



Mark Scheme (Unused)

January 2022

Pearson Edexcel International Advanced Level  
In Chemistry (WCH16)  
Paper 01: Practical Skills in Chemistry II

Question number	Answer	Additional guidance	Mark
1(a)	<ul style="list-style-type: none"> <li>X contains a transition metal ion</li> </ul>	Accept X contains iron(II) / $\text{Fe}^{2+}$ / nickel(II) / $\text{Ni}^{2+}$ / chromium(III) / $\text{Cr}^{3+}$ Allow X is a transition metal compound Ignore references to the d block Ignore does not contain $\text{Fe}^{3+}$	1

Question Number	Answer	Additional guidance	Mark
1(b)	<ul style="list-style-type: none"> <li>(cation is) ammonium (ion) / <math>\text{NH}_4^+</math></li> </ul>	Ignore references to the gas being ammonia / $\text{NH}_3$	1

Question number	Answer	Additional guidance	Mark
1(c)(i)	<ul style="list-style-type: none"> <li>observation (1)</li> </ul> <p>inferences</p> <ul style="list-style-type: none"> <li>carbonate / <math>\text{CO}_3^{2-}</math>(1)</li> <li>sulfite / sulfate(IV) / <math>\text{SO}_3^{2-}</math>(1)</li> </ul>	White <b>and</b> precipitate Allow ppt / ppte / solid / crystals for precipitate  Allow any two of hydrogencarbonate / $\text{HCO}_3^-$ hydrogensulfite / hydrogensulfate(IV) / $\text{HSO}_3^-$ hydrogensulfate / $\text{HSO}_4^-$ ethanedioate / oxalate / $\text{C}_2\text{O}_4^{2-}$ If name and formula are given both must be correct	3

Question number	Answer	Additional guidance	Mark
1(c)(ii)	<ul style="list-style-type: none"> <li>no change</li> </ul>	Accept precipitate remains / does not dissolve Allow no reaction / no effervescence / no fizzing / no bubbling	1

Question number	Answer	Additional guidance	Mark
1(c)(iii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>identification of one suitable cation</li> </ul>	chromium(III) / $\text{Cr}^{3+}$ / $\text{Cr}(\text{H}_2\text{O})_6^{3+}$ / $\text{Cr}^{3+}(\text{aq})$ Or nickel(II) / $\text{Ni}^{2+}$ / $\text{Ni}(\text{H}_2\text{O})_6^{2+}$ / $\text{Ni}^{2+}(\text{aq})$ Do not award if oxidation state / charge omitted or incorrect Do not award iron(II) / $\text{Fe}^{2+}$ if name and formula are given both must be correct	1

Question number	Answer	Additional guidance	Mark
1(c)(iv)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li><math>\text{Cr}(\text{OH})_6^{3-}</math></li> </ul>	Ignore name even if incorrect Do not award a nickel complex	1

Question number	Answer	Additional guidance	Mark
1(c)(v)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>identification of the ion by name or formula</li> </ul>	chromate(VI) / $\text{CrO}_4^{2-}$ if name and formula are given both must be correct If oxidation state is given it must be correct	1

Question number	Answer	Additional guidance	Mark
1(c)(vi)	<ul style="list-style-type: none"> <li>identification of the ion by name or formula</li> </ul>	dichromate(VI) / $\text{Cr}_2\text{O}_7^{2-}$ if name and formula are given both must be correct If oxidation state is given it must be correct	1

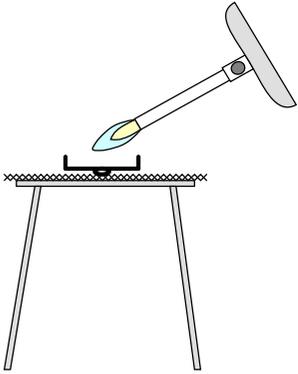
Question number	Answer	Additional guidance	Mark
1(d)	<ul style="list-style-type: none"> <li>identification of the eliminated ion by name or formula (1)</li> <li>justification (1)</li> </ul>	iron(II) / $\text{Fe}^{2+}$ cannot be the cation Or iron(II) hydroxide / $\text{Fe}(\text{OH})_2$ cannot be the precipitate because precipitate would turn brown / reddish-brown Allow iron(III) hydroxide / $\text{Fe}(\text{OH})_3$ would be formed (on standing) Ignore just 'precipitate will be oxidised'	2

