Mark Scheme (Results)

January 2017

Pearson Edexcel
International Advanced Subsidiary Level
in Chemistry (WCH01)
Paper 01 The Core Principles of 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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (multiple choice)

Question Number	Correct Answer	Mark
1	A is incorrect because elements may be diatomic **B is the correct answer** C is incorrect because compounds contain two or more elements D is incorrect because ionic compounds contain two or more elements	1

Question Number	Correct Answer	Mark
2	**B is the correct answer** Though A, C, and D are products of the reaction they do not indicate the mechanism	1

Question Number	Correct Answer	Mark
3	**A is the correct answer** Only this answer gives correct priorities and positions with the double bond taking precedence over the branch.	1

Question Number	Correct Answer	Mark
4	**B is the correct answer** There are three different points of attachment for chlorine, one of which has geometric, cis-trans isomers.	1

Question Number	Correct Answer	Mark
5	**C is the correct answer** 100 cm^3 of carbon dioxide form and 200 cm^3 of oxygen are left. Water is not a gas at room temperature and pressure.	1

Question Number	Correct Answer	Mark
6	**B is the correct answer** $10 \times 200 \times 10^{-6} \times 24 \times 1000 = 48\ cm^3$	1

Question Number	Correct Answer	Mark
7	A is untrue B is untrue C is true but is not the best evidence for ions – it merely shows particles are arranged regularly **D is the correct answer**	1

Question Number	Correct Answer	Mark
8	**B is the correct answer** All ions in the responses have the same number of electrons, so the smallest is the ion with the most positive charge.	1

Question Number	Correct Answer	Mark
9	**C is the correct answer** A, B, and D are incorrect because they all have positive values.	1

Question Number	Correct Answer	Mark
10	**A is the correct answer** B is incorrect because positive ion is never distorted C is incorrect because no ion distortion D is incorrect because negative ion is too small and distorted in the wrong direction	1

Question Number	Correct Answer	Mark
11	A is incorrect because this is the enthalpy change of formation B is incorrect because neither reactant is ionized C is incorrect because the state of the product is incorrect **D is the correct answer**	1

Question Number	Correct Answer	Mark
12	A is incorrect because the oxide ion has more electrons B is incorrect because the chloride ion has more electrons C is incorrect because the sulfur ion has more electrons **D is the correct answer**	1

Question Number	Correct Answer	Mark
13	A is incorrect because the second value is positive B is incorrect because the first value is negative and the second positive **C is the correct answer** D is incorrect because the first value is negative	1

Question Number	Correct Answer	Mark
14	**B is the correct answer** Because the chromate(VI) ion is negative and coloured yellow under these conditions	1

Question Number	Correct Answer	Mark
15	**C is the correct answer** Because the same proportions of solutions of the same concentration are used	1

Question Number	Correct Answer	Mark
16	**C is the correct answer** Because 30 x 0.025/1000 x 30 = 0.00225	1

Question Number	Correct Answer	Mark
17	**A is the correct answer** B is incorrect because silver is not divalent in this reaction C is incorrect because silver is not divalent in this reaction D is incorrect because copper is not monovalent in this reaction	1

Question Number	Correct Answer	Mark
18	**D is the correct answer** Because all the other processes produce additional products	1

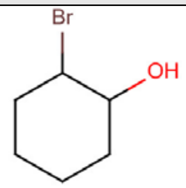
Question Number	Correct Answer	Mark
19	**A is the correct answer** B is incorrect because it is not an oxidant C is incorrect because it is not corrosive D is incorrect because it is not poisonous	1

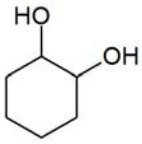
Question Number	Correct Answer	Mark
20	**A is the correct answer** B is incorrect because it is a hydroxide ion C is incorrect because it is water D is incorrect because it is an oxoniun ion And none of these have an unpaired electron	1

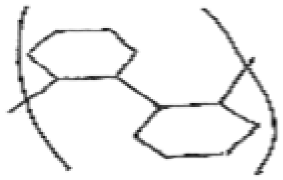
(TOTAL FOR SECTION A = 20 MARKS)

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	(Before shaking) yellow/brown solution (and colourless liquid) ALLOW red-brown/orange **(1)** (After shaking the aqueous layer) turns colourless OR Decolourises ALLOW Bromine colour fades/disappears **(1)** Two layers form OR Mention of a layer **(1)** IGNORE Incorrect name of product in this part	Red turns clear/transparent OR solid forms /bubbles/fizzing/ effervescence	3

