

### Unit 6 - Mark scheme

Question number	Answer	Additional guidance	Mark
1(a)(i)	<ul style="list-style-type: none"> <li>(cation) <math>\text{Fe}^{2+} / [\text{Fe}(\text{H}_2\text{O})_6]^{2+}</math></li> </ul>	Ignore names and any state symbols even if incorrect	1

Question number	Answer	Additional guidance	Mark
1(a)(ii)	<ul style="list-style-type: none"> <li>(green precipitate) <math>\text{Fe}(\text{OH})_2 / \text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2</math></li> </ul>	Ignore names and any state symbols even if incorrect	1

Question number	Answer	Additional guidance	Mark
1(a)(iii)	<ul style="list-style-type: none"> <li>iron(III) hydroxide</li> <li>or</li> <li><math>\text{Fe}(\text{OH})_3 / \text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3</math></li> </ul>	Ignore any state symbols even if incorrect Do not award $\text{Fe}_2\text{O}_3$	1

Question number	Answer	Additional guidance	Mark
1(a)(iv)	<ul style="list-style-type: none"> <li>Oxidation</li> </ul>	Allow redox	1

Question number	Answer	Additional guidance	Mark
1(a)(v)	<p>An answer that makes reference to:</p> <ul style="list-style-type: none"> <li>if a precipitate is formed then it may dissolve in excess</li> <li>or</li> <li>the precipitate may be amphoteric and dissolve in excess.</li> </ul>	Allow The formation of the precipitate might be overlooked (if the hydroxide is amphoteric / dissolves)	1

Question number	Answer	Additional guidance	Marks
1(b)(i)	<p>A description that makes reference to:</p> <ul style="list-style-type: none"> <li>• use of (damp) red litmus paper (1)</li> <li>• change from red to blue (shows alkalinity). (1)</li> </ul>	<p>Allow universal indicator paper (Yellow) to blue</p> <p>Do not award testing with HCl(g) or result</p>	2

Question number	Answer	Additional guidance	Marks
1(b)(ii)	<p>A description that makes reference to:</p> <ul style="list-style-type: none"> <li>• use of (conc.) HCl(aq) on a glass rod held in the gas or</li> <li>• use of (conc.) HCl(aq) on a glass stopper held in the gas (1)</li> <li>• formation of white smoke (shows presence of ammonia). (1)</li> </ul>	<p>Do not award adding dilute hydrochloric acid</p> <p>Allow white fumes / white solid Ignore reference to indicator and/or smell Do not award steamy fumes</p>	2

Question number	Answer	Additional guidance	Mark
1(c)(i)	<ul style="list-style-type: none"> <li>• (acid) removes carbonate ions that also give a white precipitate or</li> <li>• prevents other anions forming a white precipitate</li> </ul>	<p>Allow sulfite ions for carbonate ions</p>	1

Question number	Answer	Additional guidance	Mark
1(c)(ii)	Route 1: <ul style="list-style-type: none"> <li>use of mask/fume cupboard and prevent breathing in dust.</li> </ul> or Route 2: <ul style="list-style-type: none"> <li>use of gloves and poison could be irritating to the skin.</li> </ul>	Allow poison could be absorbed by the skin	1

Question number	Answer	Additional guidance	Mark
1(d)	<ul style="list-style-type: none"> <li>Any ratio of <math>\text{Fe}^{2+}</math>, <math>\text{NH}_4^+</math> and <math>\text{SO}_4^{2-}</math> ions that gives a neutral species</li> </ul>	Example formula: $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$ Allow separate formulae: $(\text{NH}_4)_2\text{SO}_4$ and $\text{FeSO}_4$	1

Question number	Answer	Additional guidance	Marks
2(a)	A description that makes reference to: <ul style="list-style-type: none"> <li>addition of Brady's reagent/2,4-dinitrophenylhydrazine (1)</li> <li>formation of orange precipitate. (1)</li> </ul>	Allow 2,4-DNPH/2,4-DNP Colour and state required Allow red/yellow	2

