



Mark Scheme (Final)

Summer 2023

Pearson Edexcel International Advanced
Subsidiary Level In Chemistry (WCH13)

Paper 01

Unit 3: Practical Skills in Chemistry I

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Using the mark scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit. () means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer. ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question	Answer	Additional Guidance	Mark
1(a)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none">barium (ion) / Ba^{2+} / Ba^{+2}	Do not award Ba/ Ba^{+} Do not award Cu^{2+} If name and formula are given both must be correct	(1)

Question	Answer	Additional Guidance	Mark
1(a)(ii)	An answer that makes reference to the following point: <ul style="list-style-type: none">iodide (ion) / I^{-}	Do not award just iodine / I / I_2^{-}	(1)

Question	Answer	Additional Guidance	Mark
1(a)(iii)	An answer that makes reference to the following point: <ul style="list-style-type: none">BaI_2	Allow TE on incorrect ions in (a)(i) and (a)(i) Ignore barium iodide	(1)

Question	Answer	Additional Guidance	Mark
1(a)(iv)	An answer that makes reference to the following points: <ul style="list-style-type: none">• test for iodide ion• result of test for iodide ion	<p>(1) Add conc sulfuric acid / H₂SO₄</p> <p>(1) Bad egg smell / purple vapour/ purple fumes / yellow solid/ black solid Ignore misty fumes (of HI) Or (To a solution of A) add chlorine water / Cl₂(aq) Solution turns yellow / orange / brown / darker / gives a purple colour with an organic solvent Do not award black Or (To a solution of A) add bromine water / Br₂(aq) Solution turns darker / more orange / gives a purple colour with an organic solvent Do not award black</p> <p>Allow TE for bromide ion and chloride ion</p>	(2)

Question	Answer	Additional Guidance	Mark
1(b)(i)	An answer that makes reference to the following points: <ul style="list-style-type: none"><li data-bbox="360 213 719 240">• test for ammonium ions<li data-bbox="360 459 824 486">• result of test on ammonium ions	<p data-bbox="1151 213 1189 240">(1)</p> <p data-bbox="1245 213 1872 284">Sodium hydroxide (solution) / NaOH ((aq)) (and heat)</p> <p data-bbox="1245 325 1554 352">Allow any named alkali</p> <p data-bbox="1151 469 1189 496">(1)</p> <p data-bbox="1245 443 1823 513">Gas/ vapour evolved turns (damp red) litmus blue/UI blue/indicator</p> <p data-bbox="1245 555 1662 582">Allow turns indicator paper blue</p> <p data-bbox="1245 624 1603 651">Ignore pungent gas evolved</p> <p data-bbox="1245 692 1890 762">Do not award if the indicator is being added to the mixture</p> <p data-bbox="1245 804 1283 831">Or</p> <p data-bbox="1245 873 1787 900">Gas evolved forms white smoke with HCl</p> <p data-bbox="1245 941 1621 968">Allow white fumes with HCl</p> <p data-bbox="1245 1010 1688 1037">Do not award steamy/misty fumes</p>	(2)

Question	Answer	Additional Guidance	Mark
1b(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none">• addition of suitable barium compound• addition of suitable acid• result of test for sulfate ions	(to a solution of ammonium sulfate add) (1) barium chloride (solution) / BaCl ₂ ((aq)) / barium nitrate (solution) / Ba(NO ₃) ₂ ((aq)) (1) hydrochloric acid/ nitric acid Allow HCl/ HNO ₃ without (aq) M2 is dependent on M1 or near miss (1) white and precipitate / ppt / ppte / solid M3 is not a stand-alone mark	(3)

Question	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to the following points: <ul style="list-style-type: none">• balanced equation and correct state symbols	$\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \longrightarrow \text{BaSO}_4(\text{s})$	(1)

