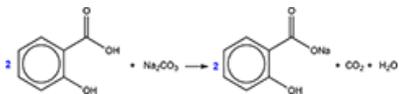
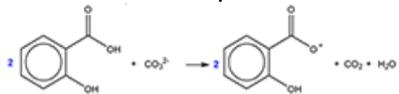
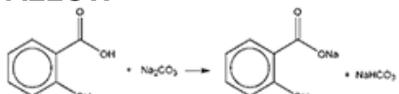


## Mark scheme

Question	Answer/Indicative content	Marks	Guidance
1	<p><b>Calculation 2 marks</b></p> $n(\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}) = 0.200 \times \frac{100}{1000}$ <p><b>OR</b> <math>2.00 \times 10^{-2}</math> (mol) <b>OR</b> 0.02(00) ✓</p> <p>Mass <math>\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} = 2.00 \times 10^{-2} \times 241.5 = 4.83</math> (g) ✓</p> <p><b>2 or more DP to match balances</b></p> <p><b>Method 3 marks</b></p> <p><b>Dissolve</b> solid in (distilled) <b>water</b> (less than 100 cm<sup>3</sup>) (in beaker) ✓</p> <p>Transfer (solution) to <b>volumetric</b> flask</p> <p><b>AND</b> Wash/rinse (from beaker to flask) ✓</p> <p>Make up to mark/up to 100 cm<sup>3</sup> with (distilled water)</p> <p><b>AND</b> Invert flask (several times to ensure mixing) ✓</p>	5	<p><b>FULL ANNOTATIONS MUST BE USED</b> <b>ALLOW ECF throughout</b></p> <p>-----</p> <p>--</p> <p><b>ALLOW ECF</b> from incorrect <math>n(\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O})</math> 4.83 g subsumes 1st mark</p> <p><b>ALLOW</b> small amount/some <b>DO NOT ALLOW</b> 100 cm<sup>3</sup> or more of water</p> <p><b>IGNORE</b> solvent</p> <p><b>ALLOW</b> graduated flask</p> <p><b>ASSUME</b> that wash/rinse is to a volumetric flask</p> <p><b>ALLOW</b> swirl/shake</p> <p>-----</p> <p><b>ALLOW</b> preparation of solutions &gt; 100 cm<sup>3</sup> <b>4 marks</b> e.g. for 250 cm<sup>3</sup></p> $n(\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}) = 0.200 \times \frac{250}{1000} \text{ OR } 0.05 \text{ (mol) } \times$ $\text{Mass } \text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} = 0.05 \times 241.5 = 12.075 \text{ (g) } \checkmark$ <p>Then method adapted for 250 cm<sup>3</sup> volumetric flask e.g. Make up to 250 cm<sup>3</sup> with water</p> <p><b><u>Examiner's Comments</u></b></p> <p>This question differentiated between candidates extremely well. See Exemplar 1 below.</p> <p>Exemplar 1</p>

			<p> <math>0.1 \text{ mol dm}^{-3}</math>  <math>0.2 \times 0.1 = 0.02 \text{ mol in } 100 \text{ cm}^3</math>  <math>M_r = 63.5 + 2 \times 16 + 96 + 54</math>  <math>= 241.5</math>  <math>0.02 \times 241.5 = 4.83 \text{ g}</math> </p> <p>Using 4.83g of <math>\text{Cu(NO}_3)_2 \cdot 3\text{H}_2\text{O}</math>, measured using a mass balance to 2 dp.</p> <p>Add this to a beaker and add enough distilled water to dissolve the salt.</p> <p>Use distilled water to wash the boat that you used to measure the copper nitrate into the beaker as well.</p> <p>Pour the solution into a volumetric flask, again washing the beaker with distilled water.</p> <p>Add more distilled water to the flask until you reach the 100 cm<sup>3</sup> mark.</p> <p>Stopper the flask and invert slowly several times.</p>
			<p>Exemplar 1 has been included to demonstrate a superb response. The comments that follow highlight some of the issues encountered in the responses. Unfortunately, nearly a quarter of candidates could not be given any marks at all for their responses. To improve, it is worth studying Exemplar 1.</p>
			<p>The candidate has communicated the key steps required to prepare the standard solution:</p>
			<ul style="list-style-type: none"> <li>• Calculation of the mass of hydrated copper(II) nitrate required.</li> <li>• Dissolving the hydrated copper(II) nitrate in water in a suitable container (a beaker).</li> <li>• Transferring the solid to a 100 cm<sup>3</sup> volumetric flask, washing the beaker with water and transferring the washings also to the volumetric flask.</li> <li>• Making the solution up to the 100 cm<sup>3</sup> mark in the volumetric flask and inverting the flask to mix the contents thoroughly.</li> </ul>
			<p>Issues with responses which arose by not reading the question closely enough:</p>
			<ul style="list-style-type: none"> <li>• Omitting to calculate the mass of hydrated copper(II) nitrate required.</li> <li>• Calculating the mass of anhydrous copper(II) nitrate instead of the hydrated salt.</li> <li>• Dissolving in 100 cm<sup>3</sup> of water and then adding more water for rinsing.</li> </ul>

				<ul style="list-style-type: none"> <li>• Not rinsing out the original container at all.</li> <li>• Making the solution up in the volumetric flask.</li> <li>• Using of a 250 cm<sup>3</sup> volumetric flask for preparing 100 cm<sup>3</sup> of solution.</li> <li>• Omitting the inversion stage.</li> <li>• Answering a different question, e.g. how to carry out a titration, how to determine an enthalpy change, how to work out the number of waters of crystallisation by heating in a crucible.</li> </ul>
		<b>Total</b>	<b>5</b>	
2	i	<p><b>Reaction with H<sub>2</sub>SO<sub>4</sub></b></p> $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 + \text{H}_2\text{O} \checkmark$ <p><b>Reaction with excess G</b></p>  <p>Correct organic product structure ✓</p> <p>Correct balanced equation ✓</p>	3	<p><b>ALLOW</b> multiples in both equations <b>IGNORE</b> state symbols</p> <p><b>ALLOW</b> <math>\text{Na}_2\text{CO}_3 + 2\text{H}_2\text{SO}_4 \rightarrow 2\text{NaHSO}_4 + \text{CO}_2 + \text{H}_2\text{O}</math></p> <p><b>ALLOW</b> ionic equation <math>\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}</math></p> <p><b>ALLOW</b> <math>\text{H}_2\text{CO}_3</math> instead of <math>\text{CO}_2 + \text{H}_2\text{O}</math></p> <p><b>ALLOW</b> <math>-\text{COO}^- (\text{Na}^+)</math> for product structure mark</p> <p><b>ALLOW</b> ionic equation</p>  <p><b>ALLOW</b></p>  <p><b>ALLOW</b> <math>\text{H}_2\text{CO}_3</math> instead of <math>\text{CO}_2 + \text{H}_2\text{O}</math></p> <p><b>ALLOW</b> correct Kekulé representation of benzene</p> <p><b><u>Examiner's Comments</u></b></p> <p>Another fairly challenging question, however most secured at least one mark for giving an equation for the reaction of sulfuric acid with sodium carbonate. Less confident candidates struggled to gain any marks as they were unable to give correct formula for sodium sulfate, giving <math>\text{NaSO}_4</math> for example.</p>

