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Mark Scheme (Results)
Summer 2014

IAL Chemistry (WCH06/01)
Chemistry Laboratory Skills II

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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.

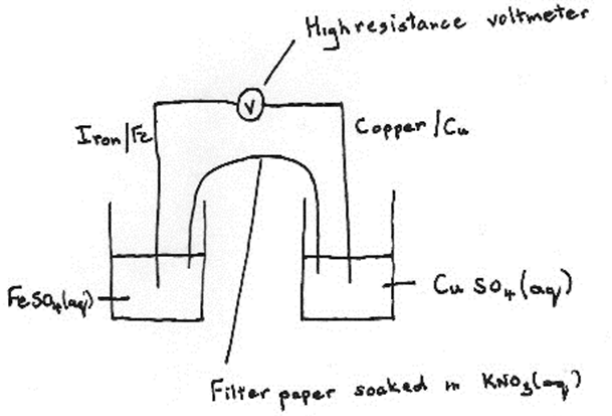
Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Acceptable Answers	Reject	Mark
1(a)	Green OR Green (Cr^{3+}) IGNORE additional information unless another wrong colour. ALLOW Shades of green like: pale green light green dark green ALLOW Violet / purple / red-violet / red-purple / mauve / ruby-violet / green-violet	Blue Blue-green Grey-green Blue-violet	**1**

Question Number	Acceptable Answers	Reject	Mark
1(b)	Green / grey-green / grey-blue **precipitate / ppt / ppte** (of $Cr(OH)_3$ / $[Cr(H_2O)_3(OH)_3]$) ALLOW recognisable spelling of state eg percipitate **(1)** **Second mark depends on first mark** (or near miss such as incorrect formula of precipitate / incorrect colour of ppt) Dissolves (to give green solution) OR Green solution forms (of $[Cr(OH)_6]^{3-}$) **(1)** IGNORE shades of colour: Light / dark etc	Other wrong descriptions like effervescence Incorrect formula for example $Cr(H_2O)_2(OH)_4]^-$ Dissolves to give a yellow / blue solution Incorrect formula for example CrO_4^{2-}	**2**

Question Number	Acceptable Answers	Reject	Mark
1(c)	CrO_4^{2-} **OR** CrO_4^{-2} **(1)** **Check the charge is correct** IGNORE brackets eg $[CrO_4]^{2-}$ Oxidation / redox (reaction) Ignore references to Cr^{3+}, Cr^{6+}, loss/gain and loss of electrons, deprotonation **(1)** **Mark each part independently.**	CrO_4^{-} $Cr_2O_7^{2-}$ Reduction Reduction / redox Redox / reduction References to Cr^{2+} 'Gain of electrons' alone	**2**

Total for Question 1 = 5 marks

Question Number	Correct Answer	Reject	Mark
2 (a)	 **First mark** Copper half cell Copper electrode dipping into copper(II) sulfate solution / solution **A** / Cu^{2+} (solution) **(1)** **Second mark** Iron half cell Iron electrode dipping into iron(II) sulfate solution/solution **B** / Fe^{2+} (solution) **(1)** Cells can be on either side Note that two platinum electrodes, or copper and iron electrodes the wrong way round loses both of the first two marks. IGNORE charges (in symbols or words) on the electrodes, even if incorrect **Third mark** Salt bridge Strip of **filter paper** with **potassium nitrate** solution / solution **C** dipping into both solutions **(1)** Only penalise electrodes / filter paper not dipping into solutions once. **Fourth mark** Circuit Voltmeter **X** / high resistance voltmeter correctly connected with or without crocodile clips **(1)**	Platinum/ Pt / iron / Fe Electrode Platinum / Pt / copper / Cu Electrode Just 'salt bridge' Any combination of meters Battery or power supply Parallel wire across voltmeter	**4**

Question Number	Correct Answer	Reject	Mark
2(b)(i)	$E_{cell} = E_{Cu} - E_{Fe}$ **(1)** $0.79 = 0.34 - E_{Fe}$ $E_{Fe} = 0.34 - 0.79 = -0.45$ (V) **(1)** Correct answer with no working **(2)** (+)0.45 (V) scores (1) only TE is allowed for wrong working with consistent answer, for example: $E_{cell} = E_{Fe} - E_{Cu}$ $0.79 = E_{Fe} - 0.34$ $E_{Fe} = 0.79 + 0.34 = (+)1.13$ (V) Award second mark only		**2**

Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	$-0.45 = -0.44 + 0.013 \ln [Fe^{2+}]$ $\ln [Fe^{2+}] = (-0.45 + 0.44)/0.013$ **(1)** $= -0.769$ $[Fe^{2+}] = \exp(-0.769) = 0.46348$ $= 0.46$ (mol dm^{-3}) **(1)** ACCEPT any answer which gives 0.46 when rounded to 2 sf Correct answer with no working **(2)** 0.76 gives 0.46761 = 0.47 worth (1) ALLOW TE from (b)(i) is allowed. Notice this may mean that the concentration is greater than 10 mol dm^{-3} which is allowed even though impossible. SOME EXAMPLES ARE: +0.45 V gives $\ln[Fe^{2+}] = 68.46$ so $[Fe^{2+}] = 5.4 \times 10^{29}$ Give 1 mark out of 2 for either statement +1.13 V gives $\ln[Fe^{2+}] = 120.769$ so $[Fe^{2+}] = 2.81 \times 10^{52}$ Give 1 mark out of 2 for either statement Internal TE for this part can also be awarded if $\ln[Fe^{2+}]$ has a value and is correctly converted to $[Fe^{2+}]$. It is quite common to get $\ln[Fe^{2+}] = +0.769$ when $[Fe^{2+}] = 2.158 = 2.16$ is worth 1 mark	0.76	**2**

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>2(c)(i)</td><td>
<table>
<tr><th>Titration</th><th>Rough</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Burette reading (final) / cm^3</td><td>25.00</td><td>24.40</td><td>24.40</td><td>25.70</td></tr>
<tr><td>Burette reading (initial) / cm^3</td><td>1.00</td><td>2.10</td><td>1.60</td><td>3.30</td></tr>
<tr><td>Titre /cm^3</td><td>24.(00)</td><td>22.3(0)</td><td>22.8(0)</td><td>22.4(0)</td></tr>
<tr><td>Titres used to calculate mean (✓)</td><td></td><td>✓</td><td></td><td>✓</td></tr>
</table>
All four titres correct

Note that the trailing zeroes are not essential (1)

Mean Titre 22.35 (cm^3) (1)

ALLOW TE on titres due to incorrect subtractions</td><td>22.40 / 22.4 / 22.50 / 22.875 (cm^3)</td><td>2</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
2(c)(ii)	Colourless to (first permanent pale) pink / purple **Both** colours required ALLOW Pale green / light green / green for colourless Pale yellow for colourless	Dark green	**1**

Question Number	Acceptable Answers	Reject	Mark
2(c)(iii)	$(MnO_4^- + 8H^+ + 5Fe^{2+}) \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$ $Mn^{2+} + 4H_2O$... **(1)** ... $+ 5Fe^{3+}$ **(1)** But allow $+ 5e^{(-)}$ on either side of correct balanced equation for 1 max IGNORE state symbols even if incorrect	$+ 5e^{(-)}$ alone	**2**

Question Number	Acceptable Answers	Reject	Mark
2(c)(iv)	mol MnO_4^- = 22.35 x 0.0300/1000 **(1)** = 6.705×10^{-4} mol Fe^{2+} = $6.705 \times 10^{-4} \times 5$ **(1)** = 3.353×10^{-3} $[Fe^{2+}]$ = $3.353 \times 10^{-3} \times 1000/25.0$ **(1)** = 0.1341 = **0.134** (mol dm^{-3}) **to 3 SF** **(1)** Correct answer with no working **(4)** Correct answer not to 3 sf with no working **(3)** ALLOW TE on mean titre in 2c(i) and equation in (iii) 22.5 gives 0.135 22.6 gives 0.136 Internal TEs should also be given if steps of the calculation are omitted. Some will multiply by 1000/22.35 in the last step to give 0.150 which is 3 out of 4 marks 0.15 would be 2 out of 4 marks		**4**

Question Number	Acceptable Answers	Reject	Mark
2(c)(v)	$\frac{(0.157 - \text{answer to 2c(iv)})}{0.157} \times 100$ Correct answer: $\frac{(0.157 - 0.134)}{0.157} \times 100$ = 14.6% IGNORE sf except 1 Some TEs from (iv): 0.135 gives 14.01% 0.136 gives 13.38% 0.150 gives 4.46%		**1**

Question Number	Acceptable Answers	Reject	Mark
2(c)(vi)	Pipette 0.06/25 x 100 = (±) 0.24% **(1)** Burette 0.10/22.35 x 100 = (±) 0.44743 = (±) 0.45% **(1)** ALLOW TE on titre in 2c(i) 22.5 gives = (±) 0.4444 = (±) 0.44% 22.6 gives = (±) 0.44248 = (±) 0.44% But 0.1/25 x 100 = 0.4 does not get a mark So 0.4 with **no working** gets no mark		**2**