Question number	Answer	Additional guidance	Marks
2(b)	<p>A description of any two of the following tests:</p> <p>Test 1:</p> <ul style="list-style-type: none"> <li>• (warm with) Tollens' reagent/ammoniacal silver nitrate (1)</li> <li>• formation of silver 'mirror' /solid silver/black solid. (1)</li> </ul> <p>or</p> <p>Test 2:</p> <ul style="list-style-type: none"> <li>• (heat with) addition of Fehling's/Benedict's solution (1)</li> <li>• change (from blue solution) to (brick) red precipitate. (1)</li> </ul> <p>or</p> <p>Test 3:</p> <ul style="list-style-type: none"> <li>• (heat with) addition of acidified potassium dichromate(VI) (1)</li> <li>• colour change (of orange) to green. (1)</li> </ul>	<p>Ignore references to spectroscopy</p> <p>Accept description of formation of Tollens' reagent</p> <p>Do not award Fehling's and Benedict's as separate tests</p> <p>Allow acidified dichromate(VI) ions</p> <p>Accept orange to blue</p>	4

Question number	Answer	Additional guidance	Mark
2(c)	<ul style="list-style-type: none"> <li>• (pale) yellow precipitate</li> </ul>	<p>Allow antiseptic smell</p> <p>Ignore name of precipitate</p>	1

Question number	Answer	Additional guidance	Marks
2(d)(i)	<p>A deduction that makes reference to:</p> <ul style="list-style-type: none"> <li>• area ratio of three means three equivalent hydrogens/three hydrogens in the same (chemical) environment (1)</li> <li>• (splitting pattern of a singlet) as there are no hydrogens on the adjacent carbon (1)</li> <li>• hence X is butanone. (1)</li> </ul>	<p>Accept 'proton' for 'hydrogen'</p> <p>Ignore reference to chemical shift</p> <p>Do not award identification unless an attempt at justification is given</p>	3

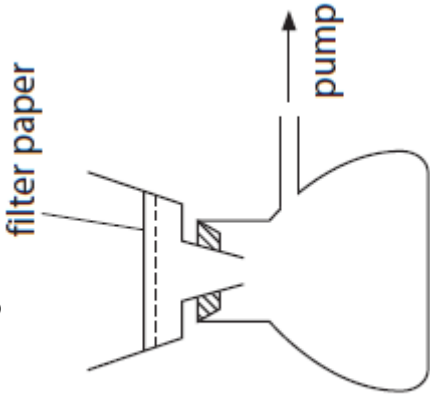
Question number	Answer	Additional guidance	Marks
2(d)(ii)	<p>An explanation that makes reference to:</p> <ul style="list-style-type: none"> <li>• peak is due to TMS/tetramethylsilane (1)</li> <li>• added to calibrate the NMR machine or (1)</li> <li>• added to provide a reference point/a zero point</li> </ul>		2

Question number	Answer	Additional guidance	Mark
3(a)(i)	<ul style="list-style-type: none"> <li>• <math>2\text{Co}^{2+} + \text{H}_2\text{O}_2 + 2\text{H}^+ \rightarrow 2\text{Co}^{3+} + 2\text{H}_2\text{O}</math></li> </ul>	<p>Allow multiples</p> <p>Ignore state symbols even if incorrect</p>	1

Question number	Answer	Additional guidance	Marks
3(a)(ii)	<ul style="list-style-type: none"> <li>• calculation of number of moles of hydrogen peroxide (1)</li> <li>• calculation of <math>M_r</math> of <math>\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}</math> (1)</li> <li>• calculation of number of moles of <math>\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}</math> (1)</li> <li>• use of mol ratio (1)</li> </ul>	Example of calculation: $n(\text{H}_2\text{O}_2) = (0.75 \div 34) = 0.022$ (mol) $M_r = 290.9$ $0.012375$ (mol) Minimum $\text{H}_2\text{O}_2$ needed $= 0.012375 \div 2 = 0.006188$ (mol)	4

