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**CHEMISTRY**

**9701/33**

Paper 3 Advanced Practical Skills 1

**May/June 2017**

MARK SCHEME

Maximum Mark: 40

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**Published**

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This document consists of **10** printed pages.

Question	Answer	Marks
1(a)	<p><b>I Correct headings</b> The following data are recorded in the space provided</p> <ul style="list-style-type: none"> <li>• mass of container with <b>FA 2</b></li> <li>• mass of (empty) container</li> <li>• mass of <b>FA 2</b></li> </ul> <p><i>'Mass' must be stated for each piece of data.</i> <i>Unit / g (etc.) must be given for each piece of data.</i> <i>Subtraction for mass of FA 2 used must be correct.</i></p>	<b>1</b>
	<p><b>II</b> All the following data are recorded</p> <ul style="list-style-type: none"> <li>• two burette readings <b>and</b> titre for the rough titration</li> <li>• initial and final burette readings for <b>two</b> (or more) accurate titrations</li> </ul>	<b>1</b>
	<p><b>III Titre values</b> recorded for accurate titrations, <b>and Appropriate headings</b> and units in the <b>accurate</b> titration table</p> <ul style="list-style-type: none"> <li>• initial / start (burette) reading / volume</li> <li>• final / end (burette) reading / volume</li> <li>• titre <b>or</b> volume / <b>FA 1 and</b> used / added</li> <li>• unit: / cm<sup>3</sup> <b>or</b> (cm<sup>3</sup>) <b>or</b> in cm<sup>3</sup> (for each heading) <b>or</b> cm<sup>3</sup> unit given for each volume recorded</li> </ul>	<b>1</b>
	<p><b>IV</b> All accurate burette readings are recorded to the nearest 0.05 cm<sup>3</sup>. <i>The requirement to record to 0.05 applies to burette readings, including 0.00 cm<sup>3</sup> (if this was the initial reading), but it does <b>not</b> apply to the titre.</i> <i>This mark is <b>not</b> awarded if:</i></p> <ul style="list-style-type: none"> <li>• 50.(00) is used as an initial burette reading</li> <li>• more than one final burette reading is 50.(00)</li> <li>• any burette reading is greater than 50.(00)</li> </ul>	<b>1</b>
	<p><b>V</b> The <b>final</b> accurate titre recorded is within 0.10 cm<sup>3</sup> of any other accurate titre.</p> <ul style="list-style-type: none"> <li>• Do <b>not</b> include a reading if it is labelled "rough".</li> <li>• Do <b>not</b> award the mark if any 'accurate' burette readings (apart from initial 0 cm<sup>3</sup>) are given to <b>zero dp</b>.</li> </ul>	<b>1</b>

Question	Answer	Marks
<p><b>For assessment of accuracy (Q) marks</b>, each Examiner should round any burette readings to the nearest <math>0.05 \text{ cm}^3</math>, check subtractions and then select the “best” titres using the hierarchy:</p> <ul style="list-style-type: none"> <li>two (or more) accurate identical titres (ignoring any that are labelled “rough”), <i>then</i></li> <li>two (or more) accurate titres within <math>0.05 \text{ cm}^3</math>, <i>then</i></li> <li>two (or more) accurate titres within <math>0.10 \text{ cm}^3</math>, <i>etc.</i></li> </ul> <p>These best titres should be used to calculate the mean titre, expressed to nearest <math>0.01 \text{ cm}^3</math>.</p> <p>Calculate the candidate’s ratio to 1 dp, as shown below.  <b>Ratio = correct mean titre ÷ correct mass</b></p> <p>Calculate the difference (<math>\delta</math>) between the candidate’s ratio and the supervisor’s ratio.            Accuracy marks are awarded as follows.</p>		
1(a)	Award <b>VI, VII</b> and <b>VIII</b> if $\delta \leq 0.2$ ( $\text{cm}^3 \text{ g}^{-1}$ )	<b>1</b>
	Award <b>VI</b> and <b>VII</b> if $0.2 < \delta \leq 0.4$	<b>1</b>
	Award <b>VI</b> , only, if $0.4 < \delta \leq 0.6$	<b>1</b>
	<ul style="list-style-type: none"> <li><b>Spread penalty:</b> if the two “best” (corrected) titres used by the Examiner were <math>\geq 0.50 \text{ cm}^3</math> apart, maximum 2 accuracy marks.</li> <li>If <b>only</b> a rough titration is shown, award Q marks based on that, maximum 2 accuracy marks.</li> </ul>	

