Mark Scheme (Results)

Summer 2016

Pearson Edexcel International Advanced Level in Chemistry (WCH02) Paper 01 Application of Core Principles of Chemistry

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Summer 2016
Publications Code 46659_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.
- 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	B		**(1)**

Question Number	Correct Answer	Reject	Mark
2(a)	C		**(1)**

Question Number	Correct Answer	Reject	Mark
2(b)	A		**(1)**

Question Number	Correct Answer	Reject	Mark
2(c)	C		**(1)**

Question Number	Correct Answer	Reject	Mark
2(d)	D		**(1)**

Question Number	Correct Answer	Reject	Mark
3	D		**(1)**

Question Number	Correct Answer	Reject	Mark
4(a)	D		**(1)**

Question Number	Correct Answer	Reject	Mark
4(b)	D		**(1)**

Question Number	Correct Answer	Reject	Mark
4(c)	A		**(1)**

Question Number	Correct Answer	Reject	Mark
4(d)	D		**(1)**

Question Number	Correct Answer	Reject	Mark
5	B		**(1)**

Question Number	Correct Answer	Reject	Mark
6(a)	B		**(1)**

Question Number	Correct Answer	Reject	Mark
5(b)	B		**(1)**

Question Number	Correct Answer	Reject	Mark
7	C		**(1)**

Question Number	Correct Answer	Reject	Mark
8	B		**(1)**

9	B		**(1)**

Question Number	Correct Answer	Reject	Mark
10(a)	A		**(1)**

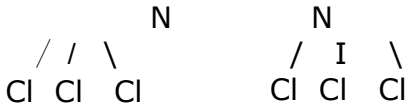
Question Number	Correct Answer	Reject	Mark
10(b)	D		**(1)**

Question Number	Correct Answer	Reject	Mark
11	C		**(1)**

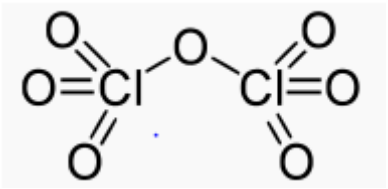
Question Number	Correct Answer	Reject	Mark
12	A		**(1)**

Section B

Question Number	Acceptable Answers	Reject	Mark
13(a)	Ignore drawn shapes Shape is **trigonal planar / triangular planar** Allow recognisable spelling eg triganol planar **(1)** Bond angle 120(°) Stand alone mark **(1)** **No** TE on incorrect shape Answers may be given the wrong way round ie bond angle first, then shape	…pyramidal **Just** planar OR Trigonal OR Triangular °C	**(2)**

Question Number	Acceptable Answers	Reject	Mark
***13(b)**	(Shape) Ignore references to tetrahedral/pyramidal  ALLOW  Lone pair on central N atom NOT required ALLOW Any correct variation as long as the shape is clear **(1)** Any angle between 106(°) – 108(°) **(1)** Mark M1 and M2 independently (Explanation) **Minimum repulsion** (between pairs/groups of electrons /centre of electron density) ALLOW **maximum separation** **(1)** (between pairs/groups of electrons /centre of electron density) Lone pair-bond pair repulsions are greater /more than bond pair-bond pair repulsions OR Lone pair(s) repel more than bond pair(s) **(1)**	No M1 if incorrect name for shape eg bipyramidal Just dot and cross TWO lone pairs ^{o}C …between atoms/ bonds …between atoms/ bonds "	**(4)**

Question Number	Correct Answer	Reject	Mark
13(c)(i)	+7 / +VII ALLOW 7^+ / 7+	7, -7	**(1)**

Question Number	Correct Answer	Reject	Mark
13(c)(ii)	 ALLOW O O | | O – Cl – O – Cl - O | | O O OR O O ↑ ↑ O ← Cl – O – Cl → O ↓ ↓ O O IGNORE Any dot and cross diagram or added dots and crosses		**(1)**

Question Number	Correct Answer	Reject	Mark
13(c)(iii)	$Cl_2O_7 + H_2O \rightarrow 2HClO_4$ Ignore state symbols even if incorrect. Atoms can be in any order. ALLOW $H_2Cl_2O_8$ ALLOW multiples		**(1)**

(Total for Question 13 = 9 marks)

