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Mark Scheme (Results)

January 2014

IAL Chemistry (WCH03/01)

Unit 3: Chemistry Laboratory Skills I

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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)	Ba^{2+} / barium (ion) If charge is given must be correct ALLOW Ba^{+2}	Ba Ba^{+} Cu^{2+} Correct name with incorrect formula or vice versa	**1**

Question Number	Acceptable answers	Reject	Mark
1(b)	Carbonate / CO_3^{2-} ALLOW Hydrogencarbonate / HCO_3^-/ sulfite / sulfate (IV) /SO_3^{2-} /hydroxide / OH^- / oxide/ O^{2-}	Barium carbonate sulfate	**1**

Question Number	Acceptable answers	Reject	Mark
1(c)	Cl^- / chloride (ion) ALLOW Cl^{-1}, Cl^{1-}	Cl, Cl_2, Chlorine (ion) Correct name with incorrect formula or vice versa	**1**

Question Number	Acceptable answers	Reject	Mark
1(d)(i)	(The white precipitate goes) darker / purple / grey / lilac	(Goes) black, silver, silvery, cream, pale yellow, green	**1**

Question Number	Acceptable answers	Reject	Mark
1(d)(ii)	Silver ALLOW Ag	 Ag^+	**1**

Question Number	Acceptable answers	Reject	Mark
1(e)(i)	White precipitate ALLOW White solid Both words needed	Just “goes white”	**1**

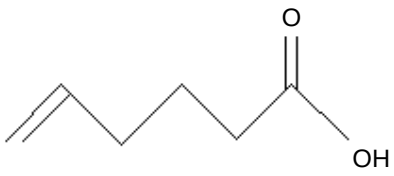
Question Number	Acceptable answers	Reject	Mark
1(e)(ii)	$BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2HCl(aq)$ OR $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ OR $Ba^{2+}(aq) + 2Cl^-(aq) + 2H^+(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) + 2Cl^-(aq) + 2H^+(aq)$ **First mark** All formulae correct (**1**) TE from the cation in 1(a) and the anion in 1(c) if the charge on the ion chosen is correct eg Cu^{2+} **Second mark** Balancing and state symbols (**1**) ALLOW second mark for ss and balancing in equation with mixture of ions and molecules $Ba^{2+}(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H^+(aq)$ scores 1 TE for second mark based on incorrect formulae only if a balanced equation forming a precipitate is given eg $2BaCl(aq) + H_2SO_4(aq) \rightarrow Ba_2SO_4(s) + 2HCl(aq)$ scores 1 No TE for equations with incorrect products e.g. H_2 and Cl_2	Any incorrect formulae For first mark, equation with mixture of ions and molecules eg $Ba^{2+}(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H^+(aq)$ $HCl(g)$ Equations in which hydrogen or sulfur dioxide is formed	**2**

Question Number	Acceptable answers	Reject	Mark
1(f)(i)	HCl / hydrogen chloride ALLOW (Droplets of) hydrochloric acid	Hydrogen chloride ions Hydrochloric acid gas	**1**

Question Number	Acceptable answers	Reject	Mark
1(f)(ii)	(mix gas being tested with) ammonia / hold open ammonia bottle near fumes (**1**) ALLOW (test with) ammonia (gas) Use of ammonia solution if clearly on a glass rod / stopper White smoke / white solid forms (**1**) Allow **dense white** fumes, **white** precipitate No TE if gas in (f)(i) is not HCl No TE in second mark if test given for first mark is incorrect	Dissolve in water and test with silver nitrate Indicators Misty / smoky fumes Just “White fumes”	**2**

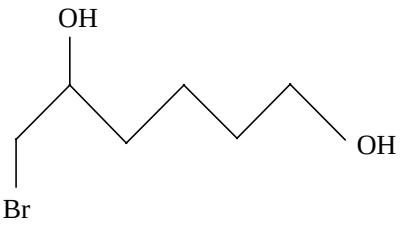
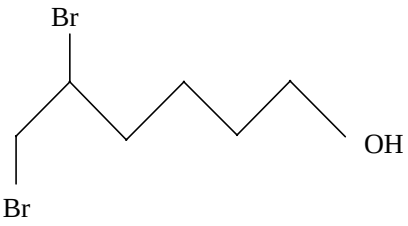
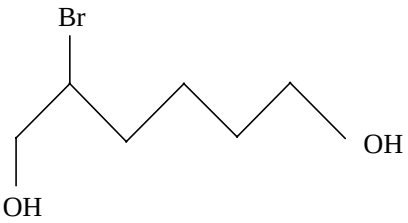
Total for Question 1 = 11 marks

Question Number	Acceptable answers	Reject	Mark
2(a)(i)	Orange to green / blue / brown ALLOW Dark green / green-brown	Combinations of blue and green Green to orange	**1**

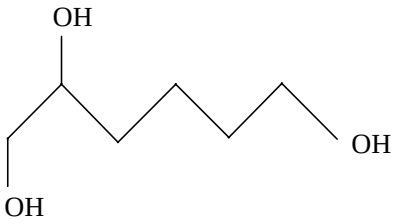
Question Number	Acceptable answers	Reject	Mark
2(a)(ii)	$CH_2=CH(CH_2)_3COOH$ Double bond need not be shown ALLOW CO_2H for COOH ALLOW  ALLOW displayed formula	$C_6H_{10}O_2$ Formulae not showing H atoms	**1**