					Although many attempted the equation showing the reaction of compound <b>G</b> with sodium carbonate, only some correctly identified that only the carboxyl group would react, not the phenol. A small minority of students were able to balance the second equation gaining all 3 marks.
		ii	(NaOH) reacts with phenol / -OH (in compound G / H) <b>OR</b> (NaOH) would hydrolyse the ester / compound H	1	<p><b>IGNORE</b> comment about whether it improves or not</p> <p><b>DO NOT ALLOW</b> (NaOH) reacts with alcohol</p> <p><b><u>Examiner's Comments</u></b></p> <p>The best responses correctly identified that using sodium hydroxide was not an improvement and explained this either by stating that it would react with the phenol group or hydrolyse the ester group in compound <b>H</b>. However, most candidates appeared not to consider a reaction with <b>H</b> in their answer. Many focused on the neutralisation of sulfuric acid in a similar way to sodium carbonate and gave responses such as:</p> <ul style="list-style-type: none"> <li>stronger base</li> <li>no effervescence so harder to see when completely reacted</li> <li>no CO<sub>2</sub> produced so easier/safer/higher atom economy/less waste</li> <li>requires double the moles compared to Na<sub>2</sub>SO<sub>4</sub> to react</li> </ul>
			<b>Total</b>	<b>4</b>	
3	a		strong acid: <b>fully dissociates/ionises</b> <b>AND</b> weak acid: <b>partially dissociates/ionises</b> ✓	1	<p>strong acid fully dissociates</p> <p><b>ALLOW</b> weak acid dissociates/ionises <b>less</b></p> <p>strong acid releases all H<sup>+</sup> ions</p> <p><b>ALLOW</b> weak acid partially releases H<sup>+</sup> ions</p> <p>strong acid dissociates</p> <p><b>IGNORE</b> more strong acid dissociates quicker</p> <p><b>DO NOT ALLOW</b></p>

					<p>strong acid fully dissociates weak acid does not fully dissociate</p> <p><i>Response does not state that weak acid dissociates</i></p> <p><b>IGNORE</b> breaks down for dissociate/ionise <b>DO NOT ALLOW</b> comparison of concentrations</p> <p><b>Examiner's Comments</b></p> <p>Most candidates described a strong and a weak acid in terms of dissociation or ionisation, with few just describing one of the two types of acid.</p>					
	b	i	<table border="1"> <tr> <td>Titre/cm<sup>3</sup></td> <td>24.40</td> <td>24.15</td> <td>24.25</td> <td>✓</td> </tr> </table> <p>Correct subtractions to obtain titres <b>to 2 DP</b></p>	Titre/cm <sup>3</sup>	24.40	24.15	24.25	✓	1	<p><b>DO NOT ALLOW</b> 24.4</p> <p><b>Examiner's Comments</b></p> <p>Most candidates were able to work out these simple subtractions. Candidates were told that the titration readings were read to the nearest 0.05 cm<sup>3</sup>, requiring volumes to be recorded to two decimal places, which may include a '0'. The right-hand initial reading is therefore 24.10cm<sup>3</sup> and not 24.1 cm<sup>3</sup>, which continues to be the commonest error seen.</p>
Titre/cm <sup>3</sup>	24.40	24.15	24.25	✓						
		ii	<p>mean titre = <math>\frac{24.15 + 24.25}{2} = 24.20 \text{ (cm}^3\text{)} \checkmark</math> <i>i.e. using concordant (consistent) titres</i></p>	1	<p><b>ALLOW</b> 24.2 <i>DP already assessed in b(i)</i></p> <p><b>DO NOT ALLOW</b> mean of all three titres, <i>i.e. <math>\frac{24.40 + 24.15 + 24.25}{3} = 24.26/24.27</math></i></p> <p><b>ALLOW ECF</b> from incorrect concordant titres from <b>22b(i)</b></p> <p><b>Examiner's Comments</b></p> <p>Candidates are expected to use only concordant titres when working out the mean titre and the left-hand titre of</p>					

				24.40cm <sup>3</sup> should be rejected. Most candidates did this to produce 24.20 cm <sup>3</sup> as their mean titre. Use of 24.2 was allowed because rounding of a '0' as the second decimal place had already been penalised in Question 21 (b) (i). Predictably, the most common error was to use all three titres to produce the incorrect mean of 20.27cm <sup>3</sup> .
		iii	<p><b>FIRST CHECK ANSWER ON ANSWER LINE</b>  <b>IF answer = 89.4 (%) award 5 marks</b></p> <p><b>CHECK</b> mean titre from <b>22b(ii)</b> first.  <b>THEN</b> apply <b>ECF</b> throughout using THIS mean titre</p> <p><b>First 3 mark must come from the titration</b></p> <p><math>n(\text{Na}_2\text{CO}_3)</math></p> $= 0.200 \times \frac{24.20}{1000} = 4.84 \times 10^{-3} \text{ (mol)}$ <p style="text-align: right;">✓</p> <p><math>n(\text{CH}_3\text{COOH})</math> in 25.0 cm<sup>3</sup></p> $= 2 \times 4.84 \times 10^{-3} = 9.68 \times 10^{-3} \text{ (mol)}$ <p style="text-align: right;">✓</p> <p><math>n(\text{CH}_3\text{COOH})</math> in 250 cm<sup>3</sup></p> $= 10 \times 9.68 \times 10^{-3} = 9.68 \times 10^{-2} \text{ (mol)}$ <p style="text-align: right;">✓</p> <p><b>mass of CH<sub>3</sub>COOH in 250 cm<sup>3</sup></b></p> $= 60 \times 9.68 \times 10^{-2} = 5.808 \text{ (g)}$ <p style="text-align: right;">✓</p> <p><b>% composition to 3 SF</b></p> $= \frac{5.808}{6.50} \times 100 = 89.4 \text{ (%)}$ <p style="text-align: right;"><b>3 SF</b> ✓</p>	<p><b>ALLOW 3SF</b> or more throughout  <b>IGNORE</b> trailing zeroes,  e.g. <b>ALLOW</b> 24.2 for 24.20</p> <p><b>ALLOW ECF</b> from incorrect mean titre in <b>b(ii)</b></p> <p><b>ALLOW ECF</b> from 2 × incorrect <math>n(\text{Na}_2\text{CO}_3)</math></p> <p><b>ALLOW ECF</b> from incorrect <math>n(\text{CH}_3\text{COOH})</math>,  <b>OR</b>  from <math>n(\text{Na}_2\text{CO}_3)</math> if <math>n(\text{CH}_3\text{COOH})</math> stage omitted</p> <p><b>ALLOW 5.81 (3 SF)</b></p> <p><b>IF</b> mass is rounded to 5.81, Answer is still 89.4%  <i>Calculator = 89.38461538</i></p> <p><i>8.94% is 4 marks (omission of × 10 stage)</i></p> <p><b>IF</b> incorrect mean titre of 24.26/24.27 cm<sup>3</sup> used: (<i>mean of all 3 titres in b(ii)</i>), % composition = 89.6% to 3 SF for <b>ALL 5 marks by ECF</b></p> <p>-----  -----</p> <p><b>NOTE:</b> Some candidates are calculating <math>n(\text{CH}_3\text{COOH})</math> based on the 6.50 g sample being pure  <b>DO NOT ALLOW 0.108(3.....)</b></p> $n(\text{CH}_3\text{COOH}) = \frac{6.50}{60} = 0.108(3.....)$ <p><b>COMMON ERRORS</b></p>

Calculator: 89.35384615

### COMMON ERRORS

**Omitting  $\div 1000$  for  $n(\text{Na}_2\text{CO}_3)$**

*Up to 3 marks are possible*

$$n(\text{Na}_2\text{CO}_3) = 0.200 \times 24.20 = 4.84 \text{ (mol)} \quad \times$$

$$n(\text{CH}_3\text{COOH}) \text{ in } 25.0 \text{ cm}^3 = 2 \times 4.84 = 9.68 \text{ (mol)} \quad \checkmark$$

$$n(\text{CH}_3\text{COOH}) \text{ in } 250 \text{ cm}^3 = 10 \times 9.68 = 96.8 \text{ (mol)} \quad \checkmark$$

$$\text{mass of CH}_3\text{COOH in } 250 \text{ cm}^3 = 60 \times 96.8 = 5808 \text{ (g)} \quad \checkmark$$

$$\% \text{ composition to 3 SF} = \frac{5808}{6.50} \times 100 = 89400 \text{ (\%)} \quad \times$$