Question Number	Correct Answer	Reject	Mark
14(a)(i)	(Concentrated) sulfuric acid acts as an oxidizing agent /oxidises iodide OR Iodide ions/HI act as a reducing agent OR Iodide ions/HI reduce the sulfuric acid **(1)** Iodide ions/HI are oxidized/converted to **iodine** ALLOW **Iodine** is formed **(1)**	...reduced to iodine	**(2)**

Question Number	Correct Answer	Reject	Mark
14(a)(ii)	Allow multiples for both equations. Ignore state symbols even if incorrect. $P_4 + 6I_2 \rightarrow 4PI_3$ OR $2P + 3I_2 \rightarrow 2PI_3$ ALLOW $P_2 + 3I_2 \rightarrow 2PI_3$ **(1)** $PI_3 + 3C_4H_9OH \rightarrow 3C_4H_9I + H_3PO_3$ ALLOW $P(OH)_3$ TE for second mark $PI_5 + C_4H_9OH \rightarrow C_4H_9I + POI_3 + HI$ **(1)**	P_3 PI_5	**(2)**

Question Number	Correct Answer	Reject	Mark
14(b)(i)	As a (co-)solvent for both (aqueous) silver nitrate and bromoalkane OR As a (co-)solvent for polar and non-polar molecules OR To allow the reagents/reactants to mix/dissolve/become miscible ALLOW To dissolve the halogenoalkane (as it is not water soluble) OR Just (As a) co-solvent	Just solvent	**(1)**

Question Number	Correct Answer	Reject	Mark
14(b)(ii)	Butan-1-ol ALLOW 1-butanol OR Butane-1-ol	Butanol But-1-ol	**(1)**

Question Number	Correct Answer	Reject	Mark
14(b)(iii)	Yellow **(1)** $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ **(1)**	Pale yellow/ cream	**(2)**

Question Number	Correct Answer	Reject	Mark
14(b)(iv)	<table><tr><th></th><th>Observation with dilute aqueous ammonia</th><th>Observation with concentrated aqueous ammonia</th></tr><tr><td>Precipitate from Tube **A**</td><td>Dissolves/ soluble</td><td>Dissolves/ soluble</td></tr><tr><td>Precipitate from Tube **C**</td><td>No change/ insoluble/ppt **and** remains</td><td>No change/ insoluble/ppt **and** remains</td></tr></table> Any two correct scores 1 mark All four correct boxes scores 2 marks		**(2)**

Question Number	Correct Answer	Reject	Mark
14(b)(v)	**CBA** OR AgI, AgBr, AgCl OR Silver iodide, silver bromide, silver chloride		**(1)**

Question Number	Correct Answer	Reject	Mark
***14(b)(vi)**	The carbon-halogen bond polarity decreases from chlorine to iodine **(1)** Allow reverse argument The rate depends on the carbon-halogen bond strength (which decreases from chlorine to iodine) **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
14(c)(i)	$CH_3CH_2CHCH_2$ ALLOW $CH_3CH_2CH=CH_2$ OR Displayed/ skeletal formula Ignore C_4H_8		**(1)**

Question Number	Correct Answer	Reject	Mark
14(c)(ii)	Type – elimination ALLOW dehydrohalogenation		**(1)**

Question Number	Correct Answer	Reject	Mark
14(c)(iii)	**M2** depends on **M1** Bromine/Br_2 (water) **(1)** (Yellow to) colourless **(1)** ALLOW Other colours brown/red/orange for bromine water OR **Acidified** potassium manganate(VII) OR H^+ **and** MnO_4^- **(1)** Purple/pink to colourless **(1)**	 ….to clear Any other colour ….to clear	**(20**

Question Number	Correct Answer	Reject	Mark
14(d)(i)	$2NH_3 + CH_3CH_2CH_2CH_2I \rightarrow CH_3CH_2CH_2CH_2NH_2 + NH_4I$ ($NH_4^+I^-$) ALLOW $NH_3 + CH_3CH_2CH_2CH_2I \rightarrow CH_3CH_2CH_2CH_2NH_2 + HI$ C_4H_9 for carbon chain Displayed formulae	$C_4H_{11}N$	**(1)**

Question Number	Correct Answer	Reject	Mark
14(d)(ii)	$(CH_3CH_2CH_2CH_2)_2NH$ OR $(CH_3CH_2CH_2CH_2)_3N$ OR $(CH_3CH_2CH_2CH_2)_4N^{(+)}I^{(-)}$ ALLOW C_4H_9 for carbon chain Displayed formulae		**(1)**