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	 The OH and Br must be on two adjacent carbon atoms in either order on a six membered ring IGNORE Point of attachment of OH. Attempt to show stereochemistry eg bonds at odd angles		1

Question Number	Acceptable Answers	Reject	Mark
21(b)	 **(1)** **Comment** IGNORE Point of attachment of OH; even if –H-O Attempt to show stereochemistry **Name** Cyclohex**an**(e)-1,2-diol /1,2-dihydroxycyclohex**an**e /1,2-diolcyclohex**an**e IGNORE punctuation **(1)** Mark name and formula independently ALLOW TE for hex**an**(e)-n,(n+1)-diol with corresponding formula max1 Otherwise NO TE from incorrect formula		2

Question Number	Acceptable Answers	Reject	Mark
21(c)	**First mark**  Correct structure ALLOW Separated joining bond provided it points to both carbons IGNORE curious bond angles **(1)** **Second mark** Extension bonds ALLOW Two cyclic monomers, neither of which may be correct, joined together can score 1 max for extension bonds on adjacent carbons Fused rings with extension bonds on the adjacent carbons can score 1 max Separated extension bonds, where there is a gap between the bond and a cyclic structure are allowed if they are pointing to the carbons adjacent to the joining bond Second mark for **any** 12 carbon structures (which may be linear) **with extension bonds** IGNORE Brackets and numbers or letters after brackets eg n, 2, n/2 More than two units **(1)**		2

(TOTAL FOR QUESTION 21 = 8 MARKS)

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	Any two from (Some) zinc reacts / disappears (to give a colourless solution) ALLOW zinc / solid dissolves / disappears **(1)** Bubbles (of gas forming) effervescence/fizzing **(1)** (excess Zn) solid seen at the bottom (of the container) **(1)** Temperature increases / mixture warms **(1)** **IGNORE** Hydrogen gas forming	Incorrect gas Crystals / white solid forming	2

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$ OR $Zn(s) + 2H_3O^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g) + 2H_2O(l)$ **(2)** **OR** LHS correct with state symbols **(1)** RHS correct with state symbols **(1)** Correct ionic equation without state symbols or incorrect state symbols **(1)** ALLOW Sulfate ions on both sides for 1 max IGNORE full equation if ionic equation subsequently given		2

Question Number	Acceptable Answers	Reject	Mark
***22(b)**	**MP1** Filter (to remove excess zinc) **(1)** IGNORE impurities **MP2** Evaporate to crystallisation point ALLOW Boil to remove (some) water / reduce (excess) volume / heat to concentrate (the solution) **(1)** **MP3** (Cover and) cool / wait for crystals to form **And** Filter/decant / pick out the crystals (from supernatant liquid) **(1)** IGNORE washing **MP4** Dry crystals with filter papers / dry crystals with tissue paper / in a desiccator / in an oven at ≤ 50°C **(1)** The last key point mark awarded should only be given if sequence is correct.	…to remove **all** solvent / water Just 'dry'	4

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	287.5 (g mol^{-1}) ALLOW 287.4 (g mol^{-1}) IGNORE units even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	($\frac{20 \times 1.00}{1000}$ =) 0.0200 (mol) IGNORE units even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
22(c)(iii)	COMMENT Please use calculator to check use of unexpected molar masses **Method 1** Expected mass 0.0200 x 287.5 (= 5.75 (g)) **(1)** Yield = $\frac{4.00}{5.75}$ x 100 (= 69.5652)= 70% **(1)** **Method 2** 4/287.5 (= 0.01391 (mol)) **(1)** 0.01391/0.02 x 100 = 70% **(1)** ALLOW TE from (i) and (ii) ALLOW TE from first mark to second mark 191.5 x 0.02 = 3.83 → 100% (to 2 SF) 223.5 x 0.02 = 4.47 → 89% 161.5 x 0.02 = 3.23 →120% Correct answer no working scores (2)	Answer not to 2SF	2

(TOTAL FOR QUESTION 22 = MARKS)

Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	Any two from: • The same **general** formula ALLOW example of any general formula alone • Each member differs by CH_2 / by a mass of 14 • Contains the same functional group or have similar / same **chemical** properties • Smooth gradation of / gradual change / trend in physical properties IGNORE Same physical properties / same properties	Same empirical formula / same molecular formula	2

Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	Structural isomers have the same molecular formulae but different structural formulae / structures / displayed formulae / skeletal formula ALLOW **Just** 'different arrangement of same atoms' IGNORE General formula **(1)** When the last carbon atom is added to the chain, in butane there are two possible points of attachment but in propane there is only one. ALLOW Butane can form a branched chain / but propane cannot form a branched chain OR Two isomers of C_4H_{10} correctly drawn (alone) There is only one way of arranging the atoms in propane but two ways in butane **(1)** IGNORE More (carbon) atoms in butane Any other comments providing it is non-contradictory		2

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ Correct reactants and products **(1)** Balancing **(1)** 2^{nd} mark dependent on first BUT ALLOW one mark for correctly balanced equation for C_3H_6 IGNORE state symbols even if incorrect		2

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	Molar mass of propane = (3 x 12 + 8 x 1 =) 44 **(1)** $\frac{80 \times 1000}{44}$ = 1818 (mol) **(1)** ALLOW TE from first to second mark Correct answer no working 2 marks IGNORE SF except 1		2

Question Number	Acceptable Answers	Reject	Mark
23(b)(iii)	1818 x 2220 = 4.04×10^6(kJ) = 4036363000 / 4.04×10^9 (J) TE from (ii) e.g. 1.8 give 3996(kJ) IGNORE sign even if incorrect / IGNORE SF		1

Question Number	Acceptable Answers	Reject	Mark
23(b)(iv)	$\frac{4036363000}{4800}$ = 8.41×10^5 s =1 4000 min = 234 hours Ignore SF ALLOW 230 – 234 (early rounding) TE from (iii)		1

Question Number	Acceptable Answers	Reject	Mark
23(b)(v)	**Both marks can be awarded in either space** **Any two from** **MP1** For butane 80 kg produces 3.97 X 10^6 kJ whereas propane produces 4.04 X10^6 kJ OR Butane has a higher molar mass so energy per g/kg is about the same (slightly less) (values propane 50 J g^{-1}, Butane 48 J g^{-1}) **(1)** **MP2** Incomplete combustion more likely for butane ALLOW Butane needs more oxygen for complete combustion OR Butane does not burn as easily / quickly / efficiently ALLOW Butane / longer hydrocarbon is less efficient Butane takes longer to burn **(1)** **MP3** Butane may not vaporise at high altitudes / if it is cold / butane is less volatile OR Butane has higher boiling temperature **(1)** IGNORE More carbon dioxide formed / butane has greater density More energy required for burning		2

Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	3C(g) + 8H(g)		1

Question Number	Acceptable Answers	Reject	Mark
23(c)(ii)	3 x 716.7 + 8 x 218 −(-104.5) **(2)** (2 150.1 + 1 744) + 104.5 = (+)3 998.6 (kJ mol^{-1}) **(1)** Correct answer no working **(3)** Ignore SF and units even if incorrect (+)1039.2 scores 1 mark (missing both multiples) (+)2472.6 scores 2 marks (missing x 8) (+)2565.2 scores 2 marks (missing x 3) -3998.6 scores 2 marks (Hess wrong way round) (+)3789.6 scores 2 marks (-104.5) (+)2690.6 scores 2 marks (x 2 instead of x 8) -2690.6 scores 1 mark (x 2 instead of x 8, Hess wrong way round) (+)3126.6 scores 2 marks (x 4 instead of x 8) -3126.6 scores 1 mark (x 4 instead of x 8, Hess wrong way round)		3

Question Number	Acceptable Answers	Reject	Mark
23(c)(iii)	3 X E(C−C) = 5 173.3 − 10 X E(C−H) = 1050.3 **(1)** E(C−C) = (+) 350.1(kJmol^{-1}) **(1)** IGNORE SF except 1 IGNORE units even if incorrect		2

Question Number	Acceptable Answers	Reject	Mark
23(c)(iv)	Bond energies vary with environment (whereas bond energies in data book values are mean bond energies) ALLOW Bond energies averaged over (many / different) compounds		1

(TOTAL FOR QUESTION 23 = 19 MARKS)

Question Number	Acceptable Answers				Reject	Mark
24(a)(i)	Isotope mass number	Number of protons	Number of neutrons	Number of electrons		2
	39	19	20	19		
	41	19	22	19		
	Each correct row **(1)**					