*Impossible value*

**Using  $25.0 \text{ cm}^3$  (pipette volume) instead of  $24.20 \text{ cm}^3$**

*Up to 4 marks are possible*

$$n(\text{Na}_2\text{CO}_3) = 0.200 \times \frac{25.00}{1000} = 5.00 \times 10^{-3} \text{ (mol)} \quad \times$$

$$n(\text{CH}_3\text{COOH}) \text{ in } 25.0 \text{ cm}^3 = 2 \times 5.00 \times 10^{-3} = 1 \times 10^{-2} \text{ (mol)} \quad \checkmark$$

$$n(\text{CH}_3\text{COOH}) \text{ in } 250 \text{ cm}^3 = 10 \times 1 \times 10^{-2} = 1 \times 10^{-1} \text{ (mol)} \quad \checkmark$$

$$\text{mass of CH}_3\text{COOH in } 250 \text{ cm}^3 = 60 \times 1 \times 10^{-2} = 6.00 \text{ (g)} \quad \checkmark$$

**% composition to 3 SF**

$$= \frac{6.00}{6.50} \times 100 = 92.3 \text{ (\%)} \quad \checkmark$$

*Calculator: 92.30769231*

### Examiner's Comments

Many candidates followed a well drilled method to analyse their titration results:

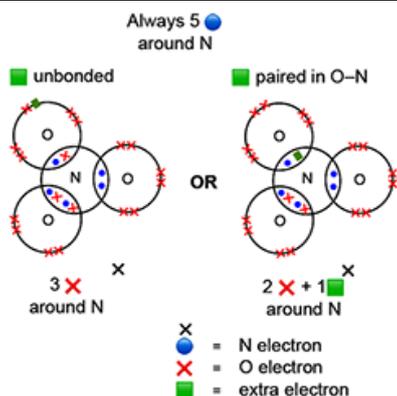
- Moles of  $\text{Na}_2\text{CO}_3$  in the mean titre
- Moles of  $\text{CH}_3\text{COOH}$  in  $25 \text{ cm}^3$
- Scaling  $\times 10$  for moles of  $\text{CH}_3\text{COOH}$  in  $250 \text{ cm}^3$

				<p>Candidates then needed to process their titration results further to determine the percentage composition:</p> <ul style="list-style-type: none"><li>• Mass of <math>\text{CH}_3\text{COOH}</math> in <math>250 \text{ cm}^3</math></li><li>• Percentage composition of <math>\text{CH}_3\text{COOH}</math> to 3 significant figures.</li></ul> <p>Most candidates were able to make some progress through the analysis. Common errors included:</p> <ul style="list-style-type: none"><li>• Not <math>\times 2</math> to obtain the moles of <math>\text{CH}_3\text{COOH}</math></li><li>• Omission of the scaling stage.</li></ul> <p>Some candidates ignored the titration results entirely, instead calculating the number of moles of <math>\text{CH}_3\text{COOH}</math> in 6.5 g of the descaler as 0.1083 mol by assuming that all of the descaler was <math>\text{CH}_3\text{COOH}</math>. This approach was flawed and could not be given any marks.</p> <p>A final comment must be made about the presentation of many of the responses. Numbers had often been sprayed across the page and it could be difficult to see how these related to a cohesive solution. It was often impossible to give marks for such responses.</p> <p>The question discriminated extremely well with some candidates given all 5 marks. Less successful responses demonstrated problems with approaching this type of question and some were given no marks at all.</p> <p>Exemplar 1</p>
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				<p>Give your answer to 3 significant figures.</p> $2420 \text{ cm}^3 \text{ N}_2\text{CO}_3 \text{ @ } 0.2 \text{ mol dm}^{-3}$ $4.84 \times 10^{-3} \text{ mol}$ $9.68 \times 10^{-3} \text{ mol ethanoic acid}$ $\frac{0.5508 \text{ g}}{6.5} \times 100$ $8.935384615$ $8.94\%$ <p>percentage composition by mass = 8.94% [4]</p> <p>Exemplar 1 shows a well-presented response, with the only error being not scaling the moles of CH<sub>3</sub>COOH from 25 to 250 cm<sup>3</sup>. The result is a percentage composition of 8.94 % instead of 89.4%. The clear presentation allowed the examiner to follow how the incorrect response had been obtained. Error carried forward allowed marks can be given for a correct method, giving a total of 4 out of 5 marks.</p>
		<b>Total</b>	<b>8</b>	
4		<p>2 Ba + O<sub>2</sub> → 2 BaO ✓</p> <p>BaO + H<sub>2</sub>O → Ba(OH)<sub>2</sub> ✓</p> <p>Neutralisation  <b>OR</b> acid-base ✓</p>	<b>3</b>	<p><b>ALLOW</b> multiples  <b>IGNORE</b> state symbols, even if incorrect</p> <p><b>ALLOW</b> Ba + H<sub>2</sub>O → BaO + H<sub>2</sub>  (reaction with steam)</p> <p><b>ALLOW</b> other correct equations e.g.  with less reactive metal oxide</p> <p><b><u>Examiner's Comments</u></b></p> <p>Some candidates coped well with this question which was based on the AS part of the specification and gained all three marks. Common errors were for unbalanced equations in reaction 1 or adding H<sub>2</sub> to the product of reaction 2. Reaction 3 was often, incorrectly, considered as: redox, halogenation, nucleophilic substitution or a precipitation reaction</p> <p> <b>Assessment for learning</b></p>

					 <b>OCR support</b>  We have produced a topic exploration pack to assist with learning about the reaction of group 2 elements and their compounds: <a href="http://www.teachcambridge.org.uk">Teach Cambridge (ocr.org.uk)</a>
			<b>Total</b>	<b>3</b>	
5	a		<p><b>H–O–N</b></p> <p>104.5° ✓</p> <p>2 bonded pairs/regions <b>AND</b> 2 lone pairs (around O)  <b>AND</b> lone pairs repel more ✓  <i>Independent of bond angle</i></p> <p><b>O–N–O</b></p> <p>120° ✓</p> <p>3 bonded regions/pairs (around N) ✓  <i>Independent of bond angle</i></p>	<p>4          (AO 1.2)          (AO 2.1)          (AO 1.2)          (AO 2.1)</p>	<p><b>Throughout,</b></p> <ul style="list-style-type: none"> <li>• <b>IGNORE</b> names of shapes (even if wrong)</li> <li>• <b>IGNORE</b> ‘electrons repel’</li> <li>• <b>DO NOT ALLOW</b> ‘atoms repel’</li> </ul> <p>-----</p> <p><b>ALLOW</b> 104–105°</p> <p>lp for lone pair (of electrons)          bp for bonding pair (of electrons)  <b>ALLOW</b> ‘bond’ for ‘bonded pair’</p> <p><b>IGNORE</b> electron density</p> <p><b>ALLOW</b> 115–125°</p> <p>3 bonded areas / environments  <b>ALLOW</b> 3 regions / areas of electron density          3 bonded groups</p> <p><b>ALLOW</b> 2 bonded pairs and 1 double bond  <b>OR</b> 2 bonded pairs and 1 bonded region</p> <p><b><u>Examiner’s Comments</u></b></p> <p>This question required candidates to apply their knowledge and understanding of bond angles and electron pair repulsion in a novel</p>

