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Mark Scheme (Results)

Summer 2015

IAL Chemistry (WCH06/01)

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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

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Question Number	Acceptable Answers	Reject	Mark
1(a)(i)	SO_4^{2-} OR SO_4^{-2}	Sulfate HSO_4^-	1

Question Number	Acceptable Answers	Reject	Mark
1(a)(ii)	(Dilute) hydrochloric (acid)/ HCl(aq) / nitric (acid) / HNO_3(aq) ALLOW HCl / HNO_3 Ignore concentrated/conc	Sulfuric acid H^+ / H_3O^+ Carboxylic acid Hydrogen chloride	1

Question Number	Acceptable Answers	Reject	Mark
1(b)(i)	Water and hydroxide can be in either order If name and formula are given, both must be correct Copper**(II)** hydroxide / $Cu(OH)_2$ / $Cu(H_2O)_4(OH)_2$ ALLOW $Cu(H_2O)_2(OH)_2$ IGNORE Copper hydroxide Square brackets in formula wherever they are	Any other numbers	1

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Question Number	Acceptable Answers	Reject	Mark
1(b)(ii)	Water and ammonia can be in either order If name and formula are given, both must be correct $[Cu(NH_3)_4]^{2+}$ OR $[Cu(H_2O)_2(NH_3)_4]^{2+}$ Charge must be included Outer brackets not required IGNORE order of ligands, but numbers must be correct	Any other numbers e.g. $[Cu(NH_3)_6]^{2+}$	1

Question Number	Acceptable Answers	Reject	Mark
1(c)	$Cu(H_2O)_6^{2+}$ OR $Cu(H_2O)_4^{2+}$ IGNORE Square brackets wherever they are	Cu^{2+} $Cu^{2+}(aq)$	1

Question Number	Acceptable Answers	Reject	Mark
1(d)	$CuSO_4$ / $Cu^{2+}SO_4^{2-}$ If charges given both must be given correctly	$CuSO_4.5H_2O$	1

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Question Number	Acceptable Answers	Reject	Mark
1(e)	Mark independently **First mark** The (3)d sub-shell(s) / (3)d-orbital(s) cannot be split OR No d-d splitting OR No d-d transitions (1) **Second mark** No colour as no ligands present ALLOW No water (of crystallization) present OR Not hydrated / Anhydrous salt IGNORE Use of copper rather than copper ions (1) Reverse arguments involving the addition of water acceptable		2

(Total for Question 1 = 8 marks)

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Question Number	Acceptable Answers	Reject	Mark
2(a)	Na^+ OR Na^{+1} OR Na^{1+} IGNORE sodium or sodium ion	Na Any charge other than +1	1

Question Number	Acceptable Answers	Reject	Mark
2(b)(i)	Measure pH/Use of alkaline buffer solution (1) and acidic buffer solution (1) ALLOW Measure pH of a (alkaline) buffer solution... (1) with known pH (1) **ALLOW** Use of acid /alkali / (de-ionized/ distilled / pure) water / **specified** neutral solution (e.g. NaCl(aq)) (1) of known pH (1) **OR** Several solutions of known pH (1) Plot graph of meter reading against (known) pH (to give a calibration curve) (1)	Neutral for pH=7	2

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Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	Universal / full range indicator (paper / solution) (1) Colour changes to (dark) green / blue IGNORE Initial colour (1) **Comment** **ALLOW for 1 mark** Any named indicator from list below **and** its colour in alkali See table below		2

	pK_{in} (298 K)	pH range		
		acid		*alkaline*
Methyl violet	0.8	yellow	0.0–1.6	blue
Malachite green	1.0	yellow	0.2–1.8	blue/green
Thymol blue (acid)	1.7	red	1.2–2.8	yellow
Methyl yellow (in ethanol)	3.5	red	2.9–4.0	yellow
Methyl orange–xylene cyanole soln.	3.7	purple	3.2–4.2	green
Methyl orange	3.7	red	3.2–4.4	yellow
Bromophenol blue	4.0	yellow	2.8–4.6	blue
Congo red	4.0	violet	3.0–5.0	red
Bromocresol green	4.7	yellow	3.8–5.4	blue
Methyl red	5.1	red	4.2–6.3	yellow
Azolitmin (litmus)		red	5.0–8.0	blue
Bromocresol purple	6.3	yellow	5.2–6.8	purple
Bromothymol blue	7.0	yellow	6.0–7.6	blue
Phenol red	7.9	yellow	6.8–8.4	red
Thymol blue (base)	8.9	yellow	8.0–9.6	blue
Phenolphthalein (in ethanol)	9.3	colourless	8.2–10.0	red
Thymolphthalein	9.7	colourless	8.3–10.6	blue
Alizarin yellow R	12.5	yellow	10.1–13.0	orange/red

