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Mark Scheme (Results)

Summer 2014

IAL Chemistry (WCH02/01)

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Summer 2014
Publications Code IA038350*

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)	B		1

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

Question Number	Correct Answer	Reject	Mark
2	B		1

Question Number	Correct Answer	Reject	Mark
3	C		1

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

Question Number	Correct Answer	Reject	Mark
4 (b)	B		1

Question Number	Correct Answer	Reject	Mark
5	A		1

Question Number	Correct Answer	Reject	Mark
6	C		1

Question Number	Correct Answer	Reject	Mark
7	A		1

Question Number	Correct Answer	Reject	Mark
8	B		1

Question Number	Correct Answer	Reject	Mark
9	D		1

Question Number	Correct Answer	Reject	Mark
10	C		1

Question Number	Correct Answer	Reject	Mark
11 (a)	D		1

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

Question Number	Correct Answer	Reject	Mark
12	C		1

Question Number	Correct Answer	Reject	Mark
13	B		1

Question Number	Correct Answer	Reject	Mark
14	A		1

Question Number	Correct Answer	Reject	Mark
15	B		1

Question Number	Correct Answer	Reject	Mark
16	D		1

Question Number	Correct Answer	Reject	Mark
17	C		1

TOTAL FOR SECTION A = 20 MARKS

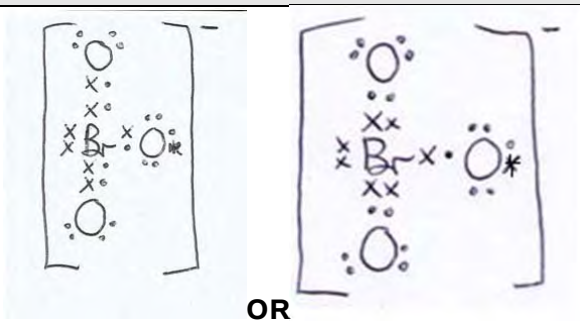
Section B

Question Number	Acceptable Answers	Reject	Mark
18 (a)	$NaCl + H_2SO_4 \rightarrow HCl + NaHSO_4$ ALLOW Multiples $HNaSO_4$ $2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2SO_4$ IGNORE state symbols even if incorrect COMMENT ALLOW Capitals or lower case in formulae		1

Question Number	Acceptable Answers	Reject	Mark
18 (b)	Ammonia (gas) / NH_3 Allow Ammonia solution/ $NH_3(aq)$ **(1)** White smoke/solid ALLOW white cloud **/ Dense** white fumes **(1)** The observation mark is consequential on use of ammonia. If name and formula are given, both must be correct.	Ammonium Incorrect identification of white smoke Misty fumes / steamy fumes/ white gas/ white ppt	2

Question Number	Acceptable Answers	Reject	Mark
18 (c)	White ppt/solid ALLOW white crystals **(1)** IGNORE identification of white solid, even if wrong (ppt/solid) dissolves (in excess) /(colourless) solution forms ALLOW (ppt/solid) disappears/ soluble **(1)** IGNORE clear solution ($c.NH_3$) dissolves AgBr (as well as AgCl) **(1)**	Just "white" Cream ppt other colours of solution Dissolves bromide ions/ bromine Just "Only AgCl dissolves in dilute NH_3" $c.NH_3$ dissolves other things	3

TOTAL FOR Q18 = 6 MARKS

Question Number	Acceptable Answers	Reject	Mark
19 (a)(i)	 **OR** 7x and 5 • around the bromine. **(1)** Total of 8 electrons round each oxygen One octet MUST INCLUDE the electron represented by * **(1)** ALLOW x for oxygen and • for bromine if clear Electrons in bonds to be shown in rows eg xx •• or x•x• between the relevant atoms; non-bonded electrons not in pairs.. All dots or all crosses then max 1 Two dative covalent bonds by the bromine to the oxygens then max 1 (loses first mark) IGNORE circles round outer shells of atoms		2