				<p>context. The best candidates rose to this challenge, securing all four marks for correct bond angles and explanations in terms of the numbers of bonded and lone pairs.</p> <p>The 104.5° and 120° were commonly seen and high scoring candidates provided excellent reasoning. The best explanation for 120° was in terms of three bonding regions and no lone pairs.</p> <p>Lower scoring responses often reasoned that bond angles are determined by lone pairs repelling the atoms, with the role of bonding pairs often being ignored.</p>
	b	i	<p><math>\text{Al}_2\text{O}_3 + 6\text{HNO}_3 \rightarrow 2\text{Al}(\text{NO}_3)_3 + 3\text{H}_2\text{O}</math></p> <p>Any <b>THREE</b> species correct ✓ Correct balanced equation ✓</p> <p><b>DO NOT ALLOW</b> more than 4 species in equation</p>	<p><b>ALLOW</b> multiples</p> <p><b>IGNORE</b> state symbols (even if wrong)</p> <p><b>ALLOW ionic equation</b></p> <p><math>\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}</math> Mark using same criteria</p> <p><b><u>Examiner's Comments</u></b></p> <p>Candidates were required to write a balanced equation for an acid–base reaction. As with Question 4 (b) (ii), candidates needed to write formulae from what should have been common ions, but the formulae for aluminium oxide and aluminium nitrate were often incorrect.</p> <p>In the equation, the reactants and products were sometimes unbalanced, or incorrectly balanced. A common error was H<sub>2</sub> instead of H<sub>2</sub>O as the second product.</p> <p>The question was an excellent discriminator.</p>
		ii		<p>2 (AO 2.1) (AO 2.5)</p> <p><b>NOT REQUIRED</b></p> <ul style="list-style-type: none"> <li>• Charge ('-')</li> <li>• Brackets</li> </ul>



8 Electrons around N as above

**1st mark:** 1 single covalent bond,  
1 dative covalent bond  
1 double bond

**2nd mark:** 8 electrons around each O

**AND** 6 O electrons around each O

Only award 2nd mark if 1st mark awarded  
**NO ECFOR**

- Circles
- N and O symbols

**IGNORE** inner shells

**ALLOW** rotated diagram

In **N=O** bond, **ALLOW** sequence × × •

**ALLOW** non-bonding electrons unpaired

**ALLOW** dot and cross labels swapped:

i.e. • for O electrons and × for N electrons

### Examiner's Comments

Candidates were expected to use the displayed formula of nitric acid to identify that the central N atom had one double bond, one covalent bond and one dative covalent bond. This information then gave the strategy for the dot and cross diagram.

Although virtually all candidates attempted the dot and cross diagram, only about a quarter of candidates could be credited with a meaningful response. The key was to use nitrogen's 5 outer shell electrons and to combine these with 3 oxygen electrons or 2 oxygen electrons and the extra electron. Then the remaining oxygen electrons could be added, taking care that there were 6 around O atom. Finally the extra electron would need to be placed in an octet gap.

Many candidates showed just 4 nitrogen electrons and this approach resulted in no marks. Other common errors included 3 double bonds around the N atom, and a lone pair on the N atom.

This dot and cross diagram discriminated between higher scoring candidates extremely well.

		Total	8	
6		<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If Mass = 318 (mg) award 6 marks</b></p> <hr/> <p><b>Mean titre                    1 mark</b></p> $= \frac{(22.30 + 22.40)}{2} = 22.35(0) \text{ (cm}^3\text{)} \checkmark$ <p><b>Analysis of results 5 marks</b></p> $n(\text{HCl}) = 0.200 \times \frac{22.35}{1000} = 4.47 \times 10^{-3} \text{ (mol)} \checkmark$ $n(\text{NaOH}) \text{ remaining in } 25.0 \text{ cm}^3 = n(\text{HCl})$ $n(\text{NaOH}) \text{ remaining in } 250 \text{ cm}^3 = 4.47 \times 10^{-3} \times 10 = 4.47 \times 10^{-2} \text{ OR } 0.0447 \text{ (mol)} \checkmark$ $n(\text{NaOH}) \text{ that reacted with aspirin} = 0.0500 - 4.47 \times 10^{-2} = 5.30 \times 10^{-3} \text{ (mol)} \checkmark$ $\text{mass in 3 tablets} = 5.30 \times 10^{-3} \times 180 = 0.954 \text{ g} \checkmark$ $\text{Mass in 1 tablet} = 318 \text{ mg} \checkmark$	<p>6 (AO 2.8 ×6)</p>	<p><b>FULL ANNOTATIONS MUST BE USED</b></p> <hr/> <p><b>Common error:</b>  Incorrect mean from all 3 titres = 22.6 cm<sup>3</sup></p> <p><b>CHECK BELOW TITRATION TABLE</b></p> <p><b>Use ECF throughout</b>  Intermediate values for working to <b>at least 3 SF.</b></p> <p><b>ALLOW</b> scaling for 1 aspirin tablet early in calc, e.g. for final 2 marks:  <math>n(\text{aspirin}) \text{ in 1 tablet} = \frac{5.30 \times 10^{-3}}{3} = 1.77 \dots \times 10^{-3} \text{ (mol)} \checkmark</math>  Mass in 1 tablet = <math>1.77 \dots \checkmark 10^{-3} \times 180 = 0.318 \text{ g} = 318 \text{ mg} \checkmark</math></p> <p><b>COMMON ERRORS:</b>  <i>No scaling × 10</i></p> $0.05 - 4.47 \times 10^{-3} \rightarrow 4.553 \times 10^{-2} \checkmark$ $4.553 \times 10^{-2} \times 180 \rightarrow 8.1954 \text{ g in 3 tablets} \checkmark$ $\rightarrow \mathbf{2731.8/2732/2730 \text{ mg in 1 tablet} \checkmark} \quad \mathbf{5 \text{ marks}}$ <hr/> <p><i>No scaling × 10 before subtraction but scaling after 4 marks</i></p> $0.05 - 4.47 \times 10^{-3} \rightarrow 4.553 \times 10^{-2} \checkmark$ $4.553 \times 10^{-2} \times 10 \times 180 \rightarrow 81954 \text{ g in 3 tablets} \mathbf{X}$ $\rightarrow \mathbf{27318 / 27320 / 27300 \text{ mg in 1 tablet} \checkmark}$ <hr/> <p><i>No subtraction from 0.05                    5 marks</i></p>

				<p>→ <math>4.47 \times 10^{-2} \times 180 \rightarrow 8.046 \rightarrow</math>  <b>2682/2680 mg</b> in 1 tablet</p> <hr/> <p><i>Omitting initial titration calculation</i> <span style="float: right;">2 marks</span></p> <p><math>0.05 \times 180 \rightarrow 9 \text{ g in 3 tablets } \checkmark \rightarrow</math>  <b>3000 mg</b> in 1 tablet <math>\checkmark</math></p> <hr/> <p><i>Mean of 22.60 (use of all 3 titres)</i> <span style="float: right;">5 marks</span></p> <p>Mean = <math>67.8/3 = 22.60</math> <del>X</del> → <math>4.52 \times 10^{-3} \checkmark \times 10 \rightarrow 4.52 \times 10^{-2} \checkmark</math>  <math>0.05 - 4.52 \times 10^{-2} \rightarrow 4.80 \times 10^{-3} \checkmark</math>  <math>4.80 \times 10^{-3} \times 180 \rightarrow 0.864 \text{ g in 3 tablets } \checkmark</math>  → <b>288 mg</b> in 1 tablet <math>\checkmark</math></p> <p><b><u>Examiner's Comments</u></b></p> <p>Compared with the application based Question 4, candidates answered this stock titration calculation well. Almost all candidates determined that the mean titre was <math>22.35 \text{ cm}^3</math> and went on to calculate the number of moles of HCl as <math>4.47 \times 10^{-3} \text{ mol}</math>. Most scaled this value by 10 to determine the moles in <math>250 \text{ cm}^3</math>.</p> <p>Most candidates then used the initial moles of HCl to determine the moles of aspirin in the 3 tablets as <math>5.30 \times 10^{-3} \text{ moles}</math>. A significant number omitted this stage but they were able to be credited for the next stage of calculation using a correct method. Consequently over half the candidates were awarded 5 or 6 marks for this stock calculation.</p>	
			<b>Total</b>	<b>6</b>	
7	a	i	$\text{SrCO}_3 + 2\text{HNO}_3 \rightarrow \text{Sr}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$ $\checkmark$	1 (AO 2.6)	<b>IGNORE</b> state symbols  <b>DO NOT ALLOW</b> $\text{H}_2\text{CO}_3$ for $\text{H}_2\text{O} +$