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Question Number	Acceptable Answers	Reject	Mark
2(b)(iii)	A pH meter because... … difficult to match colour of indicator to pH OR …the colour of universal indicator covers a range of pH ALLOW pH meters measure to at least one decimal place (after calibration) OR pH meter with any reasonable attempt at an explanation e.g. indicators cover a range pH meters give exact values	pH meter alone Any untrue statement about pH meters or indicators	1

Question Number	Acceptable Answers	Reject	Mark
2(c)(i)	**First mark - Observation** Effervescence / bubbles (of gas) (1) IGNORE Test for carbon dioxide Gas evolved (Solid) sodium carbonate dissolves **Second mark - Explanation** because the sodium carbonate reacts with / neutralises **acid**(s) present (to form carbon dioxide) ALLOW carbon dioxide is formed (1)	Incorrect observations e.g. Solid/precipitate forms Negates first mark	2

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Question Number	Acceptable Answers	Reject	Mark
2(c)(ii)	Ester OR Methyl ester IGNORE compound (of carboxylic acid and alcohol)		1

Question Number	Acceptable Answers	Reject	Mark
2(d)	**S** CH_3COOCH_3 (1) **R** CH_3COOH (1) **P** $CH_3COO^{(-)}Na^{(+)}$ (1) ALLOW displayed/skeletal formulae ALLOW TE as below: TE from 2(a) TE for **R** and **P** based on their formula for **S** TE for **P** based on their formula for **R** Ignore names even if incorrect	$CH_3COO—Na$	3

(Total for Question 2 = 12 marks)

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Question Number	Acceptable Answers	Reject	Mark
3(a)	Sulfuric acid reacts very exothermically with water ALLOW The reaction with acid is exothermic OR (Sulfuric) acid will shoot out of container OR The reaction of water with (sulphuric) acid is vigorous/splashes OR Prevent splashing of acid	nitric acid Prevent splash alone	1

Question Number	Acceptable Answers	Reject	Mark
3(b)	(Pale/straw-coloured) yellow / brown / red-brown	Red/purple/blue/black/blue-black/orange	1

Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	(Freshly prepared) starch (solution)		1

Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	(If starch is added too early) starch iodine complex formed (doesn't re-dissolve) ALLOW Iodide for iodine ALLOW (Black) solid/precipitate / complex forms OR Insoluble compound forms		1

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Question Number	Acceptable Answers	Reject	Mark
3(c)(iii)	From blue-black to colourless ALLOW From blue / black/ dark blue/ deep blue to colourless	...to clear	1

Question Number	Acceptable Answers	Reject	Mark
3(d)(i)	24.1(0) 23.8(0) 23.55 23.45 (cm^3)		1

Question Number	Acceptable Answers	Reject	Mark
3(d)(ii)	The third and fourth / 23.55 and 23.45 (cm^3) **and** They are concordant OR Within ±0.2/0.1 (cm^3) IGNORE Anomalous		1

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Question Number	Acceptable Answers	Reject	Mark
3(d)(iii)	23.5(0) (cm^3) ALLOW TE including second titre value, mean = 23.6(0) (cm^3)		1

Question Number	Acceptable Answers	Reject	Mark
3(d)(iv)	Correct answer 74.6% / 75% OR 74.9% (TE from 23.60 average titre) Ignore SF except 1SF With no working **(5)** Number of mol of thiosulfate = $\frac{23.50 \times 0.200}{1000}$ (1) = 4.70×10^{-3}/0.00470 **Second mark** EITHER Number of mol of iodine = $\frac{4.70 \times 10^{-3}}{2}$ = 2.35×10^{-3}/0.00235 **AND** Number of moles of copper ion = $2 \times 2.35 \times 10^{-3}$ (1) = 4.70×10^{-3}/0.00470 in 10 cm^3 OR From equations amount of iodine is half amount of thiosulfate and amount of copper is twice amount of iodine, so amount of copper equals amount of thiosulfate for this mark Number of moles of copper in solid		5

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	= $10 \times 4.70 \times 10^{-3}$ (1) = $4.70 \times 10^{-2}/0.0470$ Mass of copper in solid = $4.70 \times 10^{-2} \times 63.5$ (g) (1) = 2.9845 Percentage copper = $\frac{2.9845 \times 100}{4.00}$ = 74.6125 = 74.6% (1) Using 23.60 by averaging titres 2, 3 and 4 $4.72 \times 10^{-3}/0.00472$ (1) 2.36×10^{-3}0.00236 AND $4.72 \times 10^{-3}/0.00470$ (1) $4.72 \times 10^{-2}/0.0470$ (1) 2.9972 (1) 74.9% (1) Answers greater than 100% max 3		

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Question Number	Acceptable Answers	Reject	Mark
3(d)(v)	**First Mark** Uncertainty in titre value: $\frac{2 \times 0.05}{23.55} \times 100 =$ (±)0.42/0.425/0.4246% (1) **Second Mark** Uncertainty in the mass measurement: $\frac{2 \times 0.005 \times 100}{4.0} = (\pm)0.25\%$ **OR** $\frac{1 \times 0.005 \times 100}{4.0} = (\pm)0.125\%$ so it would / would not be worth using a 3 dp balance (1) Ignore SF including 1 SF		2

