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Mark Scheme (Results)

October 2016

Pearson Edexcel International GCE in Chemistry (WCH01) Paper 1

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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	Reject	Mark
1(a)	C		1
	Incorrect Answers: A – This is 80% of the starting material and not the product B - Same mass as the starting material & not the product D- This is 100% yield and not 80%		

Question Number	Correct Answer	Reject	Mark
1(b)	C		1
	Incorrect Answers: A – This is only for one mole not three B - This is for two moles not three D- This is for five moles not three		

Question Number	Correct Answer	Reject	Mark
1(c)	C		1
	Incorrect Answers: A – This is for one water molecule not six B - This is the M_r value of water just as a percentage D- This is the percentage of the salt which is not water		

Question Number	Correct Answer	Reject	Mark
2(a)	A		1
	Incorrect Answers: B– Ten times too big C - 100 times too big D- Thousand times too big		

Question Number	Correct Answer	Reject	Mark
2(b)	B		1
	Incorrect Answers: A – Incorrect M_r and ratio used C - The 2:1 ratio has not been used D- The 2:1 ratio has been used the wrong way round		

Question Number	Correct Answer	Reject	Mark
2(c)	A		1
	Incorrect Answers: B – There are no coloured compounds C - There is no white precipitate D- There are no coloured precipitates		

Question Number	Correct Answer	Reject	Mark
3(a)	A		1
	Incorrect Answers: B – Two groups attached to one of the carbons in the double bond are the same C - Two groups attached to one of the carbons in the double bond are the same D- Two groups attached to one of the carbons in the double bond are the same		

Question Number	Correct Answer	Reject	Mark
3(b)	D		1
	Incorrect Answers: A – The major product is 3-bromohexane B - The major product is 3-bromo-3-methylpentane C- The major product is 2-bromo-2-methylpentane		

Question Number	Correct Answer	Reject	Mark
3(c)	B		1
	Incorrect Answers: A – There are 12 hydrogen atoms C - There are 12 hydrogen atoms D- There are 12 hydrogen atoms		

Question Number	Correct Answer	Reject	Mark
4	A		1
	Incorrect Answers: B – The methyl groups are bonded to the same carbon C - The double bonds are still present D- The double bond has moved and results in pentavalent carbons		

Question Number	Correct Answer	Reject	Mark
5	C		1
	Incorrect Answers: A – The longest consecutive chain is 7 not 5 B - The longest consecutive chain is 7 not 5 D- The numbering of the longest chain is wrong		

Question Number	Correct Answer	Reject	Mark
6	D		1
	Incorrect Answers: A – There is no dative covalent bond B - There is no dative covalent bond C- There is no dative covalent bond		

Question Number	Correct Answer	Reject	Mark
7	C		1
	Incorrect Answers: A – Melting temperatures increase across the period with a peak at group IV not Group I B - Melting temperatures increase across the period with a peak at group IV not Group III D- Melting temperatures increase across the period with a peak at group IV not Group V		

Question Number	Correct Answer	Reject	Mark
8	A		1
	Incorrect Answers: B– Hydrogen ions do not go to the anode C - Sodium would not be formed in water D- Oxygen ions do not go to the cathode		

Question Number	Correct Answer	Reject	Mark
9(a)	D		1
	Incorrect Answers: A – Atom economy of ethene, not all alkenes B - Ethene not doubled in numerator but doubled in denominator C- Atom economy where ethene not doubled		

Question Number	Correct Answer	Reject	Mark
9(b)	B		1
	Incorrect Answers: A – Incorrect reason for use of cracking C - Incorrect reason for use of cracking D- Incorrect reason for use of cracking		

Question Number	Correct Answer	Reject	Mark
10	C		1
	Incorrect Answers: A – Carbon dioxide does cause global warming B - Carbon dioxide does cause ice caps to melt D- Carbon dioxide does cause sea levels to rise		

Question Number	Correct Answer	Reject	Mark
11	D		1
	Incorrect Answers: A – Electron configuration lacks energy level 3 electrons B - Electron configuration has an extra 18 electrons C- Electron configuration lacks energy level 3 electrons		

Question Number	Correct Answer	Reject	Mark
12	B		1
	Incorrect Answers: A – The change is not to the extrapolated peak C - The change starts at zero and not 20 and goes to only the observed peak D- The change starts at zero and not 20		