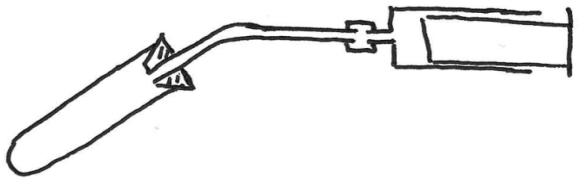
(Total for Question 14 = 19 marks)

Question Number	Correct Answer	Reject	Mark
15(a)(i)	$Ba(NO_3)_2$ ((s))		**(1)**

Question Number	Correct Answer	Reject	Mark
15(a)(ii)	(Nitrogen dioxide is a) brown gas/fumes/vapour	Any other colour with brown eg red brown.	**(1)**

Question Number	Correct Answer	Reject	Mark
15(a)(iii)	Oxygen relights/rekindles a glowing splint Ignore any reference to pops		**(1)**

Question Number	Correct Answer	Reject	Mark
15(a)(iv)	$2Ba(NO_3)_2.4H_2O \rightarrow 2BaO + 4NO_2 + O_2 + 8H_2O$ OR $Ba(NO_3)_2.4H_2O \rightarrow BaO + 2NO_2 + ½O_2 + 4H_2O$ Ignore state symbols even if incorrect ALLOW • equation in two steps • multiples • $2N_2O_4$ for $4NO_2$ **M1** Correct entities **(1)** **M2** Balancing **(1)** **M2 depends on M1** **Special case** If the anhydrous salt equation is given: $2Ba(NO_3)_2 \rightarrow 2BaO + 4NO_2 + O_2$ scores **1 max**		**(2)**

Question Number	Correct Answer	Reject	Mark
15(b)	Any 3 of the following points. • Diagram of workable method eg  ↑ Heat OR Two test tubes being heated **(1)** • Identical heating /same amount of heat /constant heating **(1)** • Identical numbers of moles/amounts ALLOW Same mass/volume **(1)** • Time taken for brown fumes to form/positive test for oxygen OR Time taken for fixed volume of gas to be collected OR Measure rate of gas given off ALLOW Gives out oxygen/nitrogen dioxide/gas faster **(1)** IGNORE Decomposes faster Heat the sample up for the same time and masure volume of gas evolved would score two bullet points	Heating in a water bath Test tubes with bungs Reflux apparatus Heat to constant mass	**(3)**

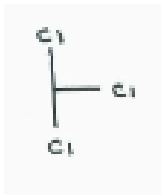
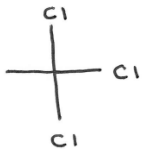
Question Number	Correct Answer	Reject	Mark
***15(c)**	**M1** Calcium (ions) are smaller than barium (ions) /have a higher charge density Allow Atoms for ions Reverse argument **(1)** **M2** The calcium **ion** polarizes/distorts **(1)** **M3** The nitrate/anion (ion)/N-O bond is polarised/distorted/broken (this weakens the N-O bond) **(1)**		**(3)**

Question Number	Correct Answer	Reject	Mark
15(d)	Calcium – red ALLOW brick red / yellow red **(1)** Barium – pale green/ apple green/green ALLOW greenish **(1)**	Crimson	**(2)**

(Total for Question 15 = 13 marks)

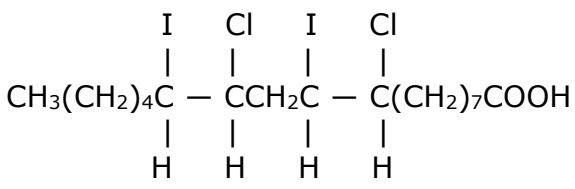
(Total for Section B = 41 marks)

Section C

Question Number	Correct Answer	Reject	Mark
16(a)(i)	ALLOW Any bond lengths and any angles. Ignore displayed/structural formulae  **(1)**  **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
16(a)(ii)	(Higher boiling temperature because) stronger / more / higher London/dispersion forces OR instantaneous dipole-induced dipole forces ALLOW Stronger Van der Waals forces/ VdW IGNORE minor spelling errors **(1)** because it has more electrons ALLOW larger surface area/more points of contact **(1)**	Just stronger intermolecular forces	**(2)**