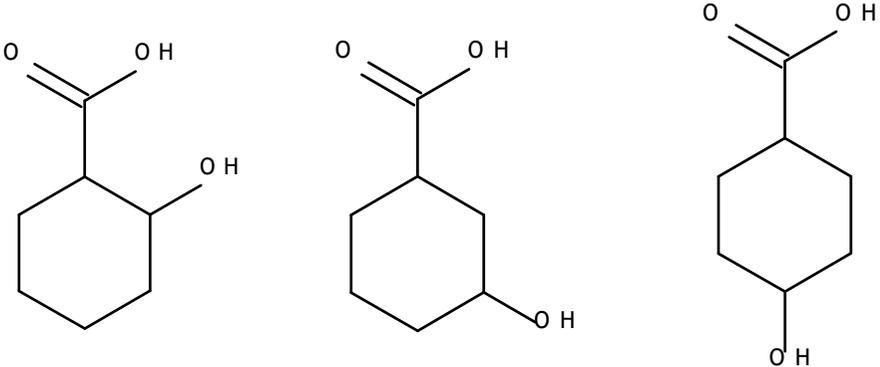
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1(e)	<ul style="list-style-type: none"> <li>balanced-charge formula of suitable compound</li> </ul>	<p>CrNH<sub>4</sub>(SO<sub>4</sub>)<sub>2</sub> / Cr<sub>2</sub>(NH<sub>4</sub>)<sub>2</sub>(SO<sub>4</sub>)<sub>4</sub> / Cr<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>·(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub></p> <p>Allow</p> <p>ions in any order</p> <p>If ion charges are given they must be correct</p> <p>Do not award unless no overall charge</p> <p>Ignore water of crystallisation</p> <p>Allow balanced-charge formula with Fe or Ni instead of Cr as TE on 1(c)(iii)</p>	1

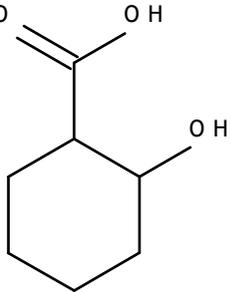
(Total for Question 1= 13 marks)

