

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/36

Paper 3 (Advanced Practical Skills), maximum raw mark 40

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Question	Sections	Indicative material	Mark
1 (a)	PDO layout	I Volume given for Rough titre and accurate titre details tabulated.	1
	MMO Collection	II Follows instructions - dilutes 45.50 – 46.50 cm ³ FB 1 and initial and final burette readings recorded for Rough titre and initial and final burette readings and volume of FB 2 added recorded for each accurate titre <i>Headings should match readings.</i> <i>Do not award this mark if:</i> <i>50(.00) is used as an initial burette reading;</i> <i>more than one final burette reading is 50.(00);</i> <i>any burette reading is greater than 50.(00)</i>	1
	MMO Decisions	III Has two uncorrected, accurate titres within 0.1 cm ³ <i>Do not consider the Rough even if ticked.</i> <i>Do not award this mark if having performed two titres within 0.1 cm³ a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless a fourth titration, within 0.1 cm³ of the third titration (or first two) has also been carried out.</i>	1
	PDO Recording	IV All accurate burette readings (initial and final) recorded to nearest 0.05 cm ³ (Accurate titration & dilution tables) <i>Assess this mark on burette readings only</i> For candidates and Supervisor scale titre for 46.00 cm ³ FB 1 diluted. Calculate titre $\times \frac{46.00}{\text{volume of FB1 added}}$ Calculate difference in Supervisor and candidate scaled values and award "quality" marks as below. [If candidate has not recorded a volume diluted, use 46.00 cm ³]	1

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	MMO Quality	<p>V, VI and VII Round any burette readings to the nearest 0.05 cm³. Check and correct subtractions in the titre table. Select the “best” titre using the hierarchy: two identical; titres within 0.05 cm³; titres within 0.1 cm³; etc.</p> <p>Award V, VI and VII for a difference from Supervisor within 0.20 cm³</p> <p>Award V and VI only for a difference of 0.20+ cm³ – 0.30 cm³</p> <p>Award V only for a difference of 0.30+ – 0.50 cm³ <i>If the “best” titres are ≥ 0.50 cm³ apart cancel one of the Q marks.</i></p>	3	[7]
(b)	ACE Interpretation	<p>Calculates the mean, correct to 2 decimal places (third decimal place rounded to the nearest 0.05 cm³) from any accurate titres within 0.20 cm³. <i>A mean of exactly .×25 or .×75 is allowed but the candidate may round up or down to the nearest 0.05 cm³.</i> <i>If ALL burette readings are given to 1 decimal place then the mean can be given to 1 decimal place if numerically correct without rounding.</i> <i>Mean of 24.3 and 24.4 = 24.35 (✓)</i> <i>Mean of 24.3 and 24.4 = 24.4 (✗)</i> Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.</p>	1	[1]
(c)	ACE Interpretation	<p>I Expression correct in step (i) $\frac{\text{volume diluted}}{1000} \times 0.125$</p> <p>II Uses answer to (i) $\times \frac{25}{250}$ in step (ii)</p> <p>III Uses answer to (ii) $\times 2$ in step (iii) and answer to (iii) $\times \frac{1000}{\text{titre}}$ in step (iv) <i>If an answer, with no working, is given in any section allow if correct.</i></p>	1 1 1	
	PDO Display	<p>IV Appropriate working shown in a minimum of 3 sections.</p> <p>V 3 to 5 significant figures in final answers to all sections attempted – minimum of 3 final answers required to qualify for the award of this mark.</p>	1 1	[5]

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(d)	ACE Interpretation	(i) For Student A explains that final burette reading was also 0.05 cm ³ greater than the true value ("error" in same direction) <i>Ignore parallax error</i> <i>Not errors cancel – reason needed</i>	1	[2]
		(ii) For Student B explains that final burette reading was 0.05 cm ³ greater than the true value ("error" in opposite direction) <i>Not errors compound each other/add up</i>	1	
(e)	ACE Conclusions	(i) Explains that carbon dioxide is acidic (and its absorption reverses the colour change of the indicator)	1	[2]
	ACE Improvements	(ii) Puts acid/ FB 3 in burette and pipettes NaOH/ FB 2 into flask or Heat the solution/Use hot solution	1	
			[Total: 17]	