Question Number	Acceptable Answers	Reject	Mark
2(c)(vii)	The apparatus error / combined errors is negligible compared to the difference (in concentration). ALLOW Percentage difference in value is bigger than percentage apparatus error. OR Percentage difference is greater than percentage error(s)	Just 'error of pipette is smaller than error of burette' Just 'apparatus error is small' '% error of apparatus is small so both pieces of apparatus are suitable' alone	**1**

Question Number	Acceptable Answers	Reject	Mark
2(c)(viii)	Fe^{2+} is (partially) oxidized (by air / oxygen) (on standing overnight) ALLOW Reverse argument OR iron/Fe (solution) is (partially) oxidized (by air / oxygen) (on standing overnight)	Absorbed moisture overnight so solution more dilute Incomplete reaction Transfer errors Impurities present	**1**

Total for Question 2 = 22 marks

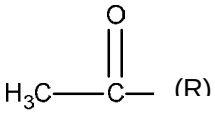
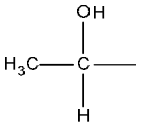
Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	Red /orange / yellow **and** precipitate ALLOW Bright and correct colour Combinations of these colours AND Solid / crystals /ppt /ppte / precipitate (ie recognisable spelling for 'precipitate')	Colour alone Pale yellow Other colour combinations eg red / brown	**1**

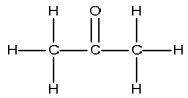
Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	Aldehyde **OR** ketone (both needed) Either order. ALLOW Carbonyl (compound/group) RCOR IGNORE contains C=O or other formulae		**1**

Question Number	Acceptable Answers	Reject	Mark
3(b)(i)	**First mark** Solutions: (aqueous) silver nitrate / $AgNO_3$ **(1)** **Second mark** (aqueous) ammonia / NH_3 / NH_4OH **(1)** Reagents in any order. IGNORE NaOH **NOTE** Ammoni(a)cal silver nitrate scores first 2 marks BUT Silver diam(m)ine / $[Ag(NH_3)_2]^+(NO_3^-)$ scores only 1 mark **Third mark** dependant on **any** silver salt and ammonia / ammoni(a)cal silver nitrate / silver diam(m)ine / $[Ag(NH_3)_2]^+$ Condition: Clean test tubes / warm / heat ALLOW heat to below 50^0C **(1)** **Fourth mark** stands alone - independent Positive result: Silver mirror / grey or black precipitate ALLOW Silver (alone) silver solid / silver ppt / ppte / metallic silver OR Silver mirror solution **(1)**	Other silver salts Silver / Ag^+ ions Silver compounds Ammonium / NH_4^+ ions Anything else eg nitric acid Shake vigorously Heat under reflux $20\text{-}25^0C$ Silver colour / silver coloured solution	**4**

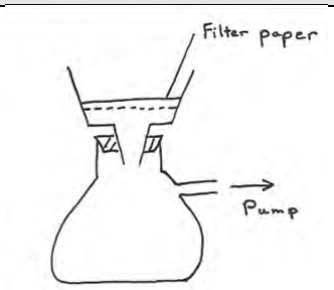
Question Number	Acceptable Answers	Reject	Mark
3(b)(ii)	Ketone ALLOW Keytone OR Carbonyl group in a ketone OR C=O in a ketone ALLOW ketone with additional correct general, displayed / structural formulae	Just 'carbonyl group' Just 'C=O'	**1**