Question number	Answer	Additional guidance	Mark																																				
2(a)	<p><b>Route 1</b></p> <ul style="list-style-type: none"> <li>calculation of moles of carbon, hydrogen and oxygen</li> <li>division by lowest number of moles</li> <li>simplest whole number ratio of C:H:O <b>and</b> empirical formula</li> <li>use of <math>M_r</math> to deduce molecular formula</li> </ul> <p><b>Route 2</b></p> <ul style="list-style-type: none"> <li>use of molecular ion peak to deduce <math>M_r</math></li> <li>calculation of mass of each element in 1 mol of <b>P</b></li> <li>calculation of moles of each element in 1 mol of <b>P</b></li> <li>statement of molecular formula of <b>P</b></li> </ul>	<p>Example of calculation</p> <table border="1" data-bbox="1283 264 1948 512"> <thead> <tr> <th></th> <th>Carbon</th> <th>Hydrogen</th> <th>Oxygen</th> </tr> </thead> <tbody> <tr> <td>%</td> <td>60.87</td> <td>4.35</td> <td>34.78</td> </tr> <tr> <td>mol</td> <td>60.87/12 = 5.0725</td> <td>4.35/1 = 4.35</td> <td>34.78/16 = 2.1738</td> </tr> <tr> <td>÷2.1738</td> <td>2.3335</td> <td>2.0011</td> <td>1</td> </tr> <tr> <td>Ratio</td> <td>7</td> <td>6</td> <td>3</td> </tr> </tbody> </table> <p><b>and</b></p> <p>(1) (Empirical formula) = <math>C_7H_6O_3</math></p> <p>(1) Molecular ion peak = Empirical formula mass = 138 <b>and</b> molecular formula = <math>C_7H_6O_3</math> or <b>P</b> is <math>C_7H_6O_3</math></p> <p>Or</p> <p>(1) Molecular ion peak = 138 = <math>M_r</math></p> <table border="1" data-bbox="1283 919 1899 1182"> <thead> <tr> <th></th> <th>Carbon</th> <th>Hydrogen</th> <th>Oxygen</th> </tr> </thead> <tbody> <tr> <td>%</td> <td>60.87</td> <td>4.35</td> <td>34.78</td> </tr> <tr> <td>mass /g+</td> <td>0.6087 x 138 = 84.0</td> <td>0.0435 x 138 = 6.003</td> <td>0.3478 x 138 = 48.00</td> </tr> <tr> <td>mol</td> <td>84/12 7</td> <td>6.003/1 = 6</td> <td>48/16 = 3</td> </tr> </tbody> </table> <p>molecular formula = <math>C_7H_6O_3</math> or <b>P</b> is <math>C_7H_6O_3</math></p> <p>(1) Correct answer with no working scores M4 only</p>		Carbon	Hydrogen	Oxygen	%	60.87	4.35	34.78	mol	60.87/12 = 5.0725	4.35/1 = 4.35	34.78/16 = 2.1738	÷2.1738	2.3335	2.0011	1	Ratio	7	6	3		Carbon	Hydrogen	Oxygen	%	60.87	4.35	34.78	mass /g+	0.6087 x 138 = 84.0	0.0435 x 138 = 6.003	0.3478 x 138 = 48.00	mol	84/12 7	6.003/1 = 6	48/16 = 3	4
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2(b)(i)	<p>An answer that explains the significance of</p> <ul style="list-style-type: none"> <li>• effervescence with sodium hydrogencarbonate (1)</li> <li>• no reaction with cold dilute solution of potassium manganate(VII) (1)</li> <li>• reaction with bromine water (1)</li> <li>• smoky flame (1)</li> </ul>	<p>Carboxylic acid group / COOH Allow just 'acid'</p> <p>No C=C / alkene group Ignore reference to oxidation not occurring Do not award other functional groups</p> <p>phenol group Do not award alkene</p> <p>aromatic compound / arene / aryl group Allow benzene ring present Ignore <b>P</b> is unsaturated / has high carbon to hydrogen ratio</p>	4

Question number	Answer	Additional guidance	Mark
2(b)(ii)	<p>An answer that makes reference to</p> <ul style="list-style-type: none"> <li>• the use of a crucible lid</li> <li>• on a tripod and gauze / pipe-clay triangle and ignition from above</li> <li>• use of a Bunsen burner</li> </ul>	<p>(1) Allow other ceramic apparatus e.g. evaporating basin / crucible Do not award use of glassware</p> <p>Allow place on a heat-proof mat</p> <p>(1) Example of diagram which scores 3 marks</p> <p>(1)</p>  <p>Allow for 3 marks</p> <p>Combustion / deflagrating spoon (1)</p> <p>Bunsen burner (1)</p> <p>Non-luminous flame / air-hole open (1)</p> <p>Do not award M2 and M3 for use of lighted splint</p>	3

Question number	Answer	Additional guidance	Mark
2(c)		<p>Three structures correct scores (2)</p> <p>Two structures correct scores (1)</p> <p>Allow any structure that shows the different substituent positions including Kekulé structures and. COOH / CO<sub>2</sub>H</p> <p>Penalise the omission of the delocalised / Kekulé ring once only</p>	2

Question number	Answer	Additional guidance	Mark
2(d)	<p>An answer that makes reference to</p> <ul style="list-style-type: none"> <li>the wavenumber of the circled peak <b>and</b> appreciation that this shows that <b>P</b> has 4 adjacent C-H groups (1)</li> <li>only possible if OH and COOH are on adjacent carbon atoms (1)</li> </ul>	<p>750—760 cm<sup>-1</sup></p> <p>Allow M2 for correct structure selected</p>  <p>or</p> <p>2-hydroxybenzoic acid</p> <p>TE on incorrect wavenumber reading for M2</p>	2

(Total for Question 2= 15 marks)

