkanes/fuels OR alkanes are flammable/combustible **and** dichromate is an oxidising agent	Allow fuels/alkanes would catch fire more easily Ignore dichromate causes alkanes to burn Do not award dichromate catches fire	**(1)**

(Total for Question 19 = 14 marks)

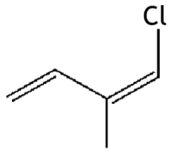
Question Number	Answer		Additional guidance	Mark
20(a)(i)	A balanced equation: • repeat unit of polypropene including extension bonds through the brackets	(1)	Example of equation:  Accept fully displayed and hybrid formulae Do not award skeletal formulae	**(2)**
	• all the rest of the equation	(1)	Allow the n anywhere on the LHS of the monomer Do not award MP1 is the n is before the brackets for the polymer Do not award if n is superscript on the RHS MP2 can be awarded if a different alkene monomer is used (and all is correct) Ignore vertical connectivity errors Penalise the omission of missing H atoms once only	

Question Number	Answer	Additional guidance	Mark
20(a)(ii)	An answer that makes reference to any **one** from: • no **small** molecule / water is made making poly(propene) • a **small** molecule / water is made making PLA • Poly(propene) is an addition polymer • PLA is a condensation polymer	Accept reverse argument Allow polymerisation of propene has a higher atom economy Allow polymerisation of lactic acid produces two products / polymerisation of propene only produces one Ignore propene contains C=C Ignore references to biodegradability	**(1)**

Question Number	Answer	Additional guidance	Mark
20(a)(iii)	• can be broken down / degraded / decayed by bacteria / microbes / organisms	Allow can be broken down by decomposers Ignore references to soil / environment / air Ignore breaks down on its own / naturally / biologically	**(1)**

Question Number	Answer	Additional guidance	Mark
20(a)(iv)	An answer including any **three** from: • takes less time than most plastics to break down (1) • reduce waste going to landfill (1) • do not require incineration (1) • <u>reduce</u> pollution / litter / harm to wildlife (1) • break down into non-harmful products OR can be used as fertiliser / biofuel (1) • help conserve crude oil reserves OR (come from a) renewable (resource) OR are more sustainable (1)	Allow degrade faster / requires less energy Do not award no waste Allow less pollution Do not award no pollution Allow a description of a renewable source Accept reverse arguments throughout Ignore environmentally friendly / global warming / carbon neutral / recycling / toxic gases	**(3)**

Question Number	Answer	Additional guidance	Mark
20(b)(i)	• both double bonds in isoprene have two atoms of hydrogen on one end / need to have different groups on both ends to form geometric isomers	Allow two identical groups / atoms are attached to one carbon of the double bond	(1)

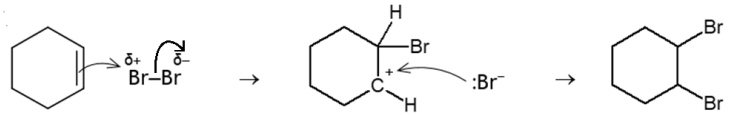
Question Number	Answer	Additional guidance	Mark
20(b))(ii)	A drawing of the other geometric isomer i.e. 	Accept displayed formulae and shortened structural formulae Ignore bond angles as long as Cl is opposite the methyl group on the double bond	(1)

Question Number	Answer	Additional guidance	Mark
20(b))(iii)	• does not allow (free) rotation / restricts rotation (around the C=C bond)	Allow limited instead of restricted Allow double bond does not rotate / double bond cannot be rotated Ignore references to groups attached to the C=C bond Ignore references to sigma and pi bonds, even if incorrect Do not award “restricted rotation around the molecule” alone	(1)

(Total for Question 20 = 10 marks)

Question Number	Answer	Additional guidance	Mark
21(a)	• mass of 0.0300 moles (1) • volume of 0.0300 moles (1)	Example of a calculation: (M_r = 12.0 × 6 + 10 × 1.0 = 82.0) 0.0300 × 82.0 = 2.46 (g) 2.46 ÷ 0.811 = (3.033) = 3 or 3.0 or 3.03 (1 or 2 or 3 SF) (cm^3) Correct answer with no working scores zero TE from M1 to M2 Ignore all units, even if incorrect	**(2)**

Question Number	Answer	Additional guidance	Mark
21(b)(i)	An answer that makes reference to the following points: • from brown / red-brown (1) • **to** colourless (1)	Allow red / brown-orange Do not award orange / yellow / brown-yellow Accept decolourises Ignore clear Correct colours in the reverse order scores (1) *Comment: Either brown or colourless alone, without an indication of whether it is the initial or final colour, scores 0*	**(2)**