Question Number	Acceptable Answers	Reject	Mark
19 (a)(ii)	There are vacant (3)**d** orbitals / They are using (3)**d** orbitals ALLOW Sub-shells for orbitals Use of D for d	2d p/ f orbitals Shell for sub-shell	1

Question Number	Acceptable Answers	Reject	Mark
19 (b)(i)	(n=8.35 ÷ 167 =) 0.05(00) (mol) **(1)** Ignore any units even if incorrect. (c= 0.05 ÷ 0.25 =) 0.2(00) (mol dm^{-3}) TE on incorrect number of moles in first mark **(1)** Correct answer without working scores **(2)** If final units are given they must be correct. ALLOW 1sf mol /dm^3 OR M	mol /dm^{-3}	2

Question Number	Acceptable Answers	Reject	Mark
19 (b)(ii)	(0.0025 x 6 =) 0.015 (mol) **(1)** (0.015 x 166 = 2.49 (g)) TE from first mark **(1)** 2.6 ≤ value ≤ 5.0 (g) TE for third mark as long as a calculation has been done for second mark. Values should be at least 0.1 g above calculated value and less than double calculated value. **(1)** ALLOW 1sf for suitable mass		3

Question Number	Acceptable Answers	Reject	Mark
19 (b)(iii)	(0.001 x 2 =) 0.002/ 2 x 10^{-3} (mol) **(1)** (V = 0.002 ÷ 0.1x1000 =) 20 (cm^3) ALLOW 0.02 **dm^3**/ 0.020 **dm^3** **(1)** If units are not in cm^3 they must be stated TE from incorrect number of mol Correct answer without working scores **(2)**	0.02 0.02 dm^{-3}	2

Question Number	Acceptable Answers	Reject	Mark
19 (b)(iv)	Mass of $KBrO_3$ **(1)** **Second mark depends on correct choice in first.** Percentage error/ uncertainty large with a small mass OR Mass is only to 1sf **(1)** IGNORE calculation, even if incorrect	Just "Mass is only to 2 decimal places" / "mass is only 0.07g"/ "mass is not accurate"	2

TOTAL FOR Q19 = 12 MARKS

Question Number	Acceptable Answers	Reject	Mark
20 *(a)	**These marks are independent** The outer electrons are further from the nucleus / the electron being removed is further from the nucleus/ larger atomic radius (in calcium) ALLOW Ca has one more shell/ more shells (of electrons) **(1)** More shielding (in calcium) **(1)** OR Reverse argument for magnesium ALLOW Discussion based on trend going down group without specifying Mg and Ca IGNORE repulsion between shells	 Larger ionic radius (in Ca) Just “Calcium is larger” Reference to molecules, delocalised electrons Just “Ca has more energy levels” Two more shells Any reference to polarising power of ions	2

Question Number	Acceptable Answers	Reject	Mark
20 (b)	Electrons are promoted/ jump / become excited to higher energy level **(1)** Electron(s) return/ fall back to lower energy level ALLOW to ground state **(1)** Release of (visible) light (energy) upon return / energy is released in visible spectrum ALLOW release of photons upon return **(1)**		3

Question Number	Acceptable Answers	Reject	Mark
20 (c)(i)	$CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$ Ignore state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)(ii)	**Observation mark:** (Calcium nitrate) produces a **brown**/ **red-brown gas** ALLOW NO_2 for gas Fumes for gas OR (Potassium nitrate) does not produce a **brown** gas IGNORE Oxygen is given off / Gas given off relights a glowing splint **(1)** **Second mark (can also be an observation):** (Only calcium nitrate) produces the oxide OR (Only potassium nitrate) produces the nitrite OR calcium nitrate is less stable to heat OR potassium nitrate decomposes at a higher temperature/takes longer to produce oxygen **(1)** ALLOW "Calcium nitrate produces a white solid **and** potassium nitrate produces a yellow solid" as an alternative for either mark NOTE Reject comparisons with one correct and one incorrect statement (this applies to both marks)	Flame colours Reference to other incorrect products.	2

Question Number	Acceptable Answers	Reject	Mark
20 (d)(i)	Hydrogen (gas) / H_2 If name and formula are given both must be correct		1

Question Number	Acceptable Answers	Reject	Mark
20 (d)(ii)	White ppt/white solid/goes milky/goes cloudy/ white suspension **(1)** $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ **(1)** ALLOW Alternative answer White precipitate forms which dissolves with excess carbon dioxide **(1)** $Ca(OH)_2 + 2CO_2 \rightarrow Ca(HCO_3)_2$ **(1)**	White solution / any solution produced	2

Question Number	Acceptable Answers	Reject	Mark
20 (d)(iii)	(One of): $Sr(OH)_2$/$Ba(OH)_2$/$Ra(OH)_2$ OR (One of):Strontium/Barium/Radium hydroxide If name and formula given then both must be correct	SrOH/ BaOH/ RaOH Just Sr/ Ba/ Ra $Mg(OH)_2$/MgOH/ magnesium hydroxide/ $Be(OH)_2$/BeOH/ beryllium hydroxide	1

Question Number	Acceptable Answers	Reject	Mark
20 (e)(i)	White ppt/solid ALLOW White crystals **(1)** ($BaSO_4$ is insoluble but) $MgSO_4$ is (very) soluble / $MgSO_4$ gives a colourless solution/ $MgSO_4$ gives no precipitate ALLOW $BaSO_4$ does not dissolve TE on first mark if it stated that a precipitate formed even if colour is wrong/ missing **(1)**	White ppt of $BaCl_2$ / $MgCl_2$ Extra observations eg effervescence Magnesium is soluble / barium is insoluble A precipitate of magnesium sulfate forms and then dissolves Just "$MgSO_4$ is more soluble / less insoluble" Reference to solubility of chlorides There would be no reaction	2

Question Number	Acceptable Answers	Reject	Mark
20 (e)(ii)	Barium sulfate is not absorbed/ is insoluble IGNORE Comments on X-rays Barium sulfate is not digested Barium sulfate is unreactive/ does not react with stomach acids References to toxicity.	Just 'Barium'	1

Question Number	Acceptable Answers	Reject	Mark
20 (f)	**First mark:** (Increase) concentration of **HCl** **(1)** **Second mark** More particles/ moles of (HCl) in the same volume OR more (frequent/ successful) collisions Allow second mark only if factor is concentration **(1)** --- Any two from three of the following for third and fourth marks: Reduce particle size / use powder (instead of lumps)/ use finely divided (solid) **(1)** (Increases) surface area **(1)** more (frequent/ successful) collisions **(1)** ALLOW Reverse arguments	Increase concentration of $CaCO_3$ /HCl **and** $CaCO_3$ /reactants Increase kinetic energy of particles Increase kinetic energy of particles	4

Question Number	Acceptable Answers	Reject	Mark
20(g)	Pressure only affects gaseous reactions/ there are no gaseous reactants (or products) /there is no significant volume change/ liquids are incompressible ALLOW pressure doesn't affect solids/ solutions Note: there are many possible correct ways of expressing the idea that pressure only affects rate of reactions involving gases. IGNORE Number of moles in reaction doesn't change		1

