



# Mark Scheme (Results)

Summer 2021

Pearson International Advanced  
Subsidiary Level  
In Chemistry (WCH13)  
Paper 01: Practical Skills in Chemistry I

Question number	Answer	Additional Guidance	Mark
<b>1(a)(i)</b>	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• identification of material</li> <li>• justification of use</li> </ul>	<p><b>(1)</b> nichrome / nickel-chromium (alloy) / NiCr / platinum / Pt</p> <p>Do not award just “nickel” or “chromium”</p> <p><b>(1)</b> inert / does not react / does not give a flame colour</p> <p>Allow does not react with HCl Allow high melting temperature / does not melt in the flame</p> <p>Ignore does not burn</p>	<b>2</b>

Question number	Answer	Additional Guidance	Mark
1(a)(ii)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• use of hydrochloric acid</li> <li>• description of method</li> <li>• flame colour of sodium</li> <li>• flame colour of potassium</li> </ul>	<p><b>Ignore reference to incorrect wires</b></p> <p><b>(1)</b> Allow any mention of HCl(aq) e.g. cleaning the wire or mixing solid and acid or making a paste/solution</p> <p>Ignore dilute</p> <p>HCl instead of HCl(aq)</p> <p><b>(1)</b> (wire then) dipped in solid / paste / solution <b>and</b> placed in (hot / roaring / colourless / blue-cone) (Bunsen) <b>flame</b></p> <p>Allow salt / compound / substance / paste /sample / solution for 'solid'</p> <p>on / over / under / near / show / above for 'in'</p> <p><b>(1)</b> yellow / gold / golden</p> <p>Allow orange</p> <p>Allow combinations of allowed colours such as yellow-orange</p> <p>Ignore persistent / bright</p> <p><b>(1)</b> Lilac</p> <p>Do not award purple</p> <p>If both correct colours are given without assigning to the correct metal/compound award 1 mark out of the 2.</p> <p>If colours are reversed award 1 mark out of 2.</p>	4

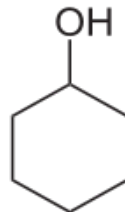
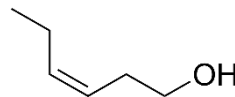

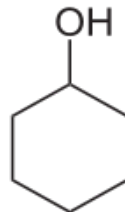
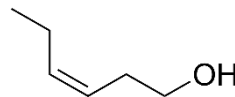

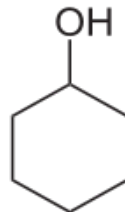
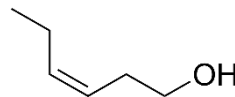

Question number	Answer	Additional Guidance	Mark
1(b)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>test for a sulfate</li> <li>result of test for a sulfate</li> <li>test for a carbonate</li> <li>result of test for a carbonate</li> </ul>	<p>Tests can be in either order.            Penalise unspecified acid once only in the two tests            For both tests the second mark depends on the first mark being scored, or a near miss.</p> <p><b>(1)</b> barium chloride (solution) / <math>\text{BaCl}_2(\text{aq})</math> <b>and</b> hydrochloric acid / <math>\text{HCl}(\text{aq})</math>            or            barium nitrate (solution) / <math>\text{Ba}(\text{NO}_3)_2(\text{aq})</math> and nitric acid / <math>\text{HNO}_3(\text{aq})</math>            Do not award sulfuric acid / <math>\text{H}_2\text{SO}_4</math></p> <p><b>(1)</b> white precipitate            Allow solid / suspension /ppt / ppte</p> <p><b>(1)</b> addition of hydrochloric acid / <math>\text{HCl}(\text{aq})</math>            Allow any named acid</p> <p><b>(1)</b> effervescence / fizzing / bubbles            Allow gas given off which turns limewater cloudy/milky            Ignore just "gas"</p>	4

(Total for Question 1 = 10 marks)