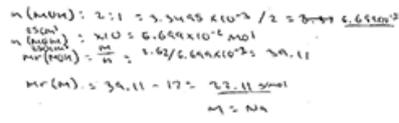
				<p>CO<sub>2</sub> (question states that a gas was produced)</p> <p><b>ALLOW</b> multiples</p> <p><b><u>Examiner's Comments</u></b></p> <p>This was often answered correctly but some candidates gave the incorrect formulae for Sr(NO<sub>3</sub>)<sub>2</sub> and either no other product or H<sub>2</sub> gas.</p>
	ii	<p>M<sub>r</sub> of SrCO<sub>3</sub> is different to M<sub>r</sub> CaCO<sub>3</sub> / moles SrCO<sub>3</sub> are different to moles CaCO<sub>3</sub> ✓</p> <p>M<sub>r</sub> of SrCO<sub>3</sub> &gt; M<sub>r</sub> CaCO<sub>3</sub> / moles SrCO<sub>3</sub> &lt; moles CaCO<sub>3</sub></p> <p><b>AND</b></p> <p><b>More</b> moles/volume gas (from CaCO<sub>3</sub>) ✓</p>	<p>2 (AO 3.1 × 1)</p> <p>(AO 3.2 × 1)</p>	<p><b>ALLOW</b> ORA</p> <p><b>ALLOW</b>  <math>n(\text{SrCO}_3) = (1.00 \div 147.6) = 6.78 \times 10^{-3} \text{ (mol)}</math>  <b>AND</b> <math>n(\text{CaCO}_3) = (1.00 \div 100.1) = 9.99 \times 10^{-3} \text{ (mol)}</math></p> <p>For the 2nd mark, we are assessing the idea of the greater moles of carbonate produces more gas.</p> <p>Subsumes first mark</p> <p><b>ALLOW</b>  <math>n(\text{SrCO}_3) = (1.00 \div 147.6) = 6.78 \times 10^{-3} \text{ (mol)}</math>  <b>AND</b>  <math>n(\text{CaCO}_3) = (1.00 \div 100.1) = 9.99 \times 10^{-3} \text{ (mol)}</math>  <b>AND</b>  Calculated values (CO<sub>2</sub>) 163 cm<sup>3</sup> <b>AND</b> 240 cm<sup>3</sup></p> <p><b><u>Examiner's Comments</u></b></p> <p>Only a few candidates used the mass value given in the question to link the number of moles of the group 2 metal carbonate and the number of moles, and hence volume, of gas produced.</p> <p> <b>Misconception</b></p> <p>Many candidates answered this question in terms of the relative reactivity, or solubility of Ca and Sr</p>

					and then continuing by explaining their respective ionisation energies.
b	i	$\text{Mg} + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2 \checkmark$		1 (AO 2.6)	<p><b>ALLOW</b> multiples  <b>ALLOW</b> <math>\text{Mg}^{+2}</math>  <b>IGNORE</b> state symbols</p> <p><b><u>Examiner's Comments</u></b></p> <p>Ionic equations still present candidates with a challenge. A few candidates scored the mark but many candidates gave a full equation or one that contained a mismatch of spectator ions as well as the correct ions.</p>
	ii	<p>HCl is a strong acid/completely dissociates  <b>AND</b>  <math>\text{CH}_3\text{COOH}</math> is a weak acid/partially dissociates <math>\checkmark</math></p> <p>Greater <math>\text{H}^+</math> concentration in HCl/  <b>AND</b>            More frequent collisions / faster rate of reaction <math>\checkmark</math></p> <p>More <math>\text{CH}_3\text{COOH}</math> dissociates until same number of moles of <math>\text{H}^+</math> released  <b>OR</b>            same total moles <math>\text{H}^+</math> produced (by the end)  <b>OR</b>            (Both acids are monobasic) and have the same number of moles of acid <math>\checkmark</math></p>		3 (AO 1.1 x 1) (AO 3.1 x 2)	<p><b>IGNORE</b> HCl is a stronger acid than ethanoic acid.</p> <p><b>ALLOW</b> ORA</p> <p><b>DO NOT ALLOW</b> dibasic/tribasic</p> <p><b><u>Examiner's Comments</u></b></p> <p>This question proved challenging for the candidates to identify the three ideas: Those of comparing acids, comparing moles and comparing rates. Very few candidates were able to score the 3 marks. Most candidates recognised the different strength of the two acids, but some only used comparative language. Some linked the moles of acid used to the volume of gas produced but many simply restated the same volume and concentration which is given within the question. Only a few candidates linked the higher initial <math>[\text{H}^+]</math> in HCl to the increased rate through more frequent collisions. A common issue was describing the rate of dissociation rather than the <math>[\text{H}^+]</math> present in determining the rate of the reactions or mentioning that it dissociates more</p>

					but not linking this to the H <sup>+</sup> concentration.
			<b>Total</b>	<b>7</b>	
8			<b>C</b>	1 (AO 2.2)	<b><u>Examiner's Comments</u></b> This question was answered correctly for the most part with the answer being C.
			<b>Total</b>	<b>1</b>	
9	a		(Strong acid) completely/fully dissociates/ionises ✓	1 (AO1.1)	<b>DO NOT ALLOW</b> easily dissociates <b>ALLOW ALL</b> H <sup>+</sup> ions are released <b><u>Examiner's Comments</u></b> Most candidates knew that a strong acid completely dissociates. Only the lower-attaining candidates responded in terms of a low pH.
	b	i	$\text{CuO} + 2\text{HCl} \rightarrow \text{CuCl}_2 + \text{H}_2\text{O} \checkmark$	1 (AO2.6)	<b>ALLOW</b> multiples <b>IGNORE</b> state symbols <b>IGNORE</b> charges, even if wrong <b><u>Examiner's Comments</u></b> This question required candidates to recognise the reaction as being 'acid-base' and to interpret a formula from a name containing a Roman numeral. Candidates identifying the formula of copper(II) oxide as CuO were normally able to complete the equation. A reasonably large number identified the copper compounds as CuO <sub>2</sub> and CuCl. Overall, most candidates produced a correct equation.
		ii	$(\text{NH}_4)_2\text{CO}_3 + 2\text{HNO}_3 \rightarrow 2\text{NH}_4\text{NO}_3 + \text{CO}_2 + \text{H}_2\text{O}$ Any 4 formulae correct ✓ All 5 formulae correct and balanced ✓	2 (AO2.6 ×2)	<b>ALLOW</b> multiples <b>IGNORE</b> state symbols <b>IGNORE</b> charges, even if wrong <b>ALLOW</b> H <sub>2</sub> CO <sub>3</sub> for CO <sub>2</sub> + H <sub>2</sub> O <i>Counts as 2 formulae for marking criteria</i> <b><u>Examiner's Comments</u></b> This item was much more demanding than the equation in 22(b)(i) and was often answered incorrectly. Most were unable to work out the formula of the