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2	(a)	PDO Recording	I	Records results in a single table for both experiments. No repetition of headings	1	
		MMO Quality	II	Titre for either Flask A or B within 0.50 cm ³ of Supervisor	1	
			III	Titre for either Flask A or B within 0.30 cm ³ of Supervisor	1	
			IV	Titre for both Flask A and B within 0.30 cm ³ of Supervisor	1	[4]
	(b)	ACE Interpretation	(i)	Calculates a volume of 200 cm ³ in step (i)	1	
			(ii)	Correctly calculates titre x 5 for each flask	1	[2]
	(c)	ACE Conclusions		Mark consequentially to practical results Chooses expt with lower titre – less remains (or converse argument) or higher value in (b)(iii) <i>Allow ecf</i>	1	[1]
	(d)	ACE Conclusions		Comparison of candidate's K_c values Judgement on constancy or otherwise Supports/does not support equilibrium	1	[1]
						[Total: 8]

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FB 7 is $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2(\text{aq})$; FB 8 is $\text{Na}_2\text{SO}_4(\text{aq})$; FB 9 is $\text{CaCl}_2(\text{aq})$					
3 (a)	MMO Decisions	I	Selects sodium hydroxide as reagent (<u>Not</u> if + Al) and describes (warming the solution and) <u>testing any gas evolved</u> with red litmus/pH paper	1	[5]
	MMO Collection	II	Records positive test for ammonia gas with FB 7 only <i>Must link gas/NH_3 with positive test (Allow even if Al mentioned in I)</i>	1	
	MMO Decisions	III	Selects barium chloride or nitrate together with HCl or HNO_3 <i>Do not accept Ba^{2+} as a reagent</i> <i>Accept $\text{Ba}^{2+}(\text{aq})$ or a solution containing Ba^{2+} ions</i>	1	
	MMO Collection	IV	White ppt, persisting in acid with FB 7 and with FB 8 <i>Allow from unspecified strong acid provided there is no ppt with FB 9.</i>	1	
	MMO Conclusions	V	Mark consequentially to observations for solutions containing NH_4^+ and SO_4^{2-} ecf allowed here but not with other identities <i>Allow from strong acid or from H_2SO_4 if clearly added after $\text{Ba}^{2+}(\text{aq})$</i>	1	
(b)	PDO Layout	I	(Tabulates) observations clearly, showing: observation when each reagent is first added and observation when reagent added to <u>excess</u> if there is a ppt	1	[4]
	MMO Collection	II, III and IV	1 mark for correct observations in each of the columns or rows representing FB 7, FB 8 and FB 9 or 1 mark for correct observations in the row or column representing a reagent added (initial and excess count as one row/column)	3	

Minimum observations

Solution	FB 7	FB 8	FB 9
NaOH	Green ppt insoluble (in excess)	no reaction/no change/no ppt <i>Not “–” words needed (Only penalise once)</i>	White ppt insoluble (in excess)
NH_3	Green ppt insoluble (in excess)	colourless <u>soln</u> /no reaction/no change/no ppt	No reaction/no change/no ppt

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(c)	ACE Conclusions	<p>One mark for FB 7 and FB 9 containing Fe²⁺ and Ca²⁺ respectively provided no CON obs in (a) or (b) <i>No ecf</i> <i>Ignore FB 8, ignore supporting evidence</i></p>	1	[1]
FB 10 is CuCO₃(s)				
(d) (i)	MMO Collection	<p>I observes the <u>solid turning black</u> in step (i)</p> <p>II observes fluidity in solid layer in step (i) <i>Allow description of fluidised solid as "liquid"</i></p>	1 1	
	MMO Decisions	<p>III describes an appropriate test for any of the following <u>gases</u>: O₂, CO₂, NH₃ or SO₂ (gas or O₂/etc needed)</p>	1	
(ii)	MMO Collection	<p>IV lime water turns milky/cloudy/chalky <i>Gas or CO₂ turns limewater milky. scores III and IV</i></p>	1	
		<p>V on adding acid to residue from FB 10, observes green solution (on warming) <i>Ignore any residual solid</i> <i>Allow blue-green or bluish green</i> <i>Allow if (qualified) green solution turns blue on cooling</i> May award either III or IV here but only for gas tests for CO₂ or SO₂ or limewater observations</p>	1	[5]
				[Total: 15]