Question Number	Acceptable answers	Reject	Mark
2(b)	Any TWO of Bubbles / effervescence / fizzing Sodium dissolves / disappears **White** residue / solid / ALLOW **White** precipitate ALLOW Rise in temperature / gets hotter / heat is given out IGNORE Moves / Floats / Sinks / Catches fire / Hydrogen given off	 Just "Gas forms" Bubbles form if incorrect gas identified. White solid dissolves Crystals form Just "exothermic"	**2**

Question Number	Acceptable answers	Reject	Mark
2(c)(i)	Brown / red-brown / orange / yellow / combinations of these colours to colourless	Red to colourless Clear for colourless Paler for colourless White for colourless	**1**

Question Number	Acceptable answers	Reject	Mark
2(c)(ii)	 ALLOW  ALLOW  IGNORE orientation of Br and OH, eg both Br pointing down IGNORE lengths of bonds Check that there are **6C** in formula	Br at left hand end without a bond to it	**1**

Question Number	Acceptable answers	Reject	Mark
2(d)(i)	Purple / pink to colourless ALLOW For purple pink: pinkish-purple, dark purple For colourless: brown	Clear for colourless White for colourless Green / orange for colourless Lilac for purple	**1**

Question Number	Acceptable answers	Reject	Mark
2(d)(ii)	 IGNORE orientation of OH, eg both OH pointing down IGNORE lengths of bonds Check that there are **6C** in formula	OH at left hand end without a bond to it Bond to H of OH group	**1**

Question Number	Acceptable answers	Reject	Mark
2(e)	hex-5-en-1-ol Alkene/ C=C at 1669 – 1600 (cm^{-1}) (alkene) C-H at 3100-3010 (cm^{-1}) Correct identification **and** one correct piece of evidence (**1**) Correct identification with two pieces of evidence (**2**) Correct identification and correct bonds quoted without any data can score 1.		**2**

Total for Question 2 = 10 marks

Question Number	Acceptable answers	Reject	Mark
3(a)(i)	No sharp colour change / colour change gradual / difficult to see end-point/ end-point not clear / end-point not obvious / no specific colour change at end-point / colour change hard to distinguish many different colours during the vertical section of a pH curve	Colour changes slowly Does not give accurate results No significant colour change end-point not visible Colour does not change in vertical section of pH curve Forms various colours with acid and alkali Comments about suitability for weak/ strong acids	**1**

Question Number	Acceptable answers	Reject	Mark
3(a)(ii)	Suitable acid-base indicator (**1**) correct colours (**1**) Likely answers: methyl orange (**1**) red in acid, yellow in alkali (**1**) Phenolphthalein (**1**) colourless in acid, pink / purple / red in alkali (**1**) ALLOW Bromothymol blue (**1**) Yellow in acid, blue in alkali (**1**) No TE on colours for litmus Second mark depends on first	Litmus Orange for red Spelling is not a reasonable match for pronunciation	**2**

Question Number	Acceptable answers	Reject	Mark
3(b)(i)	$\frac{(22.80 \times 0.250)}{1000}$ = 5.70×10^{-3}/ 5.7×10^{-3} / 0.0057	6×10^{-3}	**1**

Question Number	Acceptable answers	Reject	Mark
3(b)(ii)	5.70×10^{-3} / 5.7×10^{-3} / 0.0057 TE: Same as 3b(i)		**1**

Question Number	Acceptable answers	Reject	Mark
3(b)(iii)	$(2.00 \times 10^{-2} - 5.70 \times 10^{-3})$ $=1.43 \times 10^{-2}$ / 14.30×10^{-3} / 0.0143 TE 2.00×10^{-2} – answer from 3b(ii) IGNORE SF except 1	Numbers obtained without having done a subtraction	**1**

Question Number	Acceptable answers	Reject	Mark
3(b)(iv)	Mol $Mg(OH)_2$ = answer to 3b(iii) /2 (**1**) $=7.15 \times 10^{-3}$ /0.00715 mass = 58.3 x number of mol =0.416845 =0.417 (g) (**1**) TE for second mark based on number of moles calculated for first mark. ALLOW use of 58 instead of 58.3 (giving 0.415(g)) Correct answer with no working scores 2	Answers with more or less than 3 significant figures	**2**

Question Number	Acceptable answers	Reject	Mark
3(c)(i)	Split sample into two / several portions (so that titration can be repeated) OR make solution to a standard volume (e.g. 100cm^3) and take measured aliquots	Just "repeat the titration" Just " use more concentrated acid " or "Use more acid". Use more accurate burettes / pipettes / balance	**1**

Question Number	Acceptable answers	Reject	Mark
3(c)(ii)	$\frac{100 \times (2 \times 0.05)}{40.00}$ = (±) 0.250/ 0.25% Doubling error in each reading (**1**) Final answer (**1**) 0.125%/ 0.13% scores 1 mark	0.3/ 0.30% 0.12, 0.1	**2**