Question	Answer	Marks
1(b)	<p><b>Candidate calculates the mean correctly.</b></p> <ul style="list-style-type: none"> <li>• Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm<sup>3</sup>.</li> <li>• Working / explanation must be shown <b>or</b> ticks must be put next to the two (or more) accurate readings selected.</li> <li>• The mean should be quoted to <b>2 dp</b>, and be rounded to nearest 0.01 cm<sup>3</sup>. (e.g. 26.665 cm<sup>3</sup> must be rounded to 26.67 cm<sup>3</sup>)</li> </ul> <p>Two special cases, where the mean need not be to 2 dp:</p> <ul style="list-style-type: none"> <li>• Allow mean expressed to 3 dp <b>only</b> for 0.025 or 0.075 (e.g. 26.325 cm<sup>3</sup>)</li> <li>• Allow mean if expressed to 1 dp, if <b>all</b> accurate burette readings (apart from initial 0) were given to 1 dp <b>and</b> the mean is <b>exactly</b> correct. (e.g. 26.0 and 26.2 = 26.1 is allowed) (e.g. 26.0 and 26.1 = 26.1 is wrong – should be 26.05)</li> </ul> <p><i>This mark is not awarded if:</i></p> <ul style="list-style-type: none"> <li>• The rough titre was used to calculate the mean.</li> <li>• The candidate did only one accurate titration.</li> <li>• Burette readings were incorrectly subtracted to obtain <b>any</b> of the accurate titre values.</li> <li>• <b>All</b> burette readings used to calculate the mean were recorded as integers</li> </ul> <p><b>Note:</b> the candidate's mean will sometimes be marked correct even if it was different from the mean calculated by the Examiner for the purpose of assessing accuracy.</p>	1
1(c)(i)	No of moles of H <sub>2</sub> SO <sub>4</sub> used = 0.05(0) × <sup>(b)</sup> / 1000 to minimum 2 sf	1
1(c)(ii) and 1(c)(iii)	<p><b>2NaHCO<sub>3</sub> + H<sub>2</sub>SO<sub>4</sub> → Na<sub>2</sub>SO<sub>4</sub> + 2CO<sub>2</sub> + 2H<sub>2</sub>O</b>  <b>and</b> No of moles of NaHCO<sub>3</sub> = 2 × answer (i)</p>	1

Question	Answer	Marks
1(c)(iv)	Mass of $\text{NaHCO}_3 = \text{answer (iii)} \times 10 \times 84$	1
1(c)(v)	$\% = \frac{\text{answer (iv)}}{\text{mass of FA 2 used}} \times 100$	1
	<b>All answers attempted in (i), (iii), (iv) &amp; (v) are shown to 3 or 4 sf</b> <i>Minimum 3 answers attempted to gain the mark</i>	1
1(c)(vi)	Any <b>one</b> of the following answers. <ul style="list-style-type: none"> <li>• the impurity does not react <b>with (sulfuric) acid / FA 1 / <math>\text{NaHCO}_3</math></b></li> <li>• the impurity is <b>not</b> alkaline / acidic</li> <li>• the impurity is neutral</li> </ul>	1
1(c)(vii)	$\% \text{ error } (= \frac{0.1}{250} \times 100) = 0.04\%$	1
	<b>Total:</b>	<b>16</b>