Question Number	Answer	Additional guidance	Mark
21(b)(ii)	A mechanism showing: • induced dipole on bromine (1) **and** 1,2-dibromocyclohexane as the product • two curly arrows (to form intermediate and Br^-) (1) • intermediate (1) • curly arrow from lone pair on bromide ion to the trivalent/positive carbon atom of the intermediate (1)	δ+ closer to C=C double bond Allow displayed structures penalise omission of hydrogens once only Double headed arrow from double bond to Br atom with the δ+ **and** Arrow from Br–Br bond to the Br atom or just beyond it + charge shown on trivalent carbon atom Allow all lone pairs to be shown on bromide ion Do not award lines in place of lone pairs Correctly drawn mechanism with ethene (or another alkene) can gain MP2, MP3 and MP4 Penalise single headed arrows once only Example of mechanism:  (hydrogen atoms on intermediate may be shown or omitted on skeletal structures)	**(4)**

Question Number	Answer		Mark
21(c)(i)	parts per million		**(1)**

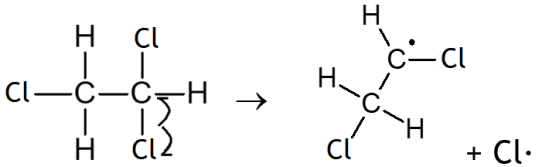
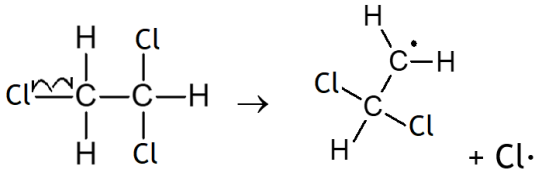
Question Number	Answer			Mark
21(c)(ii)	• choice of appropriate safe concentration	(1)	Example of calculation: (<)1.1 (ppm) Allow 1.0 to 1.1ppm	(3)
	• correct expression	(1)	$3.25/V = 1.1/10^6$ $V = 3.25 \times 10^6 / 1.1$ $= 2954545$ (cm^3)	
	• evaluation	(1)	= 2950 / 2955 / 3000 (dm^3) Do not award 2954 / 2960 (dm^3) Do not award MP3 for incorrect rounding Ignore SF Allow TE throughout If units are given they must be correct	

Question Number	Answer		Additional guidance	Mark
21(d)	• M_r of Br_2 calculated	(1)	Example of a calculation: M_r Br_2 = 159.8	(3)
	• mass of Br_2 calculated	(1)	$0.03 \times 159.8 = 4.794$ g	
	• volume of water = **mass** ÷ concentration	(1)	$v = 4.794 \div 35$ = 0.137 **dm^3** / 137 **cm^3** Ignore SF except 1 SF Allow TE throughout	

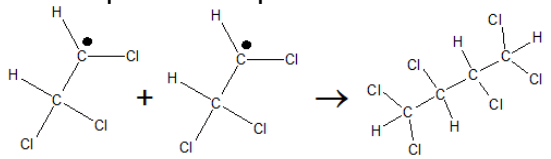
(Total for Question 21 = 15 marks)

Question Number	Answer	Additional guidance	Mark
22(a)	1,1,2-trichloroethane	Do not award 1, 2, 2-trichloroethane	**(1)**

Question Number	Answer	Additional guidance	Mark
22(b)(i)	• uv light OR uv radiation	Allow sunlight Allow uv Do not award "light"	**(1)**

Question Number	Answer	Additional guidance	Mark
22(b)(ii)	A displayed reaction equation including: • curly half arrows showing the breaking of a bond (1) • the formation of two free radicals (Cl• and one being from molecule X) (1)	Penalise the omission of the unpaired electron once only in (b)(ii) and (b)(iv) Allow the fission of a bond in isolation for MP1 Allow multiple fissions if all are correct Mark independently  or 	**(2)**

Question Number	Answer	Additional guidance	Mark
22(b)(iii)	A reaction equation showing: • a chlorine radical with 1,1,2-trichloroethane (1) • formation of two products (1)	Example of Equation: $Cl^{\bullet} + C_2H_3Cl_3 \rightarrow HCl + C_2H_2Cl_3^{\bullet}$ $Cl^{\bullet} + C_2H_3Cl_3 \rightarrow Cl_2 + C_2H_3Cl_2^{\bullet}$ Ignore further reactions Allow displayed formulae Allow radical dots placed in any location	**(2)**

Question Number	Answer	Additional guidance	Mark
22(b)(iv)	A reaction equation showing: • **displayed formula** of any radical with a formula $C_2H_3Cl_2\bullet$ or $C_2H_2Cl_3\bullet$ (1) • balanced equation with two radicals and showing the **displayed formula** of the product (1)	An example of an equation: 	**(2)**

Question Number	Answer	Additional guidance	Mark
22(b)(v)	An answer that makes reference to the points: • termination reaction (1) • suitably named product that can be derived from X (1)	Do not award addition reaction i.e. 1,1,2,3,4,4-hexachlorobutane, 1,2,2,3,3,4-hexachlorobutane, or 1,1,2,3,3,4-hexachlorobutane Allow TE name from $C_4H_4Cl_6$ structure shown in 22(b)(iv)	**(2)**

(Total for Question 22 = 10 marks)
Total for Section B = 60 marks
Total for Paper = 80 marks

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