Question Number	Correct Answer	Reject	Mark
13	A		1
	Incorrect Answers: B – The enthalpy changes are added and not subtracted C - The enthalpy changes are incorrectly doubled D- The enthalpy changes are doubled and added both incorrectly		

(TOTAL FOR SECTION A = 20 MARKS)

Section B

Question Number	Acceptable Answers	Reject	Mark
14(a)(i)	(RAM = $\frac{(13.9 \times 10) + (86.1 \times 11)}{100}$) = 10.861 (1) = 10.9 IGNORE amu / g mol^{-1} (1) Correct answer without working scores (2)	g/% answers not to 3sf	2

Question Number	Acceptable Answers	Reject	Mark
14(a)(ii)	compared to one twelfth the mass of a carbon-12 (atom/isotope) ALLOW where (one atom of) carbon-12 has a mass of exactly 12		1

Question Number	Acceptable Answers	Reject	Mark
14(a)(iii)	5 protons and 5 electrons (1) 7 neutrons (1) ALLOW use of letters p, e and n for sub-atomic particles		2

Question Number	Acceptable Answers	Reject	Mark
14(b)(i)	Any one from • deflect the ions from their normal path • additional/false peaks from particles in the air • ions would collide with particles in the air IGNORE Reference to chemical reactions/anomalous results/decreased speed of ions/ wrong percentage abundance given	Air molecules	1

Question Number	Acceptable Answers	Reject	Mark
14(b)(ii)	No effect / unaffected / they would not be accelerated/Only affects charged particles IGNORE Reference to detection/deflection/magnetic field		1

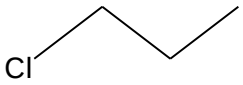
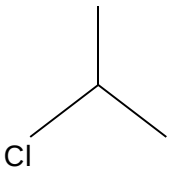
Question Number	Acceptable Answers	Reject	Mark
14(b)(iii)	Any one correct statement scores (1) Three correct statements scores (2) both oxygen atoms from the manganate(VII) ion gives a (molecular / parent ion) peak at **66** one oxygen atom from the manganate(VII) ion / one from water gives a (molecular / parent ion) peak at **64** both oxygen atoms from the water gives a (molecular / parent ion) peak at **62** IGNORE ^{18}O peak ALLOW Both oxygen atoms from the magnagate(VII) ion gives a (molecular/parent ion) peak **four** more	Reference to peaks at 32,34,36 or 63 or 65	2

Question Number	Acceptable Answers	Reject	Mark
14(c)(i)	(Error 1) peaks at 35 and 37 should be in 3:1 ratio/the peak at 35 should be three times the height of the peak at 37 ALLOW Reference to the height of the peak at 35 being at 75% compared to the height of the peak at 37 being at 25% (1) (Error 2) there should be a peak at 72 IGNORE Reference to the height/intensity of the peak at 72 (1)	Just 'greater'	2

Question Number	Acceptable Answers	Reject	Mark
14(c)(ii)	$(^{37}Cl—^{37}Cl)^+$ OR $[^{37}Cl—^{37}Cl]^+$ OR $(^{37}Cl^{37}Cl)^+$ OR $^{37}Cl—^{37}Cl^+$ OR $^{37}Cl_2{}^+$	$(^{37}Cl+^{37}Cl)^+$ $2\ ^{37}Cl^+$	1

(Total for Question 14 = 12 marks)

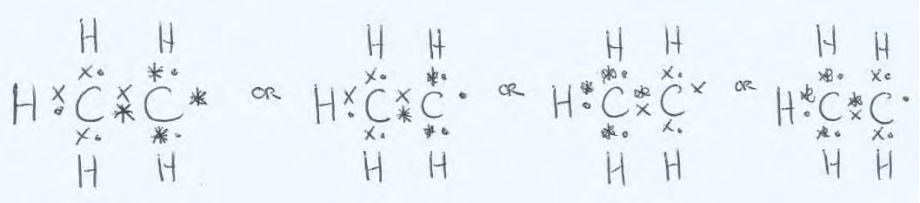
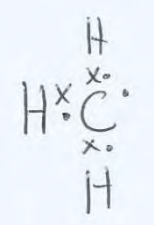
Question Number	Acceptable Answers	Reject	Mark
15(a)	$CH_4 + Br_2 \rightarrow CH_3Br + HBr$ IGNORE State symbols even if incorrect Reference to uv light	C_2H_6	1