Question number	Answer	Additional Guidance	Mark
2(a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>(add a few crystals / small amount of) phosphorus(V) chloride / phosphorus pentachloride / <math>\text{PCl}_5</math></li> <li>steamy / misty fumes (of HCl)</li> </ul>	<p>(1) Allow thionyl chloride / <math>\text{SOCl}_2</math> / Ester formation / reaction with Na Do not award <math>\text{PCl}_3</math></p> <p>(1) Allow white fumes Do not award white smoke</p> <p>Allow the formation of an ester</p> <p>M1 Addition of a carboxylic acid / named carboxylic acid and any identified strong acid Or Addition of an acyl chloride / named acyl chloride</p> <p>M2 Fruity / glue / characteristic smell of product</p> <p>Allow for addition of sodium</p> <p>M1 Addition of sodium / Na</p> <p>M2 formation of bubbles / fizzing / formation of a gas which burns with a squeaky pop</p> <p>Ignore just formation of gas / hydrogen</p>	2

Question number	Answer	Additional Guidance	Mark
2(b)(i)	<p>An answer that makes reference to one of the following pairs of points:</p> <ul style="list-style-type: none"> <li>• bromine water / aqueous bromine / bromine solution / bromine in organic solvent / Br<sub>2</sub>(aq)</li> <li>• orange / yellow / brown to colourless</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>• potassium manganate(VII) / KMnO<sub>4</sub> and sulfuric acid / H<sub>2</sub>SO<sub>4</sub></li> <li>• purple to colourless</li> </ul>	<p>In the results of both tests ignore “clear”</p> <p>(1) Allow bromine / Br<sub>2</sub>(l)</p> <p>(1) Allow just decolourises Do not award red / red-brown with aqueous bromine but allow with bromine</p> <p>(1) Allow potassium permanganate Allow acidified potassium manganate(VII)</p> <p>(1) Allow just decolourises</p>	2

Question number	Answer	Additional Guidance	Mark
2(b)(ii)	<p>An answer that makes reference to one of the following points:</p> <ul style="list-style-type: none"> <li>• orange / yellow / brown colour still present</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>• purple colour remains</li> </ul>	<p>Allow TE on colours from b(i), e.g red-brown with bromine water</p> <p>Allow no change Allow does not decolourise Allow no reaction</p>	1

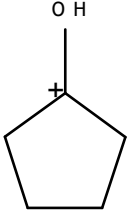
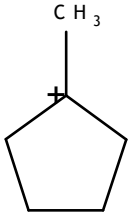
Question number	Answer	Additional Guidance	Mark								
2(c)	<ul style="list-style-type: none"><li>any two correct</li><li>third correct</li></ul>	<table><tr><th>Compound</th><th>Colour change</th></tr><tr><td></td><td>orange to green</td></tr><tr><td></td><td>orange to green</td></tr><tr><td></td><td>no change / stays orange</td></tr></table> <p>Award orange to blue</p> <p>three correct scores 2 any two correct scores 1</p> <p>All three with the colours reversed (green to orange, green to orange and stays green) scores 1</p> <p>Penalise the omission of the start colour once only Penalise yellow as the start colour once only</p>	Compound	Colour change		orange to green		orange to green		no change / stays orange	2
Compound	Colour change										
	orange to green										
	orange to green										
	no change / stays orange										

Question number	Answer	Additional Guidance	Mark
<b>2(d)(i)</b>	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>O-H bond <b>and</b> 3750–3200 (cm<sup>-1</sup>)</li> </ul>	In d(i) and d(ii) penalise a single value or a range within the range once only  Allow 3200-3750 (cm <sup>-1</sup> ) Do not award -OH / -O-H	<b>1</b>

Question number	Answer	Additional Guidance	Mark
<b>2(d)(ii)</b>	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>C=C bond <b>and</b> 1669–1645 (cm<sup>-1</sup>)</li> </ul>	Allow 1645-1669 (cm <sup>-1</sup> )  If no other mark awarded in (d)(i) and (d)(ii) allow (1) <b>in (d)(ii)</b> for identification of both bonds or both ranges	<b>1</b>