Question number	Answer	Additional guidance	Mark
3(a)(i)	<p>An answer that makes reference to</p> <ul style="list-style-type: none"> <li>transfer of the (100 cm<sup>3</sup>) solution to a (250 cm<sup>3</sup>) volumetric flask (1)</li> <li>addition of washings / rinsings (1)</li> <li>making up the solution to the mark (with distilled water / dilute sulfuric acid)</li> </ul> <p><b>and</b></p> <p>mixing (1)</p>	<p>Allow graduated / standard /measuring flask</p> <p>Allow 'to the line' / 'to 250 cm<sup>3</sup>' / to <b>bottom</b> of meniscus</p> <p>Allow any indication of mixing e.g. inverting / shaking / swirling</p>	3

Question number	Answer	Additional guidance	Mark
3(a)(ii)	<ul style="list-style-type: none"> <li>(pale) pink</li> </ul>	<p>Ignore reference to solution turning yellow</p> <p>Do not award purple / mauve</p>	1

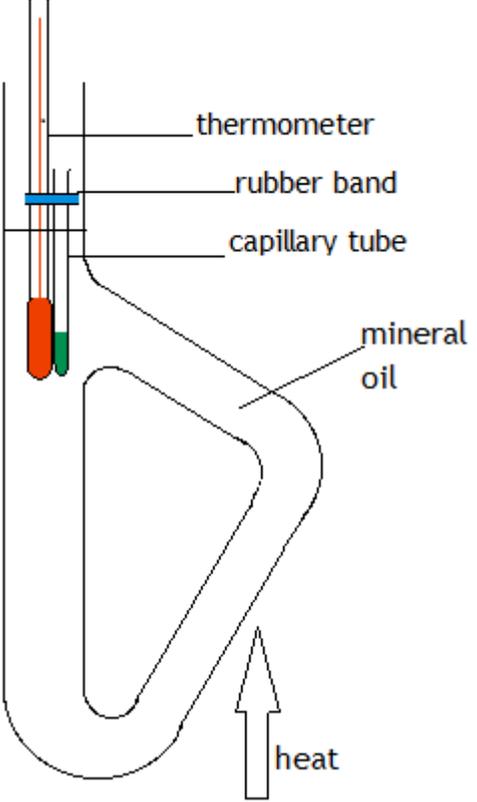
Question number	Answer	Additional guidance	Mark
3(a)(iii)	<ul style="list-style-type: none"> <li>• calculation of amount of <math>\text{MnO}_4^-</math> in the mean titre (1)</li> <li>• calculation of amount of <math>\text{FeC}_2\text{O}_4</math> in <math>25 \text{ cm}^3</math> ( x 5/3) (1)</li> <li>• calculation mass of 1 mol of <math>\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}</math> (1)</li> <li>• calculation of <math>M_r</math> of <math>\text{FeC}_2\text{O}_4</math> <b>and</b> subtraction from mass of 1 mol of <math>\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}</math> (1)</li> <li>• calculation of moles of water (<math>\div 18</math>) <b>and</b> rounding to integer value (1)</li> </ul>	<p>Example of calculation</p> $34.25 \times 0.0195 / 1000$ $= 6.67875 \times 10^{-4} / 0.000667875 \text{ (mol)}$ $6.67875 \times 10^{-4} \times 5/3$ $= 1.11313 \times 10^{-3} / 0.00111313 \text{ (mol)}$ $2.02 \div (1.11313 \times 10^{-3} \times 10) = 181.471 \text{ (g)}$ $M_r (\text{FeC}_2\text{O}_4) = (55.8 + 12 \times 2 + 16 \times 4) = 143.8$ $\text{mass of water} = 181.471 - 143.8 = 37.671 \text{ (g)}$ $37.671 \div 18 = 2.0928$ <p><b>and</b></p> $x = 2$ <p>Accept alternative routes e.g.</p> $\text{mass of FeC}_2\text{O}_4 = 0.00111313 \times 10 \times 143.8$ $= 1.60067$ $\text{mass of water} = 0.419326 \text{ g}$ <p>then calculation of moles and ratio</p> <p>Do not award correct answer with no working TE at each stage Final answer must be an integer</p>	<b>5</b>