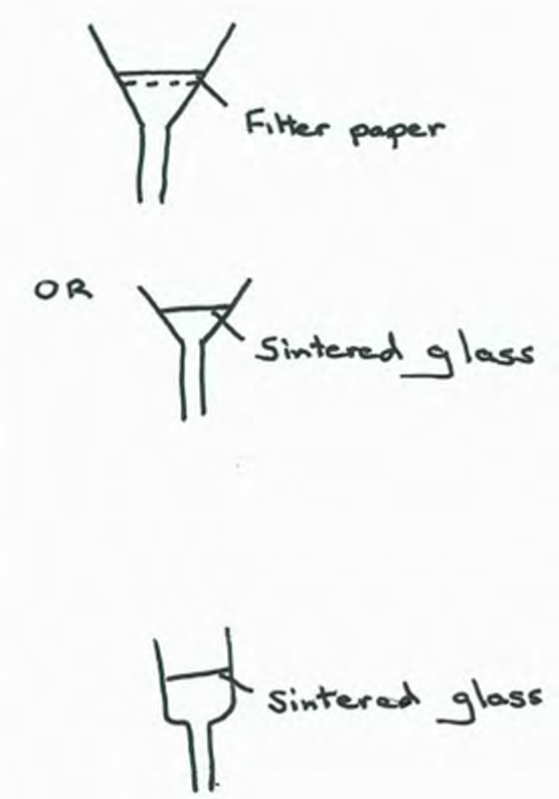
Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	(pale) yellow precipitate / solid / crystals Qualification of yellow is allowed like pale, light, creamy, or bright, but not dark. **Both** colour **and** state ALLOW 'Cloudy yellow' alone OR Recognisable spelling or abbreviations for precipitate like ppt / ppte / percipitate IGNORE antiseptic smell	Dark yellow	**1**

Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	Methyl ketone / CH_3CO (group) OR Contains  OR Methyl attached to a carbonyl (group)/C=O OR It is a 2-one ketone	 Secondary alcohol Functional group on second carbon atom	**1**

Question Number	Acceptable Answers	Reject	Mark
3(d)	**First mark** One hydrogen / proton environment OR One kind of hydrogen / proton ALLOW Hydrogen ion for proton **(1)** **Second mark** (Singlet so) no neighbouring hydrogens (on adjacent carbons) OR Chemical shift is correct for a ketone **(1)** **Third mark**  Hydrogens must be shown, but methyl groups do not have to be displayed. **(1)** ALLOW Correct structural or skeletal formula	Just 'it is a singlet' Just 'not split(ted) by any other hydrogen' Chemical shift is the same as a methyl group (alone) Chemical shift is at 2.2 (alone)	**3**

Question Number	Acceptable Answers	Reject	Mark
3(e)(i)	Faster **(1)** Solid / precipitate / crystals are drier OR more solvent / solution / filtrate removed OR Reverse argument for normal filtering **(1)** IGNORE More efficient / more effective / increases yield / more pure Reducing pressure reduces boiling temperature		**2**

Question Number	Acceptable Answers	Reject	Mark
3(e)(ii)	 **First mark** Buchner / side-armed flask **(1)** **Second mark** Side arm connected to pump **and** bung/rubber around neck of funnel OR Quickfit flask funnel shown with clear sealed join and pump labelled  **(1)** ALLOW aspirator for pump, drawings of tap pump IGNORE Blocked outlet to pump **Third mark** Buchner funnel with **flat** filter paper The filter paper must be labelled OR be drawn flat **and** clearly shown	Heated flask Large gap between funnel and flask Pressure pump (alone) Suction (alone) Filter paper which goes up the sides of the funnel Fluted filter paper	**3**

	above the pores of the funnel OR Hirsch funnels see diagrams below  Notice sintered / fitted glass does not need a filter paper IGNORE Blocked outlet to funnel **(1)** Notice heating of funnel / solvent can be ignored		

Question Number	Acceptable Answers	Reject	Mark
3(e)(iii)	**First mark** Dissolve in / mix with MINIMUM / SMALL volume / amount of HOT ethanol / solvent (to dissolve most of the solid / make a saturated solution) **(1)** **Second mark** Filter HOT (to remove insoluble impurities)# AND Cool / allow to crystallize **(1)** **Third mark** Filter (under reduced pressure) (to remove soluble impurities)# AND Wash with COLD / minimum volume of solvent **(1)** **Fourth mark** **Dry** between filter papers / with **paper** towel / in desiccator Both dry **and** method of drying ALLOW Use of **cool / warm** oven OR oven at specified temperature below 100^{o}C Use of hair drier / electric hand drier **(1)** **Note** penalties may be applied: *Penalise use of water only once #If impurities are wrong way round penalise only once Both these penalties can be applied to reduce the mark by 2	Water as solvent* Filter alone (Wash) with water* Drying agents unless in desiccator	**4**

Question Number	Acceptable Answers	Reject	Mark
3(e)(iv)	Measure the melting temperature **(1)** IGNORE References to sharp melting temperature Compare with literature / data (book) / known value **(1)** Second mark conditional on melting temperature mark IGNORE IR spectroscopy and check fingerprint region	Boiling temperature alone Chromatography and compare R_f values If melting temperature is clearly for propanone and not propanone derivative.	**2**

Total for Question 3 = 23 marks

Total for Paper = 50 Marks

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