Cambridge International AS & A Level

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CHEMISTRY **9701/32**

Paper 3 (Advanced Practical Skills 2) **May/June 2017**

MARK SCHEME

Maximum Mark: 40

Published

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Question	Answer	Marks
1(a)	**I** Initial and final burette readings and volume added recorded for rough titre **and** accurate titre details tabulated. [minimum 2 × 2 'boxes' with relevant information]	**1**
	II Initial and final burette readings recorded and volume of **FB 2** added recorded for each accurate titration. Headings and units correct for accurate titrations Headings: initial / final (burette) reading / volume **or** reading / volume at start / finish **and** volume / **FB 2** added/used **or** titre **and** Units: (cm^3) **or** / cm^3 **or** in cm^3 [or cm^3 by every entry]	**1**
	III All accurate burette readings are recorded to the nearest 0.05 cm^3 Do **not** award this mark if: 50(.00) is used as an initial burette reading; more than one final burette reading is 50(.00); any burette reading is greater than 50(.00)	**1**
	IV The **final** accurate titre recorded is within 0.10 cm^3 of any other accurate titre.	**1**

Question	Answer	Marks
1(a)	**For assessment of accuracy (Q) marks,** each Examiner should round any accurate burette readings to the nearest 0.05 cm^3, check subtractions and then select the "best" titres for supervisor and candidate using the hierarchy: *two identical; titres within 0.05 cm^3; titres within 0.1 cm^3; etc.* These best titres should be used to calculate the mean titre, expressed to the nearest 0.01 cm^3. The candidate's titre is compared to the supervisor's titre and δ calculated.	
	V, VI and **VII** Award **V**, **VI** and **VII** for $\delta \leqslant 0.20\ cm^3$ Award **V** and **VI** for $0.20\ cm^3 < \delta \leqslant 0.30\ cm^3$ Award **V** for $0.30\ cm^3 < \delta \leqslant 0.50\ cm^3$	**3**
1(b)	Check mean titre is correctly calculated from clearly selected values (ticks or working). • Candidate must average two (or more) titres where the total spread is $\leqslant 0.20\ cm^3$. • Working must be shown or ticks must be put next to the two (or more) accurate readings selected. • The mean should normally be quoted to 2 dp rounded to the nearest 0.01. [*e.g. 26.667 must be rounded to 26.67*] Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325; allow mean to 1 dp if **all** accurate burette readings were given to 1 dp and the mean is exactly correct. [*e.g. 26.0 and 26.2 = 26.1 is correct* *but 26.0 and 26.1 = 26.1 is incorrect*.] Do **not** award this mark if: • the rough titre was used to calculate the mean; • candidate carried out only 1 accurate titration; • burette readings were incorrectly subtracted to obtain any of the accurate titre values; • **all** burette readings (resulting in titre values used in calculation of mean) are integers. *Note: the candidate's mean will sometimes be marked as correct even if it is different from the mean calculated by the examiner for the purpose of assessing accuracy.*	**1**
1(c)(i)	Correctly calculates $\frac{0.100 \times 25}{1000} = 2.5(0) \times 10^{-3}$	**1**

Question	Answer	Marks
1(c)(ii)	Correctly calculates $\frac{0.0025 \times 1000}{(\mathbf{b})}$ to 3 or 4 sf	**1**
1(c)(iii)	Correct expression 12.6 ÷ **(ii)**	**1**
1(c)(iv)	Anion in **FB 1** = $CHCl_2COO^-$ (allow ecf: for candidate's answer to **(iii)**) CH_3COO^- : ⩽ 77 CH_2ClCOO^- : 77.5 – 111.5 $CHCl_2COO^-$: 112 – 146 CCl_3COO^- : ⩾ 146.5	**1**
1(d)(i)	Conc NaOH lower = > titre smaller = > smaller M_r	**1**
1(d)(ii)	No effect on identification unless closer to smaller mass acid **or** (different M_r may lead to the) identification of a different acid with matching / close to M_r	**1**
	Total:	**14**

Question	Answer	Marks
2(a)	**I** Unambiguous headings and correct units tabulated for all 6 thermometer readings, mean temps, and ΔTs	**1**
	II All thermometer readings recorded to 0.5 °C **and** ΔTs correctly calculated **and** Mean temperatures correctly calculated to nearest .5 °C or to 1 or 2 dp	**1**
	Award **III** if candidate ΔTs within 1.5 °C	**1**
	Award **III** and **IV** if candidate ΔTs within 1.0 °C	**1**
2(b)(i)	Correctly calculates n acid = 0.05(0) mol **and** n NaOH = 0.045 mol	**1**

