Mark Scheme (Results)

Summer 2019

Pearson Edexcel 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	Answer	Mark
1	The only correct answer is **D** (the weighted mean mass of an atom of the element relative to 1/12 the mass of a carbon-12 atom) **A** *is incorrect because this is the definition of relative isotopic mass* **B** *is incorrect because the carbon scale is used* **C** *is incorrect because the carbon scale is used*	**(1)**

Question Number	Answer	Mark
2	The only correct answer is **C** (atoms in one mole of helium gas) **A** *is incorrect because it is not a mass* **B** *is incorrect because each oxygen molecule contains two atoms* **D** *is incorrect because each sodium chloride contains two ions*	**(1)**

Question Number	Answer	Mark
3	The only correct answer is **C** (2-methylpropane) **A** *is incorrect because ethane has empirical formula* CH_3 **B** *is incorrect because propane has empirical formula* C_3H_8 **D** *is incorrect because 2,2-dimethylpropane has empirical formula* C_5H_{12}	**(1)**

Question Number	Answer	Mark
4	The only correct answer is **D** (16.0) **A** *is incorrect because this is the percentage of carbon* **B** *is incorrect because this is the percentage of hydrogen atoms* **C** *is incorrect because this is the mass of hydrogen x 100 divided by the mass of carbon*	**(1)**

Question Number	Answer	Mark
5	The only correct answer is **D** (6) **A** *is incorrect because ring compounds and cis/trans isomers have not been counted* **B** *is incorrect because ring compounds have not been counted* **C** *is incorrect because cis/trans isomers have not been counted*	**(1)**

Question Number	Answer	Mark
6	The only correct answer is **B** (3.0×10^{24}) **A** *is incorrect because* 6×10^{24} *is the number of electrons in one mole of neon* **C** *is incorrect because* 6×10^{23} *is the number of atoms in one mole of neon* **D** *is incorrect because* 3×10^{23} *is the number of atoms in 10.1 g of neon*	**(1)**

Question Number	Answer	Mark
7	The only correct answer is **B** (51%) **A** *is incorrect because this is the atom economy in terms of carbon only* **C** *is incorrect because this is the percentage of moles of ethanol formed* **D** *is incorrect because this is the percentage of moles of ethanol compared to the number of moles in the equation*	**(1)**

Question Number	Answer	Mark
8	The only correct answer is **B** (7000) **A** *is incorrect because the volume of blood has been divided by the volume of white cells and not expressed in parts per million* **C** *is incorrect because the value is too large by a factor of 1000* **D** *is incorrect because the volume of blood has been divided by the volume of white cells*	**(1)**

Question Number	Answer	Mark
9	The only correct answer is **D** (Precipitation) **A** *is incorrect because it is not displacement* **B** *is incorrect because it is not neutralisation* **C** *is incorrect because it is not oxidation*	**(1)**

Question Number	Answer	Mark
10	The only correct answer is C (4.6 °C) **A** *is incorrect because the temperature has been doubled instead of halved to account for the volume change* **B** *is incorrect because the volume change has not been considered* **D** *is incorrect because the temperature has been halved twice*	**(1)**

Question Number	Answer	Mark
11	The only correct answer is **D** ($Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{-}$) **A** *is incorrect because this is the first and second ionization energies and the states are incorrect* **B** *is incorrect because this is the first and second ionisation energies* **C** *is incorrect because the states are incorrect*	**(1)**

Question Number	Answer	Mark
12	The only correct answer is **A** (increases by about 200 kJ mol^{-1}) **B** *is incorrect because the first ionisation energy increases* **C** *is incorrect because the first ionisation energy does not decrease* **D** *is incorrect because this increase is too high*	**(1)**

Question Number	Answer	Mark
13	The only correct answer is **B** (3) **A** *is incorrect because elements 1 and 9 must be noble gases, as they have the lowest melting temperature.* *So element 3 must be in Group 2* **C** *is incorrect because elements 1 and 9 must be noble gases, as they have the lowest melting temperature.* *So element 3 must be in Group 2* **D** *is incorrect because elements 1 and 9 must be noble gases, as they have the lowest melting temperature. So element 3 must be in Group 2*	**(1)**