Question	Answer	Marks
2(a)	<p><b>I</b> Four weighings recorded and correct headings given <b>and</b> mass of <b>FA 4</b> used and mass of residue recorded</p> <ul style="list-style-type: none"> <li>• (Mass of) crucible, (lid)</li> <li>• (Mass of) crucible, (lid) and <b>FA 4</b> (or 'contents before heating')</li> <li>• (Mass of) crucible, (lid) and contents / residue / <b>FA 4</b> after (first) heating</li> <li>• (Mass of) crucible, (lid) and contents / residue / <b>FA 4</b> after re-heating</li> <li>• (Mass of) <b>FA 4</b></li> <li>• (Mass of) residue / <b>FA 5</b> / contents after heating</li> </ul> <p><i>If 'mass' not written then 'g' must be with each entry. Use of lid must be consistent.</i></p>	<b>1</b>
	<p><b>II</b></p> <ul style="list-style-type: none"> <li>• All <u>weighings</u> recorded to same decimal places (one or more).</li> <li>• Third and fourth weighings are within 0.05 g of each other <i>(or both equal if a one decimal place balance was used)</i></li> <li>• Mass of <b>FA 4</b> and <b>FA 5</b> / residue must be correctly subtracted.</li> </ul>	<b>1</b>

Question	Answer	Marks
2(a)	<p><b>III and IV:</b></p> <ul style="list-style-type: none"> <li>For assessment of accuracy, examiner must check and correct (if necessary) the masses of <b>FA 4</b> used and of residue (smaller mass) obtained by the supervisor and by the candidate.</li> <li>Work out ratio <math>\frac{\text{mass of FA4}}{\text{mass of residue}}</math> for the supervisor (2 dp)</li> <li>Work out ratio <math>\frac{\text{mass of FA4}}{\text{mass of residue}}</math> for candidate (2 dp)</li> <li>Calculate the difference (<math>\delta</math>) between these two ratios.</li> </ul> <p>Award <b>III</b> and <b>IV</b> if <math>\delta \leq 0.05</math>            Award <b>III</b> if <math>0.05 &lt; \delta \leq 0.10</math></p>	<b>2</b>
2(b)(i) and 2(b)(ii)	<p><b>(i)</b> Mass <math>\text{NaHCO}_3 = \left( \frac{\% \text{ purity from 1(c)(v)}}{100} \right) \times \text{mass of FA 4 used}</math>  <b>and</b>  <b>(ii)</b> Mass impurity = mass of <b>FA 4</b> – answer <b>(i)</b>  <b>or</b> mass impurity = <math>\frac{\% \text{ impurity}}{100} \times \text{mass FA 4}</math></p>	<b>1</b>
2(b)(iii)	<p>Mass of decomposition solid = mass of residue (<b>FA 5</b>) from table – mass of impurity <b>(ii)</b> <b>and</b> expressed to 2, 3 or 4 sig fig  <b>or</b> mass of decomposition solid = mass of <math>\text{NaHCO}_3</math> – mass <b>lost</b> on heating  <b>[(i) – (mass FA 4 – mass FA 5)]</b></p>	<b>1</b>
2(b)(iv)	<p>Mass of residue obtained = answer <b>(iii)</b> <math>\times \frac{84}{\text{answer (i)}}</math></p>	<b>1</b>