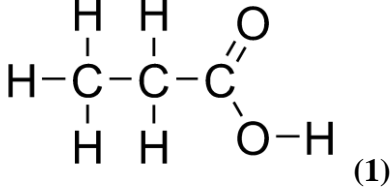
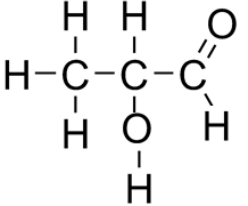
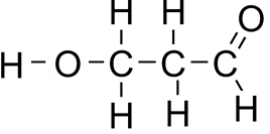
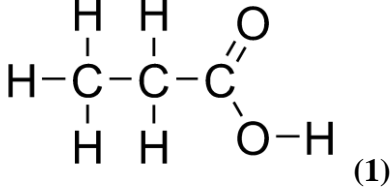
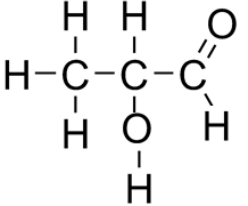
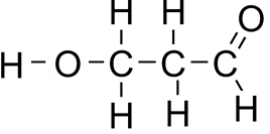
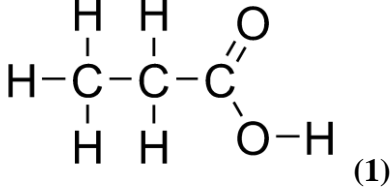
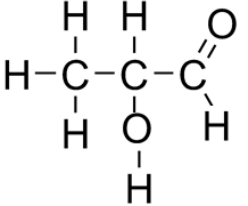
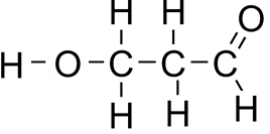
(Total for Question 1 = 11 marks)

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Question	Answer	Additional Guidance	Mark
2(a)	An answer that makes reference to the following point: <ul style="list-style-type: none">hydrogen chloride / HCl/ HCl (gas)	Allow hydrochloric acid / HCl (aq) If name and formula given both must be correct	(1)

Question	Answer	Additional Guidance	Mark
2(b)	An answer that makes reference to the following point: <ul style="list-style-type: none">carbon dioxide / CO₂/ CO₂ (gas)	If name and formula given both must be correct	(1)

Question	Answer	Additional Guidance	Mark
2(c)	An answer that makes reference to the following points: <ul style="list-style-type: none">blue (solution) (1)(produces) (brick) red / orange/ brown and precipitate/solid / ppt / ppte / (1)	Do not award blue solid or ppt Allow cloudy red/orange/brown solution If formula given (of ppt), Cu ₂ O it must be correct	(2)

Question	Answer	Additional Guidance	Mark								
<p>2(d)(i)</p>	<p>An answer that makes reference to the following structures:</p> <ul style="list-style-type: none"> • structure of C • possible structure of D • possible structure of D <p>Ignore connectivity of the OH unless horizontal</p> <p>Accept displayed / structural / skeletal formula or any combination</p> <p>Do not award COH for the CHO of the aldehydes but only penalise once in parts (d)(i) and (d)(iii)</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2" style="text-align: center; background-color: #cccccc;">Structure of C</th> </tr> <tr> <td colspan="2" style="text-align: center;">  <p style="text-align: right;">(1)</p> </td> </tr> <tr> <th style="width: 50%; text-align: center; background-color: #cccccc;">Possible structure of D</th> <th style="width: 50%; text-align: center; background-color: #cccccc;">Possible structure of D</th> </tr> <tr> <td style="text-align: center;">  <p style="text-align: right;">(1)</p> </td> <td style="text-align: center;">  <p style="text-align: right;">(1)</p> </td> </tr> </table>	Structure of C		 <p style="text-align: right;">(1)</p>		Possible structure of D	Possible structure of D	 <p style="text-align: right;">(1)</p>	 <p style="text-align: right;">(1)</p>	<p>(3)</p>
Structure of C											
 <p style="text-align: right;">(1)</p>											
Possible structure of D	Possible structure of D										
 <p style="text-align: right;">(1)</p>	 <p style="text-align: right;">(1)</p>										

	Answer	Additional Guidance	Mark
2(d)(ii)	An answer that makes reference to the following points <ul style="list-style-type: none">• 2962 - 2853 (cm^{-1}) and C-H (stretching in alkanes)	No TE on wrong structures	(1)

Question	Answer	Additional Guidance	Mark
2(d)(iii)	An explanation that makes reference to the following points: <ul style="list-style-type: none">• (peak at $m/z = 15$ is due to) $\text{CH}_3^{(+)}$ This is a stand-alone mark <ul style="list-style-type: none">• (only formed) from 2-hydroxypropanal.	(1) Do not award $\text{CH}_3 \bullet$ (1) Allow any reference to the correct structure e.g., the first one	(2)

(Total for Question 2 = 10 marks)

Question	Answer	Additional Guidance	Mark
3(a)(i)	An explanation that makes reference to the following points: <ul style="list-style-type: none">• distillation takes place• before complete oxidation can occur	<p>(1) Allow distillation apparatus (not reflux)</p> <p>(1) Allow incomplete reaction/ incomplete oxidