Mark Scheme (Results)

Summer 2015

IAL Chemistry (WCH02/01)

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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

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1	C		1

Question Number	Correct Answer	Reject	Mark
2	D		1

Question Number	Correct Answer	Reject	Mark
3	B		1

Question Number	Correct Answer	Reject	Mark
4	A		1

Question Number	Correct Answer	Reject	Mark
5	C		1

Question Number	Correct Answer	Reject	Mark
6	C		1

Question Number	Correct Answer	Reject	Mark
7	D		1

Question Number	Correct Answer	Reject	Mark
8	A		1

Question Number	Correct Answer	Reject	Mark
9	B		1

Question Number	Correct Answer	Reject	Mark
10	D		1

Question Number	Correct Answer	Reject	Mark
11	B		1

Question Number	Correct Answer	Reject	Mark
12	A		1

Question Number	Correct Answer	Reject	Mark
13	B		1

Question Number	Correct Answer	Reject	Mark
14	C		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	B		1

Question Number	Correct Answer	Reject	Mark
18	C		1

Question Number	Correct Answer	Reject	Mark
19	A		1

Question Number	Correct Answer	Reject	Mark
20	C		1

(TOTAL FOR SECTION A = 20 MARKS)

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	(n=0.05 x 0.00450=) 2.25×10^{-4} / 0.000225 (mol) IGNORE SF except 1SF		1

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	(n=2.25×10^{-4} x 2=) 4.50×10^{-4} / 0.000450 (mol) TE ans to (a)(i) x 2 IGNORE SF except 1SF		1

Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	(c=$4.50 \times 10^{-4} \div 0.025$=) 1.8×10^{-2} / 0.018 / 1.80×10^{-2} /0.0180 (mol dm^{-3}) TE ans to (a)(ii) ÷0.025 IGNORE SF except 1SF		1

Question Number	Acceptable Answers	Reject	Mark
21(a)(iv)	Start at final answer (the difference) if correct or correct TE from (iii) then give 3 marks with or without correct working Ignore SF except 1SF for the "difference" only but do not penalise trailing zeros **NOTE** Negative value for "difference" does not get MP3 but can score MP1 and MP2 only **If answer is incorrect** then look at following working **MP1** Initial KOH concentration n=226.8 ÷ 56.1= (1) 4.04278/4.04 (mol) ALLOW use of 56 **MP2** [KOH]= 4.04278 ÷ 45 = (1) 8.9840×10^{-2} / 0.089840 (mol dm^{-3}) NOTE 56 gives 0.09 A TE is allowed from incorrect number of mols **MP3** Difference ($8.9840 \times 10^{-2} - 1.80 \times 10^{-2}$ =) 7.1840×10^{-2} / 0.071840 (mol dm^{-3}) NOTE 56 gives 0.072 (1) **Transferred errors** 8.98×10^{-2} – **ans to (a)(iii)** OR Their initial concentration of KOH – ans to (a)(iii) COMMENT A difference of 0.071 means there has been a rounding error and so will score 2 marks only if rounding errors have not already been penalised.	0.07	3

Question Number	Acceptable Answers	Reject	Mark
21(a)(v)	Correct final answer (181/182) to 3SF with or without working scores (2) **Answer to (iv)** x 45 OR x 56.1 (1) n=7.18 x 10^{-2}x 45= (3.231) (mol) m=3.231 x 56.1 = (181.359 / 181.4) OR 181.2591 / 181.3 = 181 (g) NOTE ALLOW USE OF 56 (1) **Alternative method** **Answer to (ii)** x $\frac{45000}{25}$ OR x 56/56.1 (1) Amount = 0.81 (mol) Mass of KOH left 0.81 x 56.1/56 = 45.441/45.36 (g) Mass used = 226.8 – 45.441/45.36 = 181 (g) (1)		2

Some TE values:

Part	Answer	Mark	Answer	Mark
(i)	$\frac{25 \times 0.05}{1000}$ = 1.25 x 10^{-3}	0	$\frac{25 \times 4.5}{1000}$ = 0.1125	0
(ii)	2.5 x 10^{-3}	1	0.225	1
(iii)	0.1	1	9	1
(iv)	0.089 – 0.1 = -0.0102	2	0.089 - 9 = -8.91	2
(v)	0.459 (mol) and 25.7 (g)	2	400.95 (mol) and 22 500 (g)	2

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	(From) (pale/bright) pink/red (1) (To) colourless (1) ALLOW one mark for 'colourless to pink/red (1) Second mark dependant on shade of pink/red/purple for first colour	purple …clear	2