(Total for Question 3 = 15 marks)

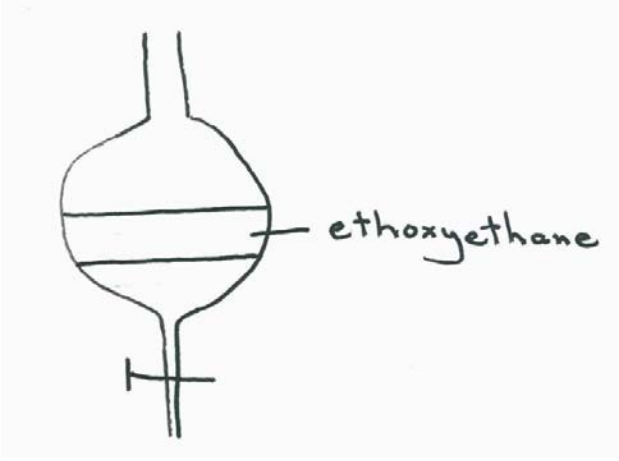
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Question Number	Acceptable Answers	Reject	Mark
4(a)	Mass of bromine = 6.0 x 3.1 (1) (= 18.6 (g)) Number of moles of bromine = $\frac{6.0 \times 3.1}{2 \times 79.9}$ = 0.116(40) = 0.12 (1) ALLOW Number of moles of bromine = $\frac{18.6}{2 \times 80}$ = 0.11625 = 0.12 Correct answer no working scores (2) IGNORE SF except 1 SF	 $\frac{6.0x3.1}{1000}$	2

Question Number	Acceptable Answers	Reject	Mark
4(b)	Mark Independently $2Fe + 3Br_2 \rightarrow 2FeBr_3$ OR multiples (1) $Br_2 + FeBr_3 \rightarrow Br^{\delta+}...Br^{\delta-}FeBr_3$ Allow any attachment between the centre bromine atom and the iron and / or the other bromine atom. e.g. $Br^{\delta+}— Br^{\delta-}$ **.**$FeBr_3$ OR $Br_2 + FeBr_3 \rightarrow Br^+ + FeBr_4^-$ (1) Ignore states even if incorrect	 $\rightarrow Br^- + FeBr_4^+$	2

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Question Number	Acceptable Answers	Reject	Mark
4(c)	To neutralize / react with HBr (formed) ALLOW To neutralize / react with acid OR To remove / react with bromine	To neutralize (the solution)	1

Question Number	Acceptable Answers	Reject	Mark
4(d)	 Separating funnel which must have narrower neck than the container (capable of taking a stopper) **and** a tap (1) Upper layer ethoxyethane (1)	Burette Filter funnel	2

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Question Number	Acceptable Answers	Reject	Mark
4(e)	(Concentrated) nitric acid/ HNO_3 **and** (concentrated) sulfuric acid/ H_2SO_4	**Dilute** sulfuric acid Any additional chemicals like Ammonia/NH_3 Bromine/Br_2 Sodium hydroxide/NaOH	1

Question Number	Acceptable Answers	Reject	Mark
4(f)	(0.75 x 0.70 x 0.70 x100 =) 36.75 / 36.8 / 37 (%) Correct answer with no working	Any other answers e.g. 36.7 / 37.0 / 40	1

Question Number	Acceptable Answers	Reject	Mark
4(g)(i)	(While rotating the tube) heat one end of the tube in a Bunsen flame (until the glass starts to melt) ALLOW Heat in a flame OR Heat (one end of the) tube		1

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Question Number	Acceptable Answers	Reject	Mark
4(g)(ii)	By gently tapping or dropping the tube / rubbing the open end with a milled coin ALLOW Hit / flick tube with finger OR Use (very small) dry crystals IGNORE Shaking / use of wire / sticks / pins / needles	Heat	1

Question Number	Acceptable Answers	Reject	Mark
4(g)(iii)	**Any two from** High boiling temperature/ point (compared with sample melting temperature) OR not volatile Does not decompose / oxidize (at high temperature) Mobile / non-viscous / non-sticky IGNORE Any reference to thermal conductivity and heat capacity **ALLOW** Clear liquid (ignore colourless) High ignition temperature/non-(in)flammable Non-toxic IGNORE Unreactive alone / safety aspects	High melting temperature Just 'does not react with the crystals'	2

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Question Number	Acceptable Answers	Reject	Mark
4(g)(iv)	**Before recrystallization** 185 – 201°C A range of at least 5°C ALLOW 180 - 205 °C A range of at least 5°C (1) **After recrystallization** 199 – 201°C ALLOW 197 - 203°C A range of no more than 4°C (1)	Single temperature Single temperature	2

(Total for Question 4 = 15 marks)

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