Question number	Answer	Additional Guidance	Mark
2(d)(iii)	<ul style="list-style-type: none"> <li>all three molecular ions have a <math>m/z = 100</math> / all three compounds have a molar mass of <math>100 \text{ (g mol}^{-1}\text{)}</math></li> </ul>	<p>Allow this is the molecular ion peak of all three compounds</p> <p>Allow this is the molecular mass of all three compounds</p> <p>Allow the three compounds are isomers</p> <p>Allow the compounds have the same molar mass</p> <p>Allow the compounds are <math>\text{C}_6\text{H}_{12}\text{O}</math> / have the same molecular formula</p> <p>Do not award the compounds have the same molecular ion</p>	1

Question number	Answer	Additional Guidance	Mark
2(d)(iv)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>  </li> <li>CH<sub>3</sub>• / CH<sub>3</sub> (radical)</li> </ul>	<p>(1) Allow the + anywhere including outside of brackets around the structure Allow displayed formula</p> <p>Allow CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>COH<sup>+</sup> showing linked carbons in ring Do not award structures with extra -H on C-OH Do not award structures which do not contain a ring</p> <p>Ignore C<sub>5</sub>H<sub>9</sub>O<sup>+</sup> / C<sub>5</sub>H<sub>8</sub>OH<sup>+</sup> / CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>OH<sup>+</sup></p> <p>(1) Allow displayed formula Allow methyl (radical) Allow CH<sub>3</sub><sup>+</sup></p> <p>Allow (1) for  and OH• / OH / OH<sup>+</sup></p>	2

(Total for Question 2 = 12 marks)

Question number	Answer	Additional Guidance	Mark
3(a)	<ul style="list-style-type: none"> <li>(from) yellow (1)</li> <li>(to) orange (1)</li> </ul>	<p>Correct colours reversed scores (1)</p> <p>Allow peach for orange</p> <p>Ignore modifiers e.g. pale</p> <p>Do not award to red or to pink</p>	2

Question number	Answer	Additional Guidance	Mark								
3(b)(i)	<ul style="list-style-type: none"><li>two correct values</li></ul>	<table><tr><td>3</td><td>4</td></tr><tr><td>23.05</td><td>45.1(0)</td></tr><tr><td>1.25</td><td>23.20</td></tr><tr><td>21.8(0)</td><td>21.90</td></tr></table>	3	4	23.05	45.1(0)	1.25	23.20	21.8(0)	21.90	1
3	4										
23.05	45.1(0)										
1.25	23.20										
21.8(0)	21.90										

Question number	Answer	Additional Guidance	Mark
3(b)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>it is not concordant / not within 0.2 (cm<sup>3</sup>)</li> </ul>	<p>Allow not within 0.1 (cm<sup>3</sup>)</p> <p>Allow just 'it is rough / a trial / a rangefinder'</p> <p>Do not award uncertainty e.g. <math>\pm 0.1</math> / <math>\pm 0.2</math> (cm<sup>3</sup>)</p>	1

Question number	Answer	Additional Guidance	Mark
3(b)(iii)	<ul style="list-style-type: none"> <li>calculation of mean titre (1)</li> <li>calculation of moles of hydrochloric acid (1)</li> </ul>	<p>Example of calculation:</p> $\frac{21.85 + 21.80 + 21.90}{3}$ <p>= 21.85 (cm<sup>3</sup>)</p> $\frac{21.85 \times 0.200}{1000}$ <p>= 0.00437 / <math>4.37 \times 10^{-3}</math> (mol)</p> <p>Correct answer with some working scores (2)</p> <p>Allow TE on incorrect volumes in (b)(i) and on incorrect calculation of mean titre.</p> <p>Ignore SF except 1SF</p>	2