Question Number	Acceptable Answers	Reject	Mark
24(a)(ii)	Isotopes OR atoms OR they OR elements OR species that have the same numbers of protons (and electrons) / 19 protons but different numbers of neutrons / 20 and 22 neutrons Must mention both protons and neutrons		1

Question Number	Acceptable Answers	Reject	Mark
24(a)(iii)	$\frac{39x + 41(100 - x)}{100} = 39.1$ ALLOW $\frac{39x + 41y}{100} = 39.1$ **(1)** -2x = 3 910 -4 100 = - 190 x = 95 39 – 95% 41 – 5% **(1)** Both correct with no working 2		2

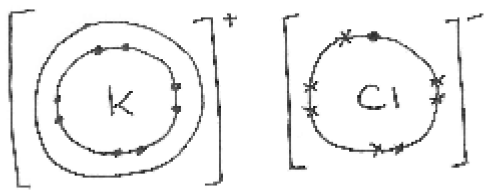
Question Number	Acceptable Answers	Reject	Mark
24(b)(i)	$10^{2.6}$ = 398 ± 40 (kJ mol^{-1}) ALLOW Any value between 250 - 550 (kJ mol^{-1}) OR $10^{5.7}$ = 501 000 ± 50 000 (kJ mol^{-1}) ALLOW Any value between 250,000 – 760,000 (kJ mol^{-1}) IGNORE units even if incorrect $e^{2.6}$ etc		1

Question Number	Acceptable Answers	Reject	Mark
24(b)(ii)	The large range (of numbers from 398 to 500 000 is too big a range to plot directly) **OR** to fit numbers onto graph **OR** (Taking logarithms) makes the numbers manageable to plot **ALLOW** Ionisation energies **too large**		1

Question Number	Acceptable Answers	Reject	Mark
24(b)(iii)	$K(g) - e^{(-)} \rightarrow K^+(g)$ **OR** $K(g) \rightarrow K^+(g) + e^{(-)}$ States, **dependent** on **correct electron transfer** **(1)** Rest of the equation correct **(1)**		2

Question Number	Acceptable Answers	Reject	Mark
24*(b)(iv)	**Any two from** Electrons removed from (more) positive ion each time / proton : electron ratio increases ALLOW greater effective nuclear charge **(1)** So the ion is smaller / has less electrons / has less electron repulsion / electron (to be removed) is closer to nucleus **(1)** so greater electrostatic attraction / greater attraction between nucleus and electron **(1)** IGNORE Shielding increasing Nuclear charge increasing		2

Question Number	Acceptable Answers	Reject	Mark
24*(b)(v)	Any three from • Each rise is caused by removing an electron from an inner (quantum) shell / energy level OR shell / energy level which is closer to the nucleus • The first sharp increase is when a 3p electron is removed (for the first time / rather than a 4s electron) • The second sharp increase is when a 2p electron is removed (for the first time / rather than a 3s electron) • The third sharp increase is when a 1s electron is removed (for the first time / rather than a 2s electron)		3

Question Number	Acceptable Answers	Reject	Mark
24(c)(i)	 (1) (1) OR No electrons around the potassium ion IGNORE the absence of empty ring around the potassium IGNORE inner electrons ALLOW 1 for two correct electronic structures with no charges		2

Question Number	Acceptable Answers	Reject	Mark
24(c)(ii)	Potassium conducts when solid (or molten) ALLOW potassium conducts in all states **(1)** Whereas potassium chloride (only) conducts when molten / in (aqueous) solution **(1)**		2

Question Number		Reject	Mark
24(c)(iii)*	Both solids are held together by forces of (electrostatic) attraction OR Both have positive and negative particles **(1)** (In both solids positive ions) are in fixed positions / in a lattice / regular arrangement OR both have regular 3D shape / arrangement OR lattice structures IGNORE Giant structures **(1)**	Both have positive and negative ions	2

Question Number	Acceptable Answers	Reject	Mark
24(c)(iv)*	In metal electrons are free to move / delocalised electrons OR In KCl electrons are not free to move / not delocalised OR In ionic solid negative ions are in fixed positions OR KCl contains anions and cations **and** (only) cations in K / K does not contain anions		1

(TOTAL FOR QUESTION 24) =21 MARKS

TOTAL FOR PAPER = 80 MARKS

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