Question	Answer	Marks
2(b)(v)	If correct, (84 g) NaHCO <sub>3</sub> would give <b>40</b> g residue / NaOH ( <i>owtte</i> ) <b>or</b> mole ratio 1: <b>1.3</b> (so not 1:1) <b>or</b> Answers could refer to mass / moles of CO <sub>2</sub>	<b>1</b>
2(c)(i)	Lid reduces / stops absorption of water (vapour) by solid / residue / <b>FA 5</b> while cooling	<b>1</b>
2(c)(ii)	Repeat the experiment <b>and</b> ignore anomalous results / to obtain concordant / consistent results <b>or</b> cool in a desiccator <b>or</b> use larger mass of <b>FA 4</b> / contents / solid	<b>1</b>
2(d)(i)	Any <b>two</b> observations required <ul style="list-style-type: none"> <li>• fizzing / effervescence / bubbling</li> <li>• gas turns limewater milky / chalky / cloudy white / white ppt</li> <li>• solid dissolves / colourless solution <b>forms</b></li> <li>• rapid/brisk effervescence = 2 observations</li> </ul>	<b>1</b>
2(d)(ii)	<b>FA 5</b> contains carbonate ion / CO <sub>3</sub> <sup>2-</sup> <b>and</b> reference to fizzing (with acid) <b>or</b> to CO <sub>2</sub> liberated (with acid) <b>or</b> positive limewater test <b>or</b> correct equation	<b>1</b>
2(d)(iii)	<b>2NaHCO<sub>3</sub>(s) → H<sub>2</sub>O(g) + CO<sub>2</sub>(g) + Na<sub>2</sub>CO<sub>3</sub>(s)</b>	<b>1</b>
2(d)(iv)	(From equation) 84 g NaHCO <sub>3</sub> should give 0.5 × 106 g residue (= 53 g) <b>and</b> gives a (sensible) comment based on student's 52.3 g	<b>1</b>
	<b>Total:</b>	<b>14</b>



Question	Answer	Marks
<b>FA 6 is <math>MnCl_2</math>; FA 7 is <math>Al_2(SO_4)_3</math></b>		
3(a)(i)	<b>Ba<sup>2+</sup> test: all observations correct</b> <ul style="list-style-type: none"> <li>• <b>FA 6</b> – no change / no reaction / no ppt / solution stays colourless <b>with both</b></li> <li>• <b>FA 7</b> – white precipitate with Ba<sup>2+</sup> <b>and</b></li> <li>• white ppt (remains) / insoluble / no reaction with HNO<sub>3</sub></li> </ul>	<b>1</b>
	<b>AgNO<sub>3</sub> test: both observations correct</b> <ul style="list-style-type: none"> <li>• <b>FA 6</b> – white precipitate</li> <li>• <b>FA 7</b> – no change / no reaction / solution stays colourless / no ppt</li> </ul>	<b>1</b>
	<b>Na<sub>2</sub>CO<sub>3</sub> test: both observations correct</b> <ul style="list-style-type: none"> <li>• <b>FA 6</b> – no reaction / solid does not dissolve / no effervescence</li> <li>• <b>FA 7</b> – fizzing / bubbling / effervescence / <b>or</b> gas / CO<sub>2</sub> turns limewater milky / chalky / cloudy white / (forms) white ppt</li> </ul>	<b>1</b>
3(a)(ii)	<b>FA 7</b> has lower pH <b>and</b> gas / CO <sub>2</sub> given off / it fizzes (more rapidly if fizzing with both) with sodium carbonate	<b>1</b>

Question	Answer	Marks
3(b)	<b>Reagents:</b> NaOH <b>and</b> NH <sub>3</sub> (names or correct formulae)	<b>1</b>
	<b>Observations</b> – (3 × 1 mark) <ul style="list-style-type: none"> <li>• <b>FA 6</b> + NaOH : off-white / buff / beige / light brown ppt</li> <li>• <b>FA 6</b> + NH<sub>3</sub> : off-white / buff / beige / light brown ppt</li> </ul>	<b>1</b>
	<ul style="list-style-type: none"> <li>• <b>FA 6</b> : both ppts insoluble in excess <b>and</b> darken / turn brown with either</li> </ul>	<b>1</b>
	<ul style="list-style-type: none"> <li>• <b>FA 7</b> + NaOH : white ppt <b>and</b> soluble in excess</li> <li>• <b>FA 7</b> + NH<sub>3</sub> : white ppt <b>and</b> insoluble in excess</li> </ul>	<b>1</b>
3(c)	<b>Conclusions</b> (one mark for each). <ul style="list-style-type: none"> <li>• <b>FA 6</b> is MnCl<sub>2</sub></li> <li>• <b>FA 7</b> is Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub></li> </ul>	<b>2</b>
	<b>Total:</b>	<b>10</b>