Question number	Answer	Additional guidance	Marks
3(a)(iii)	<ul style="list-style-type: none"> <li>• oxygen (gas) (1)</li> <li>• <math>\text{H}_2\text{O}_2 \rightarrow \frac{1}{2}\text{O}_2 + \text{H}_2\text{O}</math> (1)</li> </ul>	Allow multiples Ignore state symbols even if incorrect	2

Question number	Answer	Additional guidance	Marks
3(b)	An answer that makes reference to: <ul style="list-style-type: none"> <li>• the salt is less soluble in ethanol (than water) (1)</li> <li>• solubility decreases with temperature. (1)</li> </ul>		2

Question number	Answer	Additional guidance	Marks
3(c)	<p>A labelled diagram that includes:</p> <ul style="list-style-type: none"> <li>• Buchner/side-armed flask (1)</li> <li>• side-arm connected to pump/water aspirator (1)</li> <li>• funnel with flat filter paper. (1)</li> </ul>	<p>Exemplar diagram:</p>  <p>Do not award fluted filter paper</p>	3

Question number	Answer	Additional guidance	Mark
3(d)(i)	<p>An answer that makes reference to:</p> <ul style="list-style-type: none"> <li>• the smallest amount of product remains in solution (after crystallisation).</li> </ul>	<p>Accept: to form a saturated solution. Ignore: to maximise yield.</p>	1

Question number	Answer	Additional guidance	Mark
3(d)(ii)	<ul style="list-style-type: none"> <li>• insoluble impurities</li> </ul>		1

Question number	Answer	Additional guidance	Mark
3(d)(iii)	<ul style="list-style-type: none"> <li>soluble impurities</li> </ul>		1
Question number	Answer	Additional guidance	Marks
3(d)(iv)	<p>A description including:</p> <ul style="list-style-type: none"> <li>the crystals need to be dried (1)</li> <li>method of drying. (1)</li> </ul>	Examples of acceptable methods: between filter papers or in a desiccator or in a warm oven	2
Question number	Answer	Additional guidance	Mark
3(e)(i)	<p>An answer that makes reference to:</p> <ul style="list-style-type: none"> <li>the crystals are not dry/the mass of the crystals includes ethanol.</li> </ul>		1
Question number	Answer	Additional guidance	Mark
3(e)(ii)	<p>An answer that makes reference to:</p> <ul style="list-style-type: none"> <li>the crystals lose ammonia.</li> </ul>	Allow loss of water loss of ethanol	1
Question Number	Answer	Additional guidance	Mark
4(a)	<ul style="list-style-type: none"> <li>deionised water may be left in the pipette which will dilute the propanoic acid dispensed from it</li> </ul>		1



Question Number	Answer	Additional guidance	Mark
4(b)	<p>A statement that makes reference to:</p> <ul style="list-style-type: none"> <li>no effect (on <math>K_a</math>) and because the colour change to pale pink is important and not the accurate volume added from the burette.</li> </ul>		1
4(c)	<p>too much/excess sodium hydroxide added from the burette</p>	Do not award reference to too much phenolphthalein/indicator added	1
4(d)	<p>calculation of percentage uncertainty</p>	<p>Example of calculation:  <math>\% = ((0.06 \div 25.00) \times 100 =) 0.24\%</math></p>	1
4(e)	<p>A description that makes reference to:</p> <ul style="list-style-type: none"> <li>use of a buffer of known pH.</li> </ul>		1
4(f)	<p>evaluation</p> <p>units and SF</p>	<p>Example of calculation:  <math>K_a = 10^{-\text{pH}}</math>  <math>= 1.2589 \times 10^{-5}</math>  <math>= 1/1.3/1.26 \times 10^{-5} \text{ mol dm}^{-3}</math></p>	2