TOTAL FOR Q20 = 20 MARKS
TOTAL FOR SECTION B = 38 MARKS

Section C

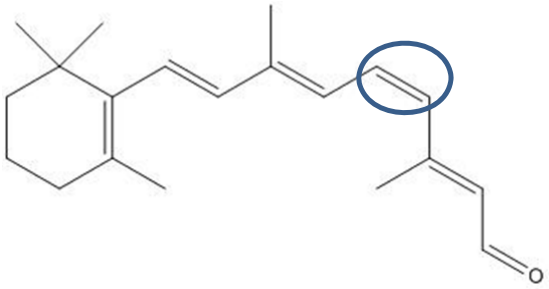
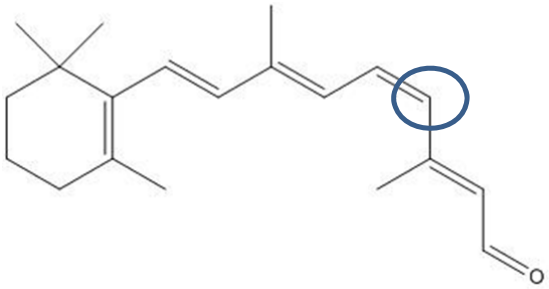
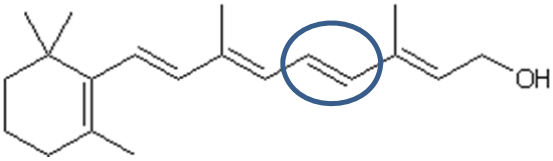
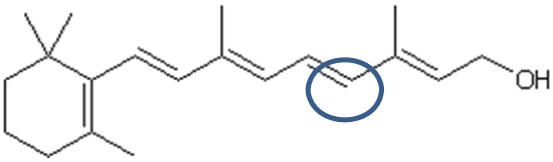
Question Number	Acceptable Answers	Reject	Mark
21 (a)	Primary **(1)** Part of the molecule which determines how it will react / atom or group responsible for its reactions / group where chemical reactions occur/ part of the molecule responsible for its (chemical) properties ALLOW The part of the molecule which reacts / Group responsible for its characteristics **(1)** IGNORE Group which determines how the molecule behaves	Molecule responsible for reactions	**2**

Question Number	Acceptable Answers	Reject	Mark
21 (b)	$C_{20}H_{30}O$ Correct number of carbons **(1)** Rest of formula correct (stand alone mark, even if C incorrect) **(1)** Note: $C_{20}H_{29}OH$ scores first mark only Ignore working (structural formula) if shown as long as a molecular formula is given	Just structural formula	**2**

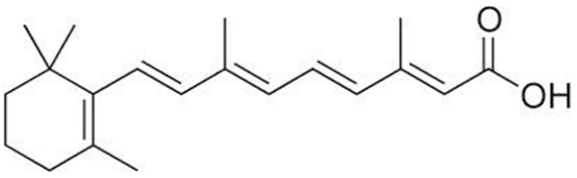
Question Number	Acceptable Answers	Reject	Mark
21 (c)(i)	Reflux apparatus produces carboxylic/ retinoic acid OR completely oxidizes the alcohol **(1)** Convert to distillation ALLOW use condenser in horizontal position/ description of distillation/ sketch of distillation apparatus **(1)** Oxidizing agent should be limiting/not in excess/remove aldehyde as it is formed/ remove before further oxidation **(1)** ALLOW Use excess alcohol 'Product' for 'aldehyde'	Oxidizes to a ketone Fractional distillation Just 'the collection of aldehyde'	**3**

Question Number	Acceptable Answers	Reject	Mark
21 (c)(ii)	$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$ +6 +3 Orange Green One mark for the correct numbers of hydrogens **(1)** One mark for the correct numbers of chromiums and electrons **(1)** One mark for each oxidation number with sign. If sign is missing penalise once only ALLOW 6+ , 3+ **(2)** One mark for both colours **(1)**	Any other colour with orange/ Green-blue	5

Question Number	Acceptable Answers	Reject	Mark
21 (c)(iii)	(Retinal) (strong) absorption at 1740-1720 (due to C=O bond) OR (Retinal) (weak) absorption at 2900–2820/ 2775–2700 (due to C-H bond) ALLOW Wavenumber/ peak/ stretch for "absorption" **(1)** No absorption at 3750–3200 /absorption at 3750-3200 shows not all retinol converted **(1)** Ignore comments on absorptions at 3300-2500	Absorption at 1725-1700 1700-1680	2