Question	Answer	Marks
2(b)(ii)	Correctly calculates $50 \times 4.2 \times \Delta T_1$ to minimum 2 sf	**1**
2(b)(iii)	Correct expression $\frac{(\mathbf{ii})}{1000 \times 0.045}$	**1**
2(b)(iv) +(v)	$2 \times$ mol NaOH in **(i)** or 0.09(0) in (iv) **and** Correctly uses $\frac{100 \times 4.2 \times \Delta T(2)}{1000 \times (\mathbf{iv})}$ in **(v)**	**1**
	Negative signs shown in **(iii)** and **(v)** and final answers to 2–4 sf in **(ii)**, **(iii)** & **(v)**	**1**
2(c)(i)	% error in vol of **FB 3** = $\frac{0.5 \times 100}{50}$ = 1.(0)%	**1**
	% error in vol of **FB 4** = $\frac{2 \times 0.25 \times 100}{25}$ = 2.(0)%	**1**
2(c)(ii)	Use a burette / pipette for volume measurements / instead of a measuring cylinder **or** Add a lid to reduce **heat loss** (by convection) / to reduce convection **or** Use thermometer reading to 0.2 °C / smaller divisions / calibrations / more sensitive	**1**
	Total	**12**

Question	Answer	Marks
	FB 5 is CH_3COOH; **FB 6** is HC*l*; **FB 7** is HNO_3; **FB 8** is $CuSO_4(aq)$; **FB 9** is Na_2edta	
3(a)(i)	Selects Na_2CO_3 / Mg	**1**
	Effervescence / bubbling / fizzing greater / faster with **FB 6**	**1**
	FB 5 is the weak acid (ora) with some evidence	**1**
3(a)(ii)	no reaction / no ppt / no change with Ag^+ **and** 'not needed' with Ba^{2+} (do not allow 'no change' unless there is no evidence of ammonia in 2nd test) Effervescence alone is not evidence so would expect 'no change'.	**1**
	Effervescence / gas / NH_3 **and** turns (damp red) litmus blue	**1**
	FB 7 is nitric acid from some evidence (can be effervescence in (ii))	**1**

Question	Answer	Marks
3(b) (i) – (vi)	**See below**	**6**

Expected observations

test	*observation*	*mark*
(i) + Na_2CO_3	(pale) blue ppt (Allow blue-green / green-blue / turquoise / cyan)	**1**
(ii) + KI then	Yellow-brown / brown (not orange)	**1**
$Na_2S_2O_3$	white / off-white ppt **and** soluble in excess	**1**
(iii) + c.HC*l* **and**	(blue) (solution) turns green (shade greener)	
(iv) + H_2O	(green) (solution) turns (pale) blue (shade bluer)	**1**
(v) + NH_3	(in excess) forming dark/deep blue **solution** **or solution** much darker than **(iv)**	**1**
(vi) + edta	(solution) more blue / darker blue than **(iv)**	**1**

Question	Answer	Marks
3(vii)	**FB 8** contains Cu^{2+}/copper(II)	**1**
3(viii)	$Cu^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CuCO_3(s)$ Allow $2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2$(aq or s) Allow $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$	**1**
	Total:	**14**

Mark allocation

Skill	***Minimum mark allocation***	Breakdown of marks	***Statement***	Minimum Marks	***Question 1***	***Question 2***	***Question 3***	***Total mark***
Manipulation, measurement and observation (MMO)	12 marks **[17]**	Successful collection of data and observations	C	**8**	1		9	**10**
		Quality of measurements and observations	Q	**2**	3	2		**5**
		Decisions relating to measurements of observations	De	**2**	1		1	**2**
Presentation of data and observations (PDO)	6 marks **[7]**	Recording data or observations	R	**2**	1	1		**2**
		Display of calculation and reasoning	Di	**2**	1	2		**3**
		Data layout	L	**2**	1	1		**2**
Analysis, conclusions and evaluation (ACE)	10 marks **[16]**	*Interpretation of data or observations and identifying sources of error*	I	**4**	3	5	1	**9**
		Drawing conclusions	Con	**5**	3		3	**6**
		Suggesting improvements	Imp	**1**		1		**1**
Total					**14**	**12**	**14**	**40**