Question Number	Acceptable Answers	Reject	Mark
15(b)	The names must correspond to the formulae but there is no TE on incorrect formulae  (1) Name: 1-chloropropane (1)  (1) Name: 2-chloropropane (1) IGNORE bond angles, bond lengths, bond orientations, punctuation		4

Question Number	Acceptable Answers	Reject	Mark
15(c)(i)	(Ethane) has no electron-rich area/no electron-dense area/ has no delta negative centre/no δ− (for the electrophile to react with) IGNORE No double bonds / no ∏ bonds but this can be credited in (c)(ii) Has maximum number of hydrogen atoms	Charge density/ No lone pair	1

Question Number	Acceptable Answers	Reject	Mark
15(c)(ii)	(Ethane) has no multiple bonds/ has no double bond / has no π bond / has only single / has only σ bonds ALLOW Ethane is saturated NOTE This may be explained in the answer to (c)(i) IGNORE Ethane is an alkane	Incorrect chemistry, e.g. donates protons	1

Question Number	Acceptable Answers	Reject	Mark
15(c)(iii)	(Equation) $Cl_2 \rightarrow 2Cl\bullet$ (1) IGNORE curly arrows even if incorrect (Name of reaction step) Initiation (1) IGNORE Free radical substitution/Homolytic fission Mark independently		2

Question Number	Acceptable Answers	Reject	Mark
15(c)(iv)	Carbon with only two hydrogens has single electron (1) Dot and cross of C−C and all C−H bonds correct (1) Example:  ALLOW One mark for ethane dot and cross diagram One mark for methyl free radical, example 	Missing H's	2

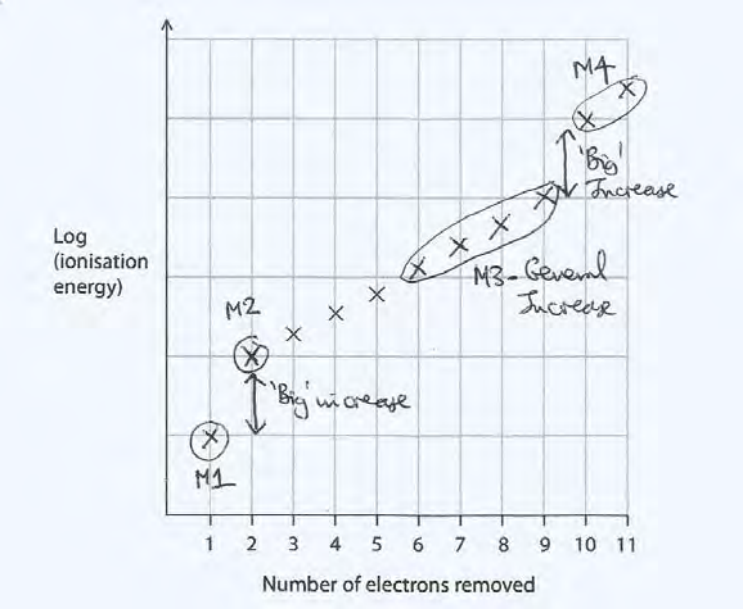
Question Number	Acceptable Answers	Reject	Mark
15(c)(v)	Increase the proportion of chlorine/ Use excess / more chlorine ALLOW decrease proportion of ethane OR Use less ethane Ignore references to temperature, pressure and uv light	Chloride Cl	1

(Total for Question 15 = 12 marks)

Question Number	Acceptable Answers	Reject	Mark
16(a)	The energy required ALLOW energy / enthalpy change/endothermic (1) to remove one electron from each atom in one mole of atoms ALLOW to remove one mole of electrons from one mole of atoms **Or** to produce one mole of singly charged positive ions from one mole of atoms (1) (all species) in the gaseous state (1) IGNORE equation even if correct	Energy given out / energy produced/ exothermic	3

Question Number	Acceptable Answers	Reject	Mark
16(b)	$Li^{+}(g) \rightarrow Li^{2+}(g) + e^{(-)}$ OR $Li^{+}(g) - e^{(-)} \rightarrow Li^{2+}(g)$ IGNORE missing (g) if gaseous is in part (a) DO NOT penalise missing gaseous state symbol if omission of gaseous is already penalised in part (a)		1