					two ammonium compounds, with NH <sub>3</sub> often shown instead of NH <sub>4</sub> . A mark was available for 4 of the 5 formulae being correct but comparatively few were able to construct the correct balanced equation. Candidates are expected to know the formula and charge of ammonium and carbonate ions and the common acids (sulfuric, hydrochloric and nitric) and these are clearly listed in the specification.												
c	i	Volumetric flask ✓		1 (AO1.2)	<p><b>ALLOW</b> graduated flask</p> <p><b>Examiner's Comments</b></p> <p>Most candidates recognised that a volumetric flask is used to accurately prepare volumes of solutions. A common error was a conical flask, perhaps by not reading the information clearly and giving the name of the flask used in the titration itself.</p>												
	ii	<table border="1" data-bbox="225 1149 750 1406"> <tbody> <tr> <td>Final reading/cm<sup>3</sup></td> <td>20.25</td> <td>40.85</td> <td>25.85</td> </tr> <tr> <td>Initial reading/cm<sup>3</sup></td> <td>0.00</td> <td>20.25</td> <td>5.50</td> </tr> <tr> <td>Titre/cm<sup>3</sup></td> <td><b>20.25</b></td> <td><b>20.60</b></td> <td><b>20.35</b></td> </tr> </tbody> </table> <p>All 3 titres correct to 2 DP ✓</p>	Final reading/cm <sup>3</sup>	20.25	40.85	25.85	Initial reading/cm <sup>3</sup>	0.00	20.25	5.50	Titre/cm <sup>3</sup>	<b>20.25</b>	<b>20.60</b>	<b>20.35</b>		1 (AO1.2)	<p><b>DO NOT ALLOW</b> 1 DP, e.g. 20.6 instead of 20.60</p> <p><b>Examiner's Comments</b></p> <p>Most candidates were able to work out these simple subtractions. Candidates were told that the titration readings were read to the nearest 0.05 cm<sup>3</sup>, requiring titres to be shown to two decimal places, which includes a '0'. The middle titre is therefore 20.60 cm<sup>3</sup> and not 20.6 cm<sup>3</sup>, which continues to be the commonest error seen.</p>
Final reading/cm <sup>3</sup>	20.25	40.85	25.85														
Initial reading/cm <sup>3</sup>	0.00	20.25	5.50														
Titre/cm <sup>3</sup>	<b>20.25</b>	<b>20.60</b>	<b>20.35</b>														
	iii	<p>mean titre = <math>\frac{20.25 + 20.35}{2} = 20.30 \text{ (cm}^3\text{)} \checkmark</math></p> <p><i>i.e. using concordant (consistent) titres</i></p>		1 (AO2.8)	<p><b>ALLOW</b> 20.3</p> <p><i>Missing '0' already penalised in c(ii)</i></p> <p><b>DO NOT ALLOW</b> mean of all three titres,</p> <p><i>i.e. <math>\frac{20.25 + 20.60 + 20.35}{3} = 20.40</math></i></p> <p><b>Examiner's Comments</b></p> <p>Candidates are expected to use only</p>												

				<p>concordant titres when working out the mean titre and the middle titre of 20.60 cm<sup>3</sup> should be rejected. Most candidates did this to produce 20.30 cm<sup>3</sup> as their mean titre. Predictably, the commonest error was to use all three titres to produce the incorrect mean of 20.40 cm<sup>3</sup>.</p>
		iv	<p> <math>n(\text{H}_2\text{SO}_4) = 0.165 \times \frac{20.30}{1000} = 3.5 \times 10^{-3} \text{ (mol)}</math>  <math>\checkmark</math>  <math>n(\text{MOH}) \text{ in } 25.0 \text{ cm}^3 = 2 \times 3.35 \times 10^{-3}</math>  <math>= 6.70 \times 10^{-3} \text{ (mol)}</math>  <math>\checkmark</math>  <math>n(\text{MOH}) \text{ in } 250.0 \text{ cm}^3 = 10 \times 6.70 \times 10^{-3}</math>  <math>= 6.70 \times 10^{-2} \text{ (mol)}</math>  <math>\checkmark</math>  <math>A_r \text{ of } \mathbf{M} = \frac{2.62}{6.70 \times 10^{-2}} \times 10^{-2} = 39.1 \text{ AND } \mathbf{M} =</math>  potassium/K <math>\checkmark</math> </p>	<p><b>ALLOW ECF</b> throughout and from incorrect concordant titres from <b>22c(iii)</b></p> <p>Calculator value = <math>3.3495 \times 10^{-3}</math></p> <p>Calculator value = <math>6.699 \times 10^{-3}</math></p> <p>Calculator value = <math>6.699 \times 10^{-2}</math></p> <p>By <b>ECF</b>, <b>ALLOW Group 1</b> metal nearest to calculated value of <math>A_r</math></p> <p><b>COMMON ERRORS</b></p> <p><b>Use of 20.4 from mean of all 3 titres ALL 4 MARKS</b></p> <p> <math>n(\text{H}_2\text{SO}_4) = 0.165 \times \frac{20.4}{1000} = 3.366 \times 10^{-3} \text{ (mol)}</math> <math>\checkmark</math> from <b>(c)(iii)</b>  <math>n(\text{MOH}) \text{ in } 25.0 \text{ cm}^3 = 2 \times 3.366 \times 10^{-3}</math>  <math>= 6.732 \times 10^{-3} \text{ (mol)}</math> <math>\checkmark</math>  <math>n(\text{MOH}) \text{ in } 250.0 \text{ cm}^3 = 10 \times 6.732 \times 10^{-3}</math>  <math>= 6.732 \times 10^{-2} \text{ (mol)}</math> <math>\checkmark</math>  <math>A_r \text{ of } \mathbf{M} = \frac{2.62}{6.732 \times 10^{-2}} = 38.9 \dots</math> <b>OR 39</b>  <b>AND M = K</b> <math>\checkmark</math>  <b>IF</b> <math>\times 10</math> is absent, <math>A_r = 389</math> <b>AND M = Cs OR Fr</b> </p> <p><b>Use of 25.0 (wrong volume) for <math>n(\text{H}_2\text{SO}_4)</math></b></p> <p> <math>n(\text{H}_2\text{SO}_4) = 0.165 \times \frac{25}{1000} = 4.125 \times 10^{-3} \text{ (mol)}</math> <b>X</b>  <math>n(\text{MOH}) \text{ in } 25.0 \text{ cm}^3 = 2 \times 4.125 \times 10^{-3}</math>  <math>= 8.25 \times 10^{-3} \text{ (mol)}</math> <math>\checkmark</math>  <math>n(\text{MOH}) \text{ in } 250.0 \text{ cm}^3 = 10 \times 8.25 \times 10^{-3}</math> </p>

				<p><math>= 8.25 \times 10^{-2} \text{ (mol) } \checkmark</math></p> <p><math>A_r \text{ of M} = \frac{2.62}{8.25 \times 10^{-2}} = 31.75 \dots \text{AND M} = \text{K} \checkmark</math></p> <p><b>IF</b> <math>\times 10</math> is absent, <math>A_r = 317.5</math> <b>AND M</b> = Cs <b>OR</b> Fr</p> <p><b><u>Examiner's Comments</u></b></p> <p>Many candidates followed a well drilled method to identify the unknown metal M as potassium:</p> <ul style="list-style-type: none"> <li>• Moles of <math>\text{H}_2\text{SO}_4</math> in the mean titre</li> <li>• Moles of KOH in <math>25 \text{ cm}^3</math></li> <li>• Scaling <math>\times 10</math> for moles of KOH in <math>250 \text{ cm}^3</math></li> <li>• Molar mass of the metal as 39.11 and identified as K.</li> </ul> <p>A number of candidates omitted the scaling stage to obtain a molar mass of 391.1. By ECF, the 'correct' identity would be caesium or francium. Some candidates then 'fiddled' their response, dividing by 10 to 'identify' the metal as K. This incorrect approach was not credited.</p> <p>Exemplar 2</p>  <p>A common error, illustrated in Exemplar 2, was for candidates to calculate 39.11 but to think that this was the mass of MOH and not M. They then subtracted 17 (for OH) from 39.11 to obtain a response of 22.11 and identified M as sodium instead of potassium.</p> <p>This error probably stems from candidates either not reading the question closely enough or confusion about the mole concept.</p>
		<b>Total</b>	<b>11</b>	