Question number	Answer	Additional Guidance	Mark
3(b)(iv)	<ul style="list-style-type: none"> <li>calculation of moles of barium hydroxide in 10 cm<sup>3</sup> <b>(1)</b></li> <li>calculation of moles of barium hydroxide in 1 dm<sup>3</sup> <b>(1)</b></li> <li>calculation of concentration in g dm<sup>-3</sup> to 2 or 3 SF <b>(1)</b></li> </ul>	<p>Example of calculation:</p> <p>moles of Ba(OH)<sub>2</sub> in 10 cm<sup>3</sup></p> <p>= ans(b)(iii) / 2</p> <p>= 0.002185 / 2.185 x 10<sup>-3</sup> (mol) (ans(1))</p> <p>moles of Ba(OH)<sub>2</sub> in 1 dm<sup>3</sup></p> <p>= ans(1) x 100</p> <p>= 0.2185 / 2.185 x 10<sup>-1</sup> (mol) (ans(2))</p> <p>= ans(2) x 171.3</p> <p>= 37.429 g</p> <p>= 37 / 37.4 (g dm<sup>-3</sup>) to 2 or 3 SF</p> <p>Do not award 37.0</p> <p>Correct answer with some working scores (3)</p> <p>Use of 171 gives 37.4 / 37.364</p> <p>ALLOW TE throughout</p>	3

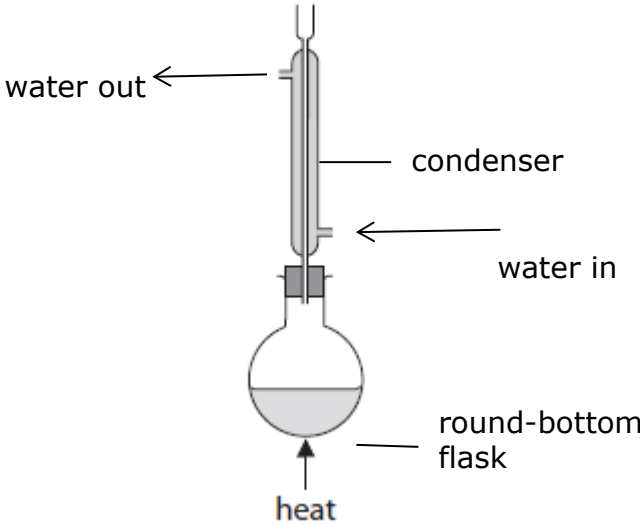
Question number	Answer	Additional Guidance	Mark
3(c)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• use of a fume cupboard</li> </ul>	<p>Allow (face) mask</p> <p>Ignore laboratory coat / goggles / gloves / well ventilated laboratory</p> <p>Comment: Allow respiratory equipment</p>	1

Question number	Answer	Additional Guidance	Mark
3(d)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• oxidising (agent) / oxidiser / oxidant</li> </ul>	<p>Do not award flammable</p>	1

**(Total for Question 3 = 11 marks)**

Question number	Answer	Additional Guidance	Mark
4(a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>gives a reason for cooling</li> <li>gives a reason why this causes a reduction in yield</li> </ul>	<p>(1) reaction is exothermic / vigorous / gives off heat / Do not award Explosive Ignore violent / quick reaction</p> <p>(1) mixture may boil causing reactant / product to escape / butan-1-ol / reactant or 1-bromobutane / product might evaporate or reaction may bubble / fizz / effervesce and overflow the round bottom flask (causing loss of reactant / product)  Allow alkene formation / charring  Ignore reference to equilibrium / rate / side reactions  Do not award transfer losses</p>	2

Question number	Answer	Additional Guidance	Mark
4(b)(i)	<ul style="list-style-type: none"> <li>anti-bumping granules</li> </ul>	<p>Allow description of anti-bumping granules Allow other names: anti-bumping chips / beads boiling stones broken porcelain boiling chips</p>	1

Question number	Answer	Additional Guidance	Mark
4(b)(ii)	<p>A diagram that</p> <ul style="list-style-type: none"> <li>contains a round bottom flask with contents and any indication of heating (1)</li> <li>contains a vertical condenser with water jacket and correct water flow (1)</li> <li>is a working apparatus: not stoppered, no gaps, a joint between flask and condenser (1)</li> </ul>	<p>Example of diagram:</p>  <p>Allow apparatus unlabelled but must have correct water flow for M2  Allow pear shaped flask  Allow an arrow pointing upward as an indication of heat  Ignore thermometers which do not seal the apparatus  M1 is available for a distillation apparatus</p>	3