Question Number	Acceptable Answers	Reject	Mark
16(c)	Helium only has two electrons/ Helium does not have a third electron to lose IGNORE Helium only has two valence electrons/ only has two electrons in its outer shell		1

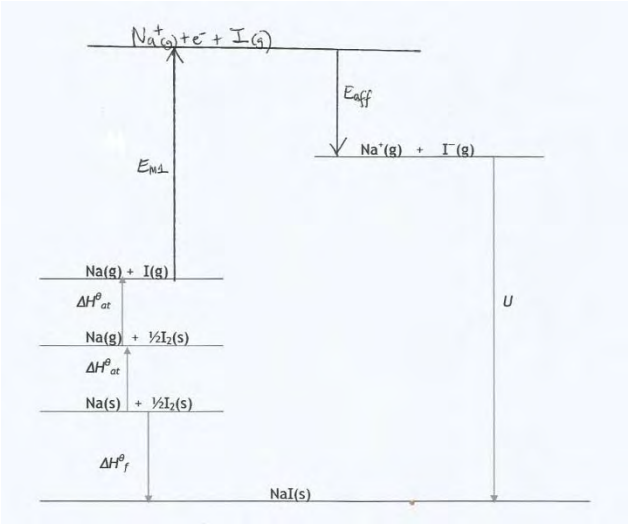
Question Number	Acceptable Answers	Reject	Mark
16(d)	**Marking point 1** One cross for electron 1 significantly below those already present (1) **Marking point 2** One cross for electron 2 slightly below the three crosses already present (1) **Marking point 3** Crosses for electrons 6 to 9 on an approximately straight line upwards continuing from electrons 3 to 5 (1) **Marking point 4** Cross for electron 10 significantly above the cross for electron 9 **and** cross for electron 11 slightly above the cross for electron 10 (1) Mark Independently IGNORE Lines drawn between crosses Example  	‘big’ increase anywhere between crosses 6 to 9 ‘big’ increase from cross 10 to cross 11	4

Question Number	Acceptable Answers	Reject	Mark
16(e)	Any three from Increased shielding (by inner electron shells) / greater repulsion between inner shell electrons (1) More shells (1) Greater distance from nucleus (to outermost electron) / increased (atomic) radius (1) These outweigh the increased nuclear attraction from the greater number of protons (1)	Reference to molecule, max 2 Ionic radius	3

Question Number	Acceptable Answers	Reject	Mark
16(f)	(For sulfur) the outermost electron is paired in the p orbital (1) Repulsion between (paired) electrons (reduces ionisation energy) (1) If no correct reference to sulfur then allow one mark for phosphorus (atom) having more stable p^3/half-filled p sub-shell	4p	2

Question Number	Acceptable Answers	Reject	Mark
16(g)	(Ionisation energy value) Any value in the range of (+)520-700 (kJ mol^{-1}) [Actual value (+)578] ALLOW Any range within the values given above (1) The outermost electron for aluminium is in a **p** orbital / subshell (1) Which has higher energy (than the **s** orbital) ALLOW is further away from the nucleus (and requires less energy to remove) than the 3s electrons (of aluminium) **Or** Shielded by the 3s electrons (1) ACCEPT Reverse arguments	2p Higher energy **level / shell**	3

(Total for Question 16 = 17 marks)

Question Number	Acceptable Answers	Reject	Mark
17(a)	Diagram similar to:  **Marking point 1** Arrow upwards for first ionisation energy of sodium and correct label on arrow (from correct entities) (1) **Marking point 2** Arrow downwards for electron affinity of iodine and correct label on arrow (from correct entities) (1) **Marking point 3** Correct entities with states (on horizontal line) Ignore missing electron (1) ALLOW Numerical values for labels on arrows Recognisable symbols for labels on arrows, such as ΔH_{IE}, ΔH_{EA}		3

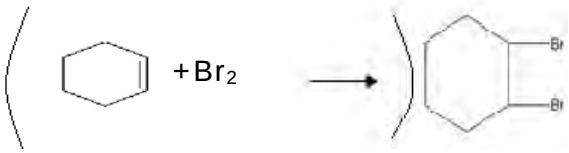
Question Number	Acceptable Answers	Reject	Mark
17 (b)	(LE = 107+107+496+288-295=) —703 kJ mol^{-1}		1