Question number	Answer	Additional guidance	Mark
3(b)(i)	<p>An answer that makes reference to</p> <ul style="list-style-type: none"> <li>• identification of a suitable method (1)</li> <li>• identification of the measurements required (1)</li> <li>• identification of a means of converting the experimental measurements into concentrations of manganate(VII) ions (1)</li> </ul>	<p>Example of method</p> <p>Use of a colorimeter / spectrophotometer</p> <p>Measurement of transmittance / absorbance values at various times</p> <p>Use of a calibration curve to obtain concentrations</p> <p>ALLOW</p> <p>Use of a gas syringe / gas collection over water</p> <p>Measurement of gas volumes at various times</p> <p>Use of molar volume and equation to convert volume of CO<sub>2</sub> into amount of manganate(VII)</p> <p>Or</p> <p>Use of mass balance</p> <p>Measurement of mass loss at various times</p> <p>Use of <math>M_r</math> and equation to convert mass of CO<sub>2</sub> into amount of manganate(VII)</p> <p>Do not award sampling methods</p>	3

Question number	Answer	Additional guidance	Mark
3(b)(ii)	<p>An answer that makes reference to</p> <ul style="list-style-type: none"> <li>rate at point <b>A</b> = <math>1 \times 10^{-6} \text{ mol dm}^{-3} \text{ s}^{-1}</math> (1)</li> <li>rate at point <b>B</b> = <math>5.5 \times 10^{-6} \text{ mol dm}^{-3} \text{ s}^{-1}</math> (1)</li> </ul>	<p>Allow <math>9 \times 10^{-7} \text{ — } 1.1 \times 10^{-6} \text{ mol dm}^{-3} \text{ s}^{-1}</math></p> <p>Allow <math>4.5 \text{ — } 6.5 \times 10^{-6} \text{ mol dm}^{-3} \text{ s}^{-1}</math></p> <p>Ignore signs</p> <p>If both values given but outside the specified ranges, units score 1 mark</p> <p>or two <b>tangents</b> and gradient calculations score 1 mark</p> <p>Penalise omission of units once only</p>	2

Question number	Answer	Additional guidance	Mark
3(b)(iii)	<p>An answer that makes reference to</p> <ul style="list-style-type: none"> <li>rate at B is faster than rate at A <b>and</b> appreciation that rate usually slows as the reaction proceeds (1)</li> <li>reaction is auto-catalysed / catalysed by product / <math>\text{Mn}^{2+}</math> (which is produced in the reaction) (1)</li> </ul>		2

(Total for Question 3= 16 marks)

Question number	Answer	Additional guidance	Mark
4(a)	<p>An answer that makes reference to</p> <p><b>M1</b></p> <ul style="list-style-type: none"> <li>sealing the capillary tube (with a Bunsen flame)</li> </ul> <p><b>and followed by</b></p> <p>inserting the solid into the capillary tube (by pushing the tube into the solid and then tapping the tube gently on the bench / rubbing with a milled coin) (1)</p> <p><b>M2</b></p> <ul style="list-style-type: none"> <li>filling the Thiele tube (just higher than the upper arm) with the clear mineral oil (1)</li> </ul> <p><b>M3</b></p> <ul style="list-style-type: none"> <li>use the rubber band to attach the capillary tube to the thermometer</li> </ul> <p><b>and</b></p> <p>so that the bottom of the tube is near the bulb of the thermometer</p> <p><b>and</b></p> <p>place them into the Thiele tube near upper part of arm (1)</p> <p><b>M4</b></p> <ul style="list-style-type: none"> <li>heat the Thiele tube (anywhere) on the <b>side-arm</b> (with the Bunsen burner) (1)</li> </ul> <p><b>M5</b></p> <ul style="list-style-type: none"> <li>note the temperature when the solid just changes into a liquid (1)</li> </ul>	<p><b>M1 to M4</b> may be scored with a labelled diagram.</p>  <p>Labels in diagram: thermometer, rubber band, capillary tube, mineral oil, heat</p> <p>Ignore just 'note melting temperature ' If the mineral oil is used in the beaker only <b>M1, M3</b> and <b>M5</b> may be scored.</p>	5

Question number	Answer	Additional guidance	Mark
4(b)	An answer that makes reference to <ul style="list-style-type: none"> <li>• the impure solid would have a lower melting temperature</li> </ul>	Allow The impure solid would melt gradually / over a (wide) range (whereas the pure solid would melt sharply)	1

**(Total for Question 4= 6 marks)**  
**Total for Question paper = 50 marks**