Question number	Answer	Additional Guidance	Mark
4(c)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>to neutralise (excess sulfuric) acid</li> </ul>	<p>Allow to remove (excess sulfuric) acid  Allow hydrobromic acid / HBr / sodium hydrogensulfate / NaHSO<sub>4</sub> / H<sup>+</sup>  Do not award just 'to neutralise' without mention of acid</p>	1

Question number	Answer	Additional Guidance	Mark
4(c)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>identifies the problem</li> <li>gives a solution</li> </ul>	<p>(1) build-up of pressure (in the separating funnel)  Ignore causes frothing  Ignore formation of CO<sub>2</sub></p> <p>(1) open / remove the stopper (with the funnel upright)  or  open the tap (with funnel inverted)</p> <p>Note: Remove the stopper to release the pressure would score 2.</p> <p>Comment: mark independently</p>	2

Question number	Answer	Additional Guidance	Mark
4(c)(iii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>drying agent / to remove water</li> </ul>	Do not award dehydration	1

Question number	Answer	Additional Guidance	Mark
4(c)(iv)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>turns from cloudy to clear</li> </ul>	Ignore colourless  Allow solution becomes clear Allow stops being cloudy Allow is no longer turbid Allow less cloudy / more clear	1

Question number	Answer	Additional Guidance	Mark
4(d)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>integer values of temperature in the ranges  lower value 99 / 100 / 101(°C) <b>and</b> upper value 103 / 104 / 105(°C)</li> </ul>	Award values to nearest 0.5 °C  Do not award other fractions or decimals of degrees other than nearest 0.5 °C  Do not award single values even if between the two ends of the range, e.g. 102 °C  Allow a value for the size of the range around a stated temperature as long as it is within the given values e.g. 3 °C around 102 °C	1

Question number	Answer	Additional Guidance	Mark
4(e)(i)	<ul style="list-style-type: none"> <li>reason for yield being less than 100%</li> </ul>	<p>Example of reasons:</p> <p>reaction incomplete transfer losses side reactions</p> <p>Ignore equilibrium reached Ignore impure reagents / impurities</p> <p>Do not award the cold water bath was not used Do not award the procedure was not followed correctly Do not award spillages</p>	1

Question number	Answer	Additional Guidance	Mark
4(e)(ii)	<ul style="list-style-type: none"> <li>• calculation of mass of 1-bromobutane required</li> <li>• calculation of moles of 1-bromobutane required</li> <li>• calculation of mass butan-1-ol required</li> <li>• calculation of percentage yield assumed</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>• calculation of moles of butan-1-ol used</li> <li>• calculation of mass of 1-bromobutane for 100 % yield</li> <li>• calculation of volume of 1-bromobutane for 100 % yield</li> <li>• calculation of % yield if 20 cm<sup>3</sup> prepared</li> </ul>	<p>Example of calculation:</p> <p>(1) = 20 x 1.27 = 25.4 (g)</p> <p>(1) = 25.4 ÷ 137 = 0.18540 (mol)</p> <p>(1) = 0.18540 x 74 = 13.720</p> <p>(1) = 100 x 13.720 ÷ 21.0 = 65.332 (%)</p> <p>(1) = 21 ÷ 74 = 0.28378 mol</p> <p>(1) = 0.28378 x 137 = 38.878 g</p> <p>(1) = 38.878 ÷ 1.27 = 30.613 (cm<sup>3</sup>)</p> <p>(1) = 100 x 20 ÷ 30.613 = 65.332 (%)</p> <p>Do not award M4 if yield greater than 100%</p> <p>Use of 0.810 instead of 1.27 gives 41.699 (%) scores (3)</p> <p>Use of transposed M<sub>r</sub> values gives 223.9 (%) scores (2)</p> <p>Allow use of 136.9 (giving 65.381(%))</p> <p>Allow TE throughout</p> <p>Ignore SF except 1SF</p> <p>Correct answer with some working scores (4)</p>	4

**(Total for Question 4 = 17 marks)**

**Total for Paper = 50 marks**