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	**Red/brown/colour** (from the hair/skin likely to have) leached out/dissolved/ solution formed ALLOW **Red/brown/colour** from the hair/skin makes the (colour) change/end point difficult to judge/see		1

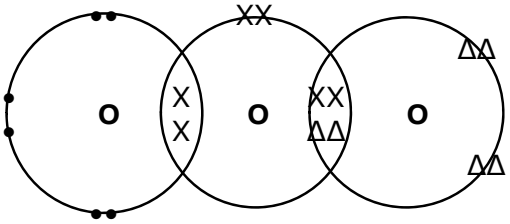
Question Number	Acceptable Answers	Reject	Mark
21(b)(iii)	No Only a few drops of indicator used OR Adding to an aqueous solution OR Ethanol mixes with water (in all proportions) ALLOW Ethanol is in solution IGNORE Any other reasons	Yes…	1

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	(Titre error) ($\frac{0.05 \times 2}{4.50}$ x 100=) ±2.2(2) (%) (1) (Sample error) ($\frac{0.06}{25}$ x 100=) ±0.24 (%) (1)		2

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	**Mark each point independently** **Any two from:** Reduce the concentration of the sulfuric acid (1) Use a larger (initial) sample/R/KOH volume (1) Use HCl(aq) (of same concentration as sulfuric acid which would have a larger titre) (1) Use greater (initial) concentration/mass of KOH (1) Use less skin (1) IGNORE (Just) use larger titre Repeat the titration Just changing the concentration	Use more skin	2

Question Number	Acceptable Answers	Reject	Mark
21(c)(iii)	When it is concordant/the same OR Within ±0.1 (cm^3) of the (mean of) other titres ALLOW Within ±0.2 (cm^3) of the other titres (**comment** this is as per the User guide) IGNORE Close/similar/almost the same as other titres		1

TOTAL FOR QUESTION 21 = 17 MARKS

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	 Eight electrons around each end oxygen of which six must be of the same symbol (1) Rest of electrons correct (1) Triangles and dots can be drawn the other way round Non-bonding electrons can be as pairs or separate		2

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	There are three areas of electron density/regions of negative charge/groups of electrons (and not two) around (the central oxygen) OR Non-bonding/lone pair (of electrons) on the **central / middle / centre oxygen atom** ALLOW There are more than two areas of electron density/regions of negative charge/groups of electrons on the **central/middle / centre oxygen atom**	Mention of other atoms Lone pair**s**	1

Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	(Increased risk of) malignant melanoma/ basal cell carcinoma(s) / (Increased risk of) **skin** cancer/DNA breakdown/mutation Retinal/eye damage/snow blindness IGNORE references to sunburn IGNORE just cancer	Reference to global warming	1

Question Number	Acceptable Answers	Reject	Mark
22(a)(iv)	(UV) is high(er) energy /high(er) frequency /short(er) wavelength OR (UV) breaks covalent bonds OR produces free radicals/ions OR Reverse answers for IR IGNORE more penetrating	Long(er) wavelength Low(er)energy/frequency	1

Question Number	Acceptable Answers	Reject	Mark
22(a)(v)	Species / molecule / atom/particles with an unpaired electron	unpaired electron**s** Just 'single electron' 'lone electron' 'free electron' 'one electron'	1

Question Number	Acceptable Answers	Reject	Mark
22(a)(vi)	**Mark independently** Dots must be shown on either second NO or on one of the NO_2 molecules **First mark** $(NO^{\bullet} + O_3 \rightarrow)\ NO_2{}^{\bullet} + O_2$ (1) **Second mark** $NO_2{}^{\bullet} + O_3 \rightarrow NO^{\bullet} + 2O_2$ OR BOTH $O_3 \rightarrow O^{\bullet} + O_2$ AND $NO_2{}^{\bullet} + O^{\bullet} \rightarrow NO^{\bullet} + O_2$ (1) **Third mark** $2O_3 \rightarrow 3O_2$ (1) Allow multiples		3

Question Number	Acceptable Answers	Reject	Mark
22(a)(vii)	**Catalyst** IGNORE anything else including catalytic converter **Comment** The word catalyst can be awarded the mark if shown in a(vi)		1

Question Number	Acceptable Answers	Reject	Mark
22(a)(viii)	They breakdown/react/dissolves (in the lower atmosphere before they rise to the ozone layer)	Reference to catalytic converter	1