10		<b>D</b>	1(AO1.1)	<p><b>Examiner's Comments</b></p> <p>Candidates were less successful with this question than Questions 1 and 2, and it appeared as if many candidates did not recognise that ammonia was an alkali. Most candidates rejected A but a significant number selected C, suggesting that they did not recognise HNO<sub>3</sub> as an acid or confused HNO<sub>3</sub> with NH<sub>3</sub>.</p>			
		<b>Total</b>	<b>1</b>				
11	i	<p><b>Titres</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 5px;">22.75</td> <td style="padding: 5px;">22.45</td> <td style="padding: 5px; text-align: center;"><b>22.70</b></td> <td style="padding: 5px;">22.55</td> </tr> </table> <p style="text-align: right; margin-right: 20px;">✓</p> <p><b>Mean titre</b></p> $\frac{22.45 + 22.55}{2} = 22.5(0) \text{ (cm}^3\text{)} \checkmark$	22.75	22.45	<b>22.70</b>	22.55	<p style="text-align: center;">2 (AO1.2×2)</p> <p><b>2 DP essential</b> i.e. last 0 for 22.70</p> <p><b>DO NOT ALLOW</b> use of trial titre.</p> <p><b>Examiner's Comments</b></p> <p>Almost all candidates calculated the titres correctly, but a significant number were penalised for recording 22.70 as 22.7. A significant number also used this result and the trial titre to derive their mean value. There were also very small numbers of candidates who used all 4, or all of titres 1, 2 and 3, to calculate their mean.</p> <p><b>OCR support</b></p> <p style="text-align: center;"></p> <p>Links to the legacy coursework tasks and PAG practice question sets can be found on OCR Interchange. Exam hints for students can be found at: <a href="https://www.ocr.org.uk/Images/592305-exam-hints-for-students.pdf">https://www.ocr.org.uk/Images/592305-exam-hints-for-students.pdf</a>.</p>
22.75	22.45	<b>22.70</b>	22.55				
	ii	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 498 mg award 5 marks</p> <p>-----</p> <p><b>Number of moles of KOH in titre</b></p> $= 0.0600 \times \frac{22.50}{1000} \text{ OR } 1.35 \times 10^{-3} \text{ (mol)} \checkmark$ <p><b>Number of moles of acid in 10 cm<sup>3</sup></b></p> $= \frac{1.35 \times 10^{-3}}{2} \text{ OR } 6.75 \times 10^{-4} \text{ (mol)} \checkmark$	<p style="text-align: center;">5 (AO2.8×3) (AO3.1) (AO3.2)</p> <p><b>ALLOW ECF</b> from incorrect titre in 19 (a) (i)</p> <p><b>ALLOW ECF</b> throughout <b>TAKE CARE: values shown may be truncated calculator values.</b></p> <p>Steps can be calculated in any order which will change the intermediate answers. Marks are for the processing of the data.</p> <p><b>ALLOW 3SF</b> up to calculated value</p>				

**Number of moles of acid in 250 cm<sup>3</sup>**  
 $= 6.75 \times 10^{-4} \times 25$  **OR**  $0.016875$  (mol) ✓

**Mass of acid in 4 tablets**  
 $= 0.016875 \times 118$  **OR**  $1.99125$  (g) ✓

**Mass in one tablet AND mg conversion**  
 (i.e. divide by 4 **AND** x 1000)  
 $= \frac{1.99 \times 10^3}{4} = 498$  (mg)✓

**Answer must be to 3SF**

throughout **BUT** ignore trailing zeros on intermediate values

**IGNORE** rounding errors past **3SF**

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**Common errors**

**5 marks**

503 mg (use of 22.725 cm<sup>3</sup>)

**4 marks** 996mg (no divided by 2)

19.9mg (no volume conversion i.e. x 25)

**Examiner's Comments**

Candidates made good progress with this calculation, many gaining 4 or 5 marks, including error carried forward from incorrect titres. Common errors included, in various combinations: not converting the final answer into mg, not converting volume to dm<sup>3</sup>, missed ratio, multiplying the moles in 10cm<sup>3</sup> acid by 10 instead of 25 and/or wrong Mr. Responses to Question 19 (a) (ii) often featured rows of figures and random sums without a single word about what the figures, or sums, were set to calculate. Candidates should remember to provide written indications of what it is they are working out – presenting the calculations without any annotations can make it harder for error carried forward marks to be given if there is an error in their calculation.

**Exemplar 1**

$$\begin{aligned}
 n(\text{OH}^-) &= \frac{10}{1000} \times 0.01 = 6 \times 10^{-4} \text{ moles} \\
 n(\text{succinic acid}) &= 6 \times 10^{-4} / 2 = 3 \times 10^{-4} \text{ moles} \\
 \text{mass of succinic acid in } 250 \text{ cm}^3 &= 3 \times 10^{-4} \times 25 = 7.5 \times 10^{-3} \\
 \text{mass of 4 tablets} &= 7.5 \times 10^{-3} \times 118 = 0.885 \text{ g} \\
 \text{mass of 1 tablet} &= \frac{0.885}{4} = 0.22125 \text{ g} = 0.221 \text{ g (3sf)} \\
 &= 0.22125 \times 1000 = 221.25 \text{ mg} \\
 \text{mass} &= 221 \text{ mg (3sf)}
 \end{aligned}$$

The exemplar here shows a good use of annotation. There is a clear indication of the mathematical process so that the error carried forward is easily identified and the candidate gains the method marks

			Total	7	
12	i	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> If answer = 731(g) award 3 marks</p> <p>----- -----</p> <p><b>n(Z)</b></p> $n(\text{Ca}_3\text{NH}_4(\text{NO}_3)_{11}\cdot 10\text{H}_2\text{O}) = \frac{1500}{1080.5} \text{ OR } 1.388246\dots$ <p>✓</p> <p><b>Mass of limestone</b></p> $n(\text{CaCO}_3) = 1.388246\dots \times 5 \text{ OR } 6.94123\dots$ <p><b>AND</b></p> $\text{mass CaCO}_3 = 6.94123\dots \times 100.1 \text{ OR } 694.8 \text{ g } \checkmark$ $\text{mass limestone} = \frac{694.8 \times 100}{95.0} = 731 \text{ g } (3\text{SF}) \checkmark$	3 (AO2.6×3)	<p><b>ALLOW ECF throughout</b> <b>ALLOW</b> calculation process in any order. <b>IGNORE</b> rounding errors past <b>3SF</b></p> <p><b>DO NOT ALLOW</b> 100 for <math>M_r</math> of <math>\text{CaCO}_3</math></p> <p><b>Common errors</b> <b>2 marks</b></p> <p>146g no x 5 for moles of <math>\text{CaCO}_3</math> 660g use of 95.0/100 29.3g divide by 5 rather than x5</p> <p><b><u>Examiner's Comments</u></b></p> <p>This proved a difficult question for most candidates. Most were able to correctly calculate the moles of fertiliser by converting kg to g. The next step was to deduce that 5 moles of calcium carbonate would be required for each mole of Z and multiply by 5, rather than the common error of dividing by 5. Few candidates were able to multiply by 100/95, to account for the impurities in limestone, with many multiplying by 95/100.</p>	
	ii	$\text{Mg}_3\text{Ca}(\text{CO}_3)_4 (\text{s}) + 8\text{HCl}(\text{aq}) \rightarrow$ $3\text{MgCl}_2(\text{aq}) + \text{CaCl}_2(\text{aq}) + 4\text{H}_2\text{O}(\text{l}) + 4\text{CO}_2(\text{g})$ <p>Correct formulae ✓</p> <p>Balanced <b>AND</b> state symbols ✓</p>	2 (AO2.6×2)	<p><b>ALLOW</b> multiples</p> <p><b>M2</b> dependent on <b>M1</b></p> <p><b>IGNORE</b> incorrect state symbol for <math>\text{Mg}_3\text{Ca}(\text{CO}_3)_4</math></p> <p><b><u>Examiner's Comments</u></b></p> <p>This was another very challenging question using an unfamiliar mineral. Most candidates identified a formula of salts containing both magnesium and</p>	