Question Number	Acceptable answers	Reject	Mark
3(d)	Any two from Use (finely) powdered magnesium hydroxide Use moderately concentrated acid / acid which is not very dilute/ acid of higher concentration / keep excess acid to minimum possible volume. Ensure good mixing / stir mixture ALLOW Measure temperature before adding magnesium hydroxide and for some time after; plot temperatures against time and extrapolate (cooling) line (to where reagents are mixed, to allow for cooling) IGNORE Put a lid on the container/ other comments on insulation	 Break magnesium hydroxide into smaller pieces Use a more accurate thermometer Just "plot temperatures against time and extrapolating"	**2**

Total for Question 3 = 13 marks

Question Number	Acceptable answers	Reject	Mark
4(a)(i)	Dehydrating agent / dehydration/ removes (elements of) water / removes H_2O / eliminates water / eliminates H and OH IGNORE reference to catalyst	Drying agent Just elimination	**1**

Question Number	Acceptable answers	Reject	Mark
4(a)(ii)	Corrosive / burns skin (**1**) Wear gloves (**1**) Second mark depends on first being corrosive **or** harms skin **or** irritant	Just "harms skin" Toxic Use tongs Avoid spillage Use fume cupboard	**2**

Question Number	Acceptable answers	Reject	Mark
4(b)	**First mark** Apparatus should not be completely sealed / put vent in apparatus / leave gap between condenser and receiving flask / insert gas outlet / use receiving flask with opening (**1**) ALLOW "Open end of apparatus for pressure release" **Second mark** Move (bulb of) thermometer to opposite opening to condenser (**1**) These points may be shown on diagram.	Just "Move thermometer up"/ "position in neck of flask" / "position in mouth of flask"	**2**

Question Number	Acceptable answers	Reject	Mark
4(c)(i)	EITHER Cyclohexene only forms London forces / cyclohexene only forms van der Waals forces / cyclohexene can only form weak forces / cyclohexene is non-polar AND water is polar (**1**) Hydrogen bonds would be broken if cyclohexene mixed with water / cyclohexene cannot form hydrogen bonds with water / cyclohexene cannot replace hydrogen bonds with a strong bond / cyclohexene cannot form bonds with water of comparable strength (to original ones) (**1**) OR (alternative approach) Hydrogen bonds would be broken if cyclohexene mixes with water (**1**) Only weaker London forces would replace them (**1**) IGNORE comments on ionic bonding in sodium chloride	Just "cyclohexene is non-polar" Cyclohexene forms permanent dipole-dipole forces Just "there are hydrogen bonds in water"	**2**

Question Number	Acceptable answers	Reject	Mark
4(c)(ii)	Separating funnel with tap (and stopper) ALLOW Any shaped tube with opening at top which can be stoppered and tap at bottom (**1**) Cyclohexene in upper layer (**1**) Don't penalise if labelled cyclohex**ane**, not –ene. Mark independently	Filter funnel Buchner funnel Very large opening at the top of the funnel. 3 layers	**2**

Question Number	Acceptable answers	Reject	Mark
4(d)(i)	(anhydrous) calcium chloride / $CaCl_2$ / magnesium sulfate / $MgSO_4$ / sodium sulphate / Na_2SO_4 ALLOW silica gel	Other compounds, even if anhydrous Incorrect formulae (concentrated) sulfuric acid	**1**

Question Number	Acceptable answers	Reject	Mark
4(d)(ii)	(cloudy) liquid would go clear/ liquid becomes less cloudy	Volume decreases Water layer disappears Viscosity changes	**1**

Question Number	Acceptable answers	Reject	Mark
4(e)	(re)distillation (collecting liquid close to its boiling point) ALLOW Simple distillation Fractional distillation Correct description of process	collecting liquid more than 5° from its boiling point) Filtering	**1**

Question Number	Acceptable answers	Reject	Mark
4(f)(i)	Mass cyclohexanol = (0.100 x 100) = 10.0/ 10 g (**1**) Volume = $\frac{10.0}{0.962}$ = 10.395 / 10.40/ 10.4 (cm^3) (**1**) Second mark TE from mass of cyclohexanol calculated	10/ 10.39(cm^3)	**2**

Question Number	Acceptable answers	Reject	Mark
4(f)(ii)	EITHER Max yield = (0.100 x 82) = 8.20/ 8.2g (**1**) % yield = $\frac{(5.50 \times 100)}{8.20}$ = 67.073/ 67.1/ 67% (**1**) Second mark TE from mass of cyclohexene, but NOT if max yield = 10.4 or 10 (ie from volume of cyclohexanol or molar mass of cyclohexanol). OR Mol cyclohexene = $\frac{5.5}{82}$ = 0.067073 (**1**) Ignore sf except 1 sf % yield = $\frac{(0.067073 \times 100)}{0.1}$ = 67.073/ 67.1/ 67% (**1**) Correct answer with no working scores 2 Use of 84 as molar mass cyclohexene scores max 1 Ignore SF except 1	0 overall if yield greater than 100%	**2**

Total for Question 4 = 16 marks