Question Number	Acceptable Answers	Reject	Mark
22(b)(i)	It has polar bonds OR $O^{\delta-} = C^{\delta+} = O^{\delta-}$ (1) (Absorption results in) change in dipole moment / (asymmetric) **bond** vibration/stretching/bending OR change in (bond/molecule) polarity (1) IGNORE Reference to global warming process	Polar molecule Bonds break	2

Question Number	Acceptable Answers	Reject	Mark
22(b)(ii)	Nitrogen/N_2 /Oxygen/O_2 / Argon/Ar	N/O Other noble gases Hydrogen/H/H_2 Water vapour	1

Question Number	Acceptable Answers	Reject	Mark
22(b)(iii)	CFCs absorb/trap **infrared** radiation **very effectively / strongly** ALLOW heat /IR for infrared OR High greenhouse factor/global warming potential OR (Very) polar C-F bonds	Depletion of ozone layer	1

Question Number	Acceptable Answers	Reject	Mark
22(b)(iv)	(CFCs) No longer being released in the atmosphere/ less used/concentration decreasing/ amount reduced OR Banned from use/production OR CFCs replaced by HCFCs / HFCs/ Propane / Butane IGNORE More carbon dioxide	…Methane	1

Question Number	Acceptable Answers	Reject	Mark
22(b)(v)	**Any two from** Anthropogenic change is man-made (1) Water vapour is always present naturally OR Water vapour present from natural sources OR Water vapour due to the water cycle/ named processes (1) The levels of water vapour have kept relatively constant (over the recent centuries) (1) Can't control natural water vapour emissions (1) COMMENT Do not penalise 'water vapour has less effect on global warming' in this question Do not penalise 'water vapour is not produced by humans' in this question		2

Question Number	Acceptable Answers	Reject	Mark
22(b)(vi)	**MP1** Carbon neutrality is where the CO_2 released on combustion is equal to the CO_2 absorbed on formation of the fuel/plant ALLOW Amount of carbon dioxide taken/reacted in equals amount given out/produced OR No net increase in atmospheric carbon dioxide (1) **MP2** CO_2 (from fossil fuels) is likely to be released from transport/production of biofuel/production of fertiliser/processing of the biofuel ALLOW Biofuels are a blend including fossil fuels (1) IGNORE Reference to 'waste'	Just 'carbon'	2

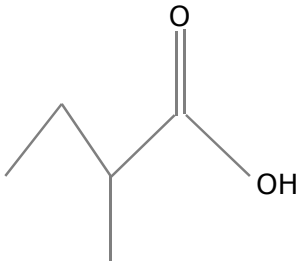
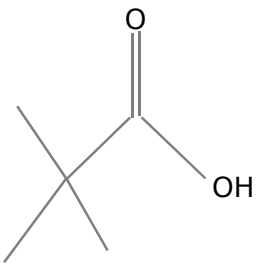
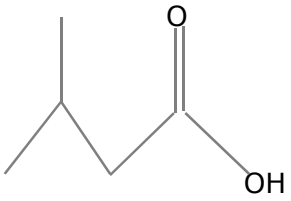
Question Number	Acceptable Answers	Reject	Mark
22(b)(vii)	**Any two from:** Use catalysts/enzymes (to reduce energy consumption) (1) Use microwave energy (which is more efficient) (1) Improve thermal insulation (1) Use heat exchangers/heat recovery (1) Reduce waste/recycle (bi-)products (1) Use renewable resources in its processes (1) Use high atom economy processes (1) Use nuclear power/renewable energy sources/use wind power/use solar power/use fuel cells (1) Use carbon capture and storage methods (1) **Note** Credit two different storage/capture methods separately for both marks eg sending carbon dioxide back to replace north sea gas under the sea (1) neutralising with scrubbers, absorbing with alkali/limestone etc (1) **Comment** Send any unexpected well-reasoned points to your TL IGNORE Use reactions needing lower temperatures Plant more trees Reduce car use Use of hydrogen as a fuel	High pressure	2

TOTAL FOR QUESTION 22 = 22 MARKS
TOTAL FOR SECTION B = 39 MARKS

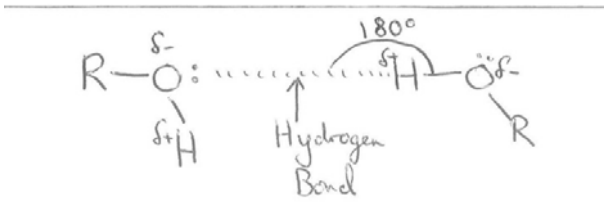
Section C

Question Number	Acceptable Answers	Reject	Mark
23(a)	**3**(-)methylbutanoic acid ALLOW **3**(-)methylbutyric acid	**2-**methylbutanoic acid	1