Question Number	Answer	Mark
14	The only correct answer is **A** (decreases, decreases) **B** *is incorrect because the first ionisation energy decreases* **C** *is incorrect because the melting temperature decreases* **D** *is incorrect because both decrease*	**(1)**

Question Number	Answer	Mark
15	The only correct answer is **C** (right, left) **A** *is incorrect because the purple colour moves to the left and the blue colour to the right* **B** *is incorrect because the blue colour moves to the right* **D** *is incorrect because the purple colour moves to the left*	**(1)**

Question Number	Answer	Mark
16	The only correct answer is A (N_2O) **B** *is incorrect because* NO_2 *contains 23 electrons* **C** *is incorrect because* COS *contains 30 electrons* **D** *is incorrect because* CS_2 *contains 38 electrons*	**(1)**

Question Number	Answer	Mark
17	The only correct answer is **B** (electrons only) **A** *is incorrect because positive ions do not move* **C** *is incorrect because there are no negative ions* **D** *is incorrect because positive ions do not move*	**(1)**

Question Number	Answer	Mark
18	The only correct answer is **D** (five, one) **A** *is incorrect because neither number is correct* **B** *is incorrect because there are five sigma bonds* **C** *is incorrect because there is only one pi bond*	**(1)**

Question Number	Answer	Mark
19	The only correct answer is **A** (increases, increases) **B** *is incorrect because boiling temperature increases* **C** *is incorrect because mean molar mass increases* **D** *is incorrect because both increase*	**(1)**

Question Number	Answer	Mark
20	The only correct answer is **C** **A** *is incorrect because it is usual to use the lowest possible number for each substituent* **B** *is incorrect because it is not a Z isomer and it is usual to use the lowest possible number for each substituent* **D** *is incorrect because it is not the Z isomer*	**(1)**

(TOTAL FOR SECTION A = 20 MARKS)

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	E - Vaporiser / heater / vaporisation ALLOW vaporised sample/vapour **(1)** F – (electrically)charged plate(s) / collimator ALLOW electric field **(1)** IGNORE slits / accelerator /acceleration / velocity selector / velocimeter / charges on plates G - (electro)magnet ALLOW magnetic field **(1)** If neither F nor G has been scored award 1 mark for acceleration **and** deflection in correct order.	Ionisation Electron Gun Vaporisation of ions Electron(ic) field	**(3)**

Question Number	Acceptable Answers	Reject	Mark
***21(a)(ii)**	**X** has higher charge / lower mass /is lighter/ has lower mass/charge (ratio) (than the ions which reach the detector) **(1)** **Y** has higher mass/is heavier / has higher mass/charge (ratio) (than the ions which reach the detector) **(1)** If no other mark has been scored Any correct comparison of **X** & **Y** scores (1) e.g. m/e(**X**) < m/e(**Y**) scores (1)	Lower charge	**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	<table><tr><th>Mass Number</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th></tr><tr><td>(63)</td><td>29</td><td>34</td><td>28</td></tr><tr><td>(65)</td><td>29</td><td>36</td><td>28</td></tr></table> 1 mark for each correct row **(2)** Any two correct columns scores (1)		**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	Isotopes have the same number of protons (29) but different numbers of neutrons 34 and 36. IGNORE Reference to electrons		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	The percentage of copper atoms is 51(%) **(1)** $A_r = \frac{36}{51} \times 63 + \frac{15}{51} \times 65$ **(1)** = 63.588 = 63.6 (to 1 DP) **(1)** ALLOW TE for M2 and M3 If 100% used A_r = 32.4 scores (2) 32 scores (1) If Au included A_r = 129.0 scores (2) 128.9/129 scores (1) Correct answer to 1 dp with no working scores **(3)**	63.5	**(3)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	The SF mark is only available on a valid calculation. Cu 51 x 63.6 = 3243.6 (use of 63.588 gives 3243.0) Au 49 x 197 = 9653 **(1)** Cu $\frac{3243.6}{12896.6}$ x 100 = 25.15 = 25% OR Au $\frac{9653}{12896.6}$ x 100 = 74.85 = 75% **(1)** (only 1 calculation needed) ALLOW TE from (c)(i) Correct answer to 2 SF with no working scores (2) Use of 63.5 for Cu gives 3238.5 gives 25.12 = 25% Working directly from the table can score (2) e.g. %Au = $\frac{100x197x49}{(63x36+65x15+197x49}$ = 74.85 = 75% 63.6/(63.6+197)x100 and 197/(63.6+197)x100 which gives 24% and 76% scores 0		**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(iii)	COMMENT Ignore SF in c(iii) 100% = 24 carat 75 % = $\frac{75}{100}$ x 24 = 18 (carat) OR 74.85 % = $\frac{74.85}{100}$ x 24 = 17.96 = 18 (carat) ALLOW TE using % Au given in (c)(ii)		**(1)**