Question Number	Correct Answer	Reject	Mark
16(a)(iii)	Because they damage the ozone layer OR (Halothane products like) 1,1,1-trichloroethane are narcotic inhalants / poisonous / toxic ALLOW Carcinogens/ greenhouse gases **IGNORE** References to just: • "formation of chlorine radicals" • formation of Cl• • harmful/bad for environment	Any statement that this compound is a CFC OR forms Cl_2 (on breaking down)	**(1)**

Question Number	Correct Answer	Reject	Mark
16(b)(i)	 I and Cl on either side of each bond, either up or down Look out for only I or Cl added with extra hydrogen, also 2I and 2Cl added	I and Cl on the same carbon	**(1)**

Question Number	Correct Answer	Reject	Mark
16(b)(ii)	ICl is a **stronger** electrophile / **better** electrophile Allow a correct description of an electrophile even if the term is not used. e.g. ICl has a vacancy for a bonding pair of electrons OR ICl (bond) is polar/has a dipole **NOTE:** ALLOW "the ICl (bond) is more polar" OR Mention of presence of the $I^{\delta+}$ (in ICl) ALLOW 'It' for ICl IGNORE ICl bond is weaker		**(1)**

Question Number	Correct Answer	Reject	Mark
16(b)(iii)	To prevent formation of free radicals OR To prevent (I-Cl) bonds breaking (homolytically) **ALLOW** To prevent **UV**/**sunlight** entering **UV**/**sunlight** causes it to react / decompose	Causes oxidation **C-Cl** breaks …heterolytically	**(1)**

Question Number	Correct Answer	Reject	Mark
16(b)(iv)	$ICl + I^- \rightarrow I_2 + Cl^-$ +1 (-1) -1 0 - 1 **(1)** (Iodine in) iodine monochloride/ICl/$I^{\delta+}$ ALLOW I^+/I($^{+1}$) (in iodine monochloride) **(1)**	Just 0 for ICl Just 'Iodine'	**(1)**

Question Number	Correct Answer	Reject	Mark
16(c)(i)	From red/brown/yellow to pale yellow/ straw coloured ALLOW Red/brown/yellow colour fades/pales	to colourless	**(1)**

Question Number	Correct Answer	Reject	Mark
16(c)(ii)	An insoluble compound forms (if starch is added too soon) OR Starch iodine complex forms ALLOW Any indication of solid formation		**(1)**

In 16(d) penalise incorrect units once **only**
ALLOW TE in all parts from the previous part(s) **Calculators needed!**

PENALISE rounding errors in (d)(v) to (d)(vii) **only once**
Also penalise 1 SF in (d)(v) to (d)(vii) **only once** unless trailing zeros omitted.

Question Number	Correct Answer	Reject	Mark
16(d)(i)	Number of moles of thiosulfate = $\frac{40.0 \times 0.100}{1000} = 4.00 \times 10^{-3}$/0.00400 (mol)		**(1)**

Question Number	Correct Answer	Reject	Mark
16(d)(ii)	Number of moles of iodine =0.00400/2 =2.00×10^{-3}/0.00200 (mol) Allow TE from (i)		**(1)**

Question Number	Correct Answer	Reject	Mark
16(d)(iii)	2.00×10^{-3}/0.00200 (mol) Allow TE from (ii)		**(1)**

Question Number	Correct Answer	Reject	Mark
16(d)(iv)	0.00200 - 0.00110 = 9.00×10^{-4}/0.00090 (mol) Allow TE from (iii) unless value is negative (or if calculation reversed for this reason) NOTE: A negative value in this part will not score. However, it will allow TE in (v) and (vi).		**(1)**

Question Number	Correct Answer	Reject	Mark
16(d)(v)	0.00090 x 100/0.200 = 0.45 (mol) NOTE: (iv) x 500		**(1)**

Question Number	Correct Answer	Reject	Mark
16(d)(vi)	0.45 x 2 x 126.9 = 114(.2) (g) If I=127 then final answer is 114(.3) (g) Ignore SF except 1.		**(1)**

Question Number	Correct Answer	Reject	Mark
16(e)	Sample titre - higher AND Iodine value – lower		**(1)**

(Total for Section C = 19 marks)

TOTAL FOR PAPER= 80 marks