					calcium, or carbonates of the separate elements. Only the most successful candidates were able to give the correct formula. Common errors, for those who solved the formulae, were the use of "4"HCl in balancing and the absence of state symbols.
			<b>Total</b>	<b>5</b>	
13	a	i	(Acid) releases H <sup>+</sup> ions/ H <sup>+</sup> donor ✓	1 (AO1.1)	<p><b>ALLOW H<sup>+</sup> OR</b> proton</p> <p><b><u>Examiner's Comments</u></b></p> <p>Most candidates scored this mark. Some candidates referred to acids having or containing H<sup>+</sup> ions rather than indicating that H<sup>+</sup> ions are donated or released. A small number of candidates gave simplistic responses in terms of pH only.</p>
		ii	(weak acid) partially dissociates/ionises ✓	1 (AO1.1)	<p><b>IGNORE</b> vague responses that do not imply a number, e.g.</p> <ul style="list-style-type: none"> <li>• poor proton donor</li> </ul> <p><b>IGNORE</b> 'doesn't easily dissociate'</p> <p><b>IGNORE</b> 'strong acid completely dissociates'</p> <p><b><u>Examiner's Comments</u></b></p> <p>Again, this was well answered by most candidates. A few candidates gave responses in terms of pH or indicated that there were more OH<sup>-</sup> ions present.</p> <p> <b>Misconception</b></p> <p>Some candidates described a solution with a low concentration of H<sup>+</sup> ions, demonstrating a confusion between concepts of weak and dilute in reference to acids. Visual picture cards can be very helpful in assessing understanding of these concepts. This</p>



				Some had errors which lead to values which weren't concordant – this should be a flag to students that they have made a mistake.
		ii	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 7.(00) award 5 marks</b></p> <hr/> <p>-</p> <p><math>n(\text{NaOH})</math></p> $= \frac{27.35 \times 0.800}{1000} = 0.02188 \checkmark$ <p><math>n(\text{A})</math> in 25.0 cm<sup>3</sup></p> $= \frac{0.02188}{3} = 0.00729(33) \checkmark$ <p><math>n(\text{A})</math> in 250 cm<sup>3</sup></p> $= 10 \times 0.00729(33) = 0.0729(33) \checkmark$ <p>mass citric acid in 250 cm<sup>3</sup></p> $= 0.0729 \times 192 = 14.(0032) \text{ (g)} \checkmark$ <p>mass citric acid in one lime</p> $= \frac{14.0}{2} = 7.(00) \text{ (g)} \checkmark$	<p><b>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</b></p> <hr/> <p>-</p> <p>ALLOW ECF from incorrect titre calculated in 1(b)(i)  Throughout:  <b>ALLOW 3 SF</b> or more, correctly rounded  e.g. <math>n(\text{NaOH}) = 0.0219</math> for 0.02188</p> <p><b>ALLOW ECF</b> from incorrect <math>n(\text{NaOH})</math></p> <p><b>ALLOW ECF</b> for all subsequent steps</p> <p>From <math>n(\text{NaOH}) = 0.0219</math>,  <math>n(\text{A}) = 0.073(0)</math>  <i>mass citric acid</i> = 14(.016)  <i>mass in 1 lime</i> = 7(.008)</p> <p>5  (AO 2.8  ×4)  (AO 2.4)</p> <p><b><u>Examiner's Comments</u></b></p> <p>Most candidates managed to gain at least 1 mark for this question. The most common mark lost was for not multiplying by 10, having missed that only 25cm<sup>3</sup> of 250 cm<sup>3</sup> citric acid solution was used in the titration. Another mark that was often lost was for not dividing by 2 to find mass in 1 lime rather than the 2 used in experiment. Some candidates used 25cm<sup>3</sup> to calculate their moles of NaOH rather than the titre value from (i).</p> <p>It is vital that candidates are given the opportunity to practice more complex multi-step calculations of this type, with modelling given for lower-attaining candidates. Identifying which information goes with each reactant is vital. All steps in the calculation should</p>

				<p>be separate and clearly labelled to help avoid confusion. Encourage candidates to keep full values in their calculators to avoid intermediate step rounding. When writing down intermediate values, ideally write down the full calculator value or where this is not possible the value must be given to at least 3 significant figures (correctly rounded). It is helpful to the examiner to know if calculator values are used and this could be indicated by using truncated answers followed by ... , for example 0.00729... for n(A).</p> <p><b>Exemplar 1</b></p>  <p>The exemplar shows a response where each step of the calculation is shown clearly. The candidate has also used pictures to aid them, recognising that the NaOH is in the burette and lime juice in the conical flask. All values are identified and there is no intermediate rounding. All 5 marks are given here.</p>
c		<p><b>Action taken to modify method</b> Use half a lime <b>OR</b> Make up lime juice (solution) in 1 dm<sup>3</sup> volumetric flask ✓</p> <p><b>Dilution ratio to justify</b> 4 times less citric acid/lime juice <b>OR</b> NaOH is 4 times more dilute (giving same titre) <b>OR</b> 1:4 ratio for NaOH concentration ✓</p>	<p>2 (AO 3.4 × 2)</p>	<p><b>ALLOW</b> any feasible method that would give a dilution factor of 4</p> <p><b>ALLOW</b> quartered</p> <p><b>Examiner's Comments</b></p> <p>A very challenging question with very few candidates scoring both marks. The response needed a clear indication of how the method would be</p>

				<p>altered and a justification for why this would work. Lots of candidates recognised the need to dilute the citric acid to obtain the correct titre but were not able to give a method of how to do this or any indication of quantities needed. Some candidates said to use a larger volume of NaOH – not recognising that this would be the titre value, e.g. “in order to keep the same titre but lower concentration of NaOH the student should titre more NaOH”. Some gave the method of how to dilute the NaOH or even just said to add water. A few suggested using a higher concentration of lime juice.</p> <p>Candidates need to be given opportunities to plan practical work to fully appreciate the impact that any changes will have (specification 1.1.1).</p> <p> <b>OCR support</b></p> <p>Further information about practical skills assessed on written exams can be found in section 3 of the practical skills handbook - <a href="https://www.ocr.org.uk/Images/208932-chemistry-practical-skills-handbook.pdf">https://www.ocr.org.uk/Images/208932-chemistry-practical-skills-handbook.pdf</a>. If using our suggested practicals, then encourage candidates to answer the extension opportunity questions to help develop a deeper understanding in preparation for written assessments.</p>
			<b>Total</b>	<b>13</b>