(**TOTAL FOR QUESTION 21 = 14 MARKS**)

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	(Black powder / suspension / solid) disappears /reacts /dissolves **(1)** Turns blue **(1)** "Blue solution forms" scores 2 marks	Bubbles of gas Effervescence Fizzing Other colours Precipitate	**(2)**

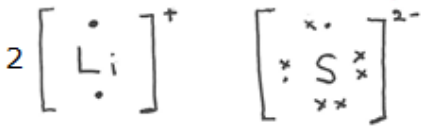
Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	$CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$ Correct species **(1)** ALLOW $Cu^{+2}(aq)$ for $Cu^{2+}(aq)$ Balancing and state symbols **(1)** Award M2 for correct states on near miss e.g. $O^{2-}(s) + 2H^+(aq) \rightarrow H_2O(l)$ Fully correct non-ionic equation $CuO(s) + 2H^+(aq) + SO_4^{2-}(aq) \rightarrow CuSO_4(aq) + H_2O(l)$		**(2)**

Question Number	Acceptable Answers	Reject	Mark
22(b)	Amount of acid $\frac{25.0 \times 0.500}{1000}$ = 0.0125 / 1.25 x10^{-2} (mol) **(1)** Amount of hydrogen = $\frac{0.0125}{2}$ = 0.00625 / 6.25 x10^{-3} (mol) **(1)** Volume of hydrogen 0.00625 x 24 = 0.15 (dm^3) OR 150 **cm^3** **(1)** ALLOW TE at each stage Correct answer with units if needed scores (3) If units are given they must be correct. Do not penalise correct intermediate rounding COMMENT Penalise rounded final values, do not penalise TE values correctly given to 1 SF e.g. 0.3 dm^3		**(3)**

Question Number	Acceptable Answers	Reject	Mark
22(c)	$H^+ + OH^- \rightarrow H_2O$ OR $H_3O^+ + OH^- \rightarrow 2H_2O$ ALLOW Multiples IGNORE state symbols even if incorrect		**(1)**

(TOTAL FOR QUESTION 22 = 8 MARKS)

Question Number	Acceptable Answers	Reject	Mark
23(a)	$(1s^2)\ 2s^2 2p^6 3s^2 3p^4$ ALLOW p_x etc		(1)

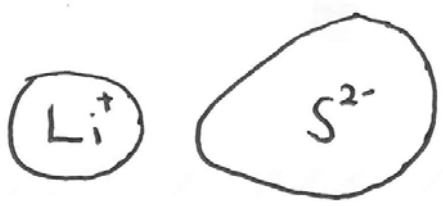
Question Number	Acceptable Answers	Reject	Mark
23(b)	 Two lithium ions correct shown in any way e.g. [Li] [Li] or $[Li]_2$ ALLOW no electrons on Li ion no brackets **(1)** One sulfide ion correct **(1)** ALLOW Any symbols for electrons e.g. open circles All dots or all crosses paired electrons on Li^+ and S^{2-} i.e. Li^+ : and 3 pairs of crosses and 1 pair of dots around S IGNORE inner shells of electrons Award one mark for both correct electron structures without charges OR Penalise omission of / incorrect charges once only	Covalently bonded diagram	(2)

Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	**W** = 2 x first ionisation (energy/enthalpy) of lithium **(1)** **X** = (standard enthalpy change of) atomisation of sulfur **(1)** **Y** = First electron affinity plus second electron affinity of sulfur ALLOW First and second electron affinity of sulfur **(1)** **Z** = (standard enthalpy change) of formation of lithium sulfide **(1)**	2x electron affinity of S Any reference to ionisation of sulfur	**(4)**

Question Number	Acceptable Answers	Reject	Mark
23(c)(ii)	**U = Z** - (**V** + **W** + **X** + **Y**) OR **U = Z** - **V** − **W** − **X** − **Y** ALLOW Terms in any order		**(1)**

Question Number	Acceptable Answers	Reject	Mark
*23(d)(i)	M2 and M3 may be scored by comparing specific ions **M1** Li ion is constant throughout OR Li ion does not affect the value of lattice energy OR Lattice energy is **only** affected by the anion ALLOW The greater the number of ions per mole the higher the lattice energy **(1)** **M2** The smaller the size of the ion, the more negative/larger/higher/ exothermic the lattice energy (e.g. F^- is smaller than Cl^- / O^{2-} is smaller than S^{2-} /smallest ion) **(1)** **M3** The greater the charge of the ion, the more negative/larger/higher the lattice energy (e.g. O^{2-} has a greater charge than F^- etc.) **(1)** ALLOW "Electrostatic forces of attraction" for "lattice energy" Reverse arguments IGNORE references to polarisation / distortion / covalent character/ electronegativity/strength of bond If no other mark is scored then "lattice energy depends on size and charge/ charge density of ion(s)" scores (1)	Atomic size/radius Nuclear charge/ionisation energy	**(3)**

Question Number	Acceptable Answers	Reject	Mark
*23(d)(ii)	The experimental / Born-Haber value is more negative / exothermic / larger / higher because of (some/additional) covalent / not 100% ionic bonding ALLOW Just 'Li_2S has covalent character' / not 100% ionic **(1)** caused by polarisation of the (large double negative) sulfide (ion) /S^{2-} **(1)** by the (small) lithium ion / Li^+ **(1)**	sulfur lithium / Li	**(3)**

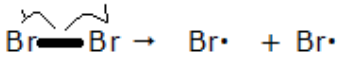
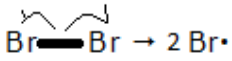
Question Number	Acceptable Answers	Reject	Mark
23(d)(iii)	 ALLOW more than one circle on either ion IGNORE the relative sizes of the ions	Dot-and-cross diagram Significant distortion of electron cloud of lithium ion i.e. lithium ion should be roughly circular. Overlap of electron densities	**(1)**

(Total for Question 23 = 15 marks)

Question Number	Acceptable Answers	Reject	Mark
24(a)(i)	Butane $C_4H_{10} + 13/2O_2 \rightarrow 4CO_2 + 5H_2O$ **(1)** Butene $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$ **(1)** ALLOW Multiples IGNORE state symbols even if incorrect		**(2)**

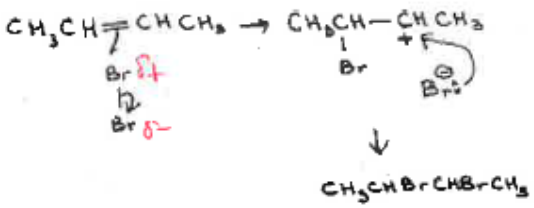
Question Number	Acceptable Answers	Reject	Mark
24(a)(ii)	Butane 0.4 + 0.15 = 0.55 (mol) **(1)** But-2-ene 0.4 +0.2 = 0.60 / 0.6 (mol) **(1)** TE on equations in (a)(i) 0.4 and 0.4 OR 0.15 and 0.2 scores 1 mark		**(2)**

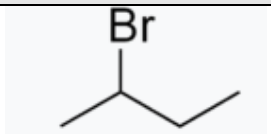
Question Number	Acceptable Answers	Reject	Mark
24(b)(i)	UV (light) / (sun)light IGNORE high temperature		**(1)**