Question Number	Acceptable Answers	Reject	Mark
23(b)	$C_5H_{10}O_2$ ALLOW atoms in any order if numbers are correct for each atom eg $H_{10}O_2C_5$/ $C_5O_2H_{10}$/ $H_{10}O_2C_5$/ $O_2C_5H_{10}$ ALLOW Additional formulae as well as correct answer	Just 'C_4H_9COOH'	1

Question Number	Acceptable Answers	Reject	Mark
23(c)	 (1) Bonds may go in other directions eg methyl group upwards  (1)	 	2

Question Number	Acceptable Answers	Reject	Mark
23*(d)	**MP1** Equal/specified volumes/masses/amounts of solvent (1) **MP2** Equal volumes of valeric acid **and** shake/stir/ mix (and allow to stand) OR Add valeric acid a drop at a time/from a burette to the solvents (1) **MP3** (Two) layers with water **and** a (single) layer with ethanol OR Immiscible with water mixes with ethanol OR Cloudy with water **and** clear with ethanol OR Measure depth of mixture/smaller rise for ethanol (1)	precipitate	3

Question Number	Acceptable Answers	Reject	Mark
23(e)	Drawing of hydrogen bond between correct atoms and in a straight line Ignore extra molecules Ignore dipoles and omission of lone pair of electrons Ignore R-OH bond angle ALLOW Any alcohol (1)  Bond angle 180° around the correct H atom and consequential on MP1 (1) NOTE If two water molecules/R-OH and a water molecule are correctly drawn with a linear hydrogen bond and 180° correctly labelled then award (1)		2

Question Number	Acceptable Answers	Reject	Mark
23(f)*(i)	Instantaneous dipole OR temporary asymmetric electron distribution (1) Induced dipole/charge in adjacent/another molecule/atom/particle (1)		2

Question Number	Acceptable Answers	Reject	Mark
23(f)(ii)	**MP1** (Boiling temperature will be) lower/ **straight chain** is higher (1) Remaining marks are dependent on **MP1** **MP2 and MP3** Branching reduces/ less(ens)/weakens the London/dispersion/ Van der Waals'/vdW forces (1) (because it has) less surface area (in contact)/ molecules can't align/molecules can't get as close (1) OR Straight chain stronger/ more/ increases London/etc forces (1) (because it has) greater surface area (in contact) /molecules can align better/molecules can get as closer/pack more closely (1) IGNORE References to energy		3

Question Number	Acceptable Answers	Reject	Mark
23(g)(i)	(The alcohol) can **only** be oxidized to the ketone OR cannot be further oxidized OR cannot be oxidized to a carboxylic acid OR Further oxidation would have to break a C-C bond IGNORE It's a secondary alcohol/It's not a primary alcohol/ Same product formed		1

Question Number	Acceptable Answers	Reject	Mark
23(g)(ii)	Alkene/carbon-carbon double bond ALLOW C=C (1) (Type of molecule) (1,2-) diol ALLOW (1,2-) dialcohol (1)	Just 'double bond' Alcohol	2

Question Number	Acceptable Answers	Reject	Mark
23(h)	**Up to 2 marks for IR points** **Penalise the omission of bonds once only** **IR MP1** 3300-2500 (cm^{-1}) O—H/OH (stretch in a carboxylic acid) (1) **IR MP2** 1725-1700 (cm^{-1}) C=O (stretch in a carboxylic acid) (1) **Ignore** 2962 – 2853 (cm^{-1}) C-H (stretch in an alkane) **Up to 3 marks for Mass Spec points** Only penalise negative charges or lack of positive charge once Molecular ion/parent ion peak /$C_5H_{10}O_2^+$ at 102 (1) $C_5H_9O_2^+$ at 101 (1) $COOH^+$ at 45 (1) $C_4H_9^+$/$CH_3CH(CH_3)CH_2^+$ at 57 (1) $C_4H_7O_2^+$/$CH_3CHCH_2CO_2H^+$ at 87 (1) OH^+ at 17 (1) CH_3^+ at 15 (1)	3095-3010 3750-3200 1700-1680	4

TOTAL FOR SECTION C (QUESTION 23) = 21 MARKS

TOTAL FOR PAPER = 80 MARKS