Question Number	Acceptable Answers	Reject	Mark
17 (c)	Energy is required to break bonds (1) In sodium these are metallic bonds/(electrostatic) attractions between metallic cations and the sea of delocalised electrons (1) In iodine these are covalent bonds (between the iodine atoms and London forces) (1) Mark independently		3

Question Number	Acceptable Answers	Reject	Mark
17(d)(i)	(Sodium iodide has) some covalent character / some covalency/some polarisation ALLOW the electron cloud of the iodide ion is distorted Ignore references to NaI being not 100% ionic/ NaI being just 'covalent' (1) which results in stronger bonding (than purely ionic) (1) Ignore References to standard conditions/expt. error		2

Question Number	Acceptable Answers	Reject	Mark
17(d)(ii)	Diagram with distorted electron density cloud towards the sodium ion Example  Ignore the size difference between the ions	Iodine contour line overlaps with sodium contour line	1

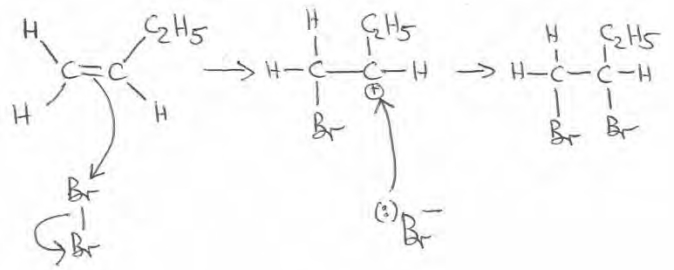
(Total for question 17 = 10 marks)

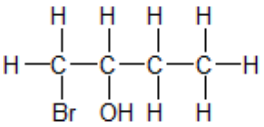
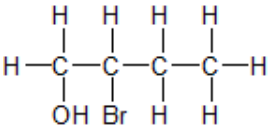
Question Number	Acceptable Answers	Reject	Mark
18(a)(i)	 IGNORE bond angles, bond lengths, bond orientations	+ H_2	1

Question Number	Acceptable Answers	Reject	Mark
18(a)(ii)	From red-brown / red / brown to colourless	Clear/white Orange/yellow/ Orange-brown	1

Question Number	Acceptable Answers	Reject	Mark
18(b)(i)	(Bonds broken =) 612 + 193 = (+)805 (Bonds made=) 347 + (290x2)=(-) 927 (1) Enthalpy of reaction =(805 — 927=) —122 (kJ mol^{-1}) Correct answer with no working scores two marks ALLOW (All bonds broken=)+4803 (All bonds made =)-4925 (1) Enthalpy of reaction = (+4803 – 4925=) -122 (kJ mol^{-1}) (1) Award one mark for (+) 122 (kJ mol^{-1}) Award one mark for a correct subtraction using one of the correct values above, example 4538 – 4925 = −387 (kJ mol^{-1})		2

Question Number	Acceptable Answers	Reject	Mark
18(b)(ii)	Bond enthalpies are for gaseous compounds **and** bromine is a liquid / 1,2 dibromobutane is a liquid IGNORE Reference to just 'different states'		1

Question Number	Acceptable Answers	Reject	Mark
18(b)(iii)	Mechanism drawn similar to  **Marking point 1** Curly arrow from double bond to Br **and** curly arrow from Br-Br bond to the Br (dipoles not required) (1) **Marking point 2** Correct carbocation structure (1) **Marking point 3** Curly arrow from anywhere on the bromide ion (including the minus sign) towards the carbocation **and** the correct product ALLOW TE on primary carbocation (1) Note the bromide ion must have a full negative charge but the lone pair of electrons need not be shown	Incorrect dipole $^{\delta-}$Br	3

Question Number	Acceptable Answers	Reject	Mark
18(b)(iv)	1-bromobutan-2-ol / $CH_3CH_2CHOHCH_2Br$/  ALLOW 2-bromobutan-1-ol / $CH_3CH_2CHBrCH_2OH$/  ALLOW 2-bromo-1-butanol ALLOW skeletal or structural formulae Penalise contradictory names/formulae	Missing H's	1

TOTAL FOR QUESTION 18 = 9 MARKS

(TOTAL FOR SECTION B = 60 MARKS)

TOTAL FOR PAPER = 80 MARKS