Question Number	Acceptable Answers	Reject	Mark
24(b)(ii)	 OR  Curly half arrows from anywhere on Br-Br bond to Br atoms or just beyond **(1)** COMMENT the Br-Br bond may be represented as a line or an electron pair or both Rest of the equation correct **(1)**		**(2)**

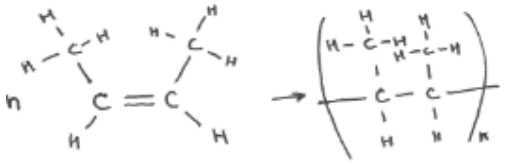
Question Number	Acceptable Answers	Reject	Mark
24(b)(iii)	$CH_3CH_2CH_2CH_3$, + Br• → $CH_3CH_2CH_2CH_2$• + HBr **(1)** $CH_3CH_2CH_2CH_2$• + Br_2 → $CH_3CH_2CH_2CH_2Br$ + Br• **(1)** ALLOW molecular formulae / reactions in either order / Br substitution at any C IGNORE curly arrows even if incorrect omission of unpaired electron(s)		**(2)**

Question Number	Acceptable Answers	Reject	Mark
24(b)(iv)	Br• + $CH_3CH_2CH_2CH_2$• → $CH_3CH_2CH_2CH_2Br$/ C_4H_9Br OR $CH_3CH_2CH_2CH_2$• + $CH_3CH_2CH_2CH_2$• → C_8H_{18} ALLOW Other radicals which might be generated / molecular formulae IGNORE curly arrows even if incorrect omission of unpaired electron(s)	C_4H_{10}•	**(1)**

Question Number	Acceptable Answers	Reject	Mark
24(b)(v)	 First step with both arrows One from double bond to Br One from Br-Br bond to Br atom or just beyond **(1)** Dipole on Br-Br **and** correct product **(1)** TE on incorrect carbocation Correct secondary carbocation intermediate No TE from incorrect alkene **(1)** Curly arrow from (or close to) lone pair on Br^- to positively charged carbon **(1)**	Incorrect alkene	**(4)**

Question Number	Acceptable Answers	Reject	Mark
24(c)	 Ignore displayed or structural formula		**(1)**

Question Number	Acceptable Answers	Reject	Mark
24(d)	$CH_3CHOHCHOHCH_3$ ALLOW $CH_3CH(OH)CH(OH)CH_3$ $CH_3(CHOH)_2CH_3$ displayed formula **(1)** IGNORE skeletal formula Butan(e)-2,3-diol ALLOW 2,3-butan(e)-diol 2,3-dihydroxybutane Do not penalise punctuation errors e.g. spaces omission of commas, hyphens **(1)** TE on **diol** given for M1	But-2,3-diol Butan(e)-2,3-ol 2,3 dibutanol	**(2)**

Question Number	Acceptable Answers	Reject	Mark
24(e)	ALLOW CH_3 in displayed formulae  Correct repeat unit **(1)** Everything else correct including the position of both "n"s. **(1)** OR *trans-but-2-ene* reactant	Dotted lines for extension bonds	**(2)**

Question Number	Acceptable Answers	Reject	Mark
24(f)(i)	Energy from forming bonds = 2 x 347 + 612 + 8 x 413 **(1)** = 694 + 612 + 3304 = 4610 (kJ mol^{-1}) Energy to atomise elements = 4 x 717 + 8 x 218 **(1)** = 2868 + 1744 = 4612 (kJ mol^{-1}) Standard enthalpy change of formation = energy(atomisation) - energy(bond formation) = +4612 – 4610 = (+)2 (kJ mol^{-1}) **(1)** Correct answer with no working scores **(3)**		**(3)**

Question Number	Acceptable Answers	Reject	Mark
24(f)(ii)	Bond energy/enthalpy depends on environment OR Mean bond energies/enthalpies used ALLOW average for mean IGNORE Non standard conditions	Just "mean values" Heat lost to the surroundings	**(1)**

(Total For Question 24 = 23 marks)
TOTAL FOR section B = 60 marks
TOTAL FOR PAPER = 80 MARKs

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