Question Number	Acceptable Answers	Reject	Mark
21 (c)(iv)	Any one of the following:   ALLOW the following circles in retin**ol**  	Any additional area circled Circles including any C atom other than those of the double bond circled on the mark scheme	1

Question Number	Acceptable Answers	Reject	Mark
21 (c)(v)	Round the carbon there are three areas with electrons / 3 regions of electron density/ 3 areas of electron density ALLOW Three bond pairs IF answer says that double bond can be treated as one bond **(1)** Electron pairs repel/ go to maximum separation/go to minimum repulsion **(1)** ALLOW Bonds repel The answer must clearly refer to electrons/ bonds/ bonding pairs at some point to score these marks. Trigonal planar ALLOW Triangular planar **(1)**	Round the carbon there are 3 bonds C with a lone pair atoms repel maximum repulsion/ minimum separation	3

Question Number	Acceptable Answers	Reject	Mark
21 (d)	 Accept any orientation of =O and –OH and length of bonds. Allow the OH displayed	COOH added to final single bond OOH added	1

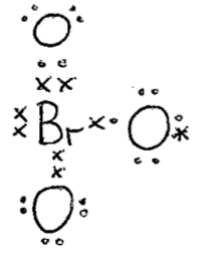
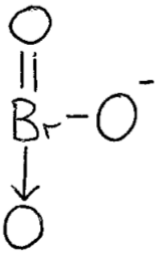
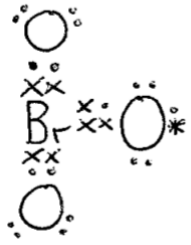
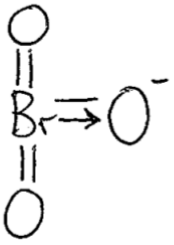
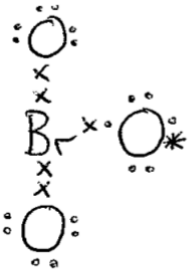
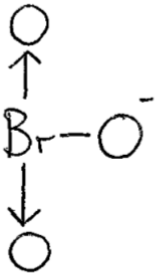
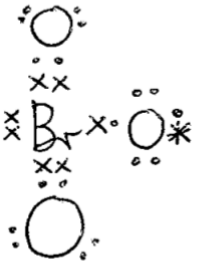
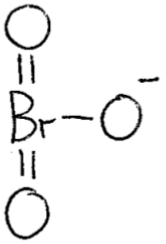
Question Number	Acceptable Answers	Reject	Mark
21 (e)	Observation and precaution marks are dependent on correct reagent. EITHER **Reagent** PCl_5 / phosphorus((V)) chloride / phosphorus pentachloride ALLOW Phosphoric(V) chloride **(1)** **Observation** Steamy/misty/white fumes **(1)** IGNORE Tests on steamy fumes eg litmus **Precaution** Use of fume cupboard **(1)** IGNORE need for safety goggles and lab coats. Incorrect reasons given for use of fume cupboard. Need for dry equipment Use of gloves **OR ALLOW** **Reagent** Sodium/ Na **(1)** **Observation** Fizzing/Bubbles **(1)** IGNORE sodium dissolves **Precaution** Handle with gloves/tweezers **(1)** IGNORE naked flames need for dry equipment need for safety goggles and lab coats.	White smoke/solid Dense white fumes Gas mask	3

TOTAL FOR SECTION C (Question 21) = 22 MARKS

TOTAL FOR PAPER = 80 MARKS

Appendix A:

Question 19ai: Additional Guidance.

Dot and Cross Diagram	Bonding Diagram	Score
		1
		1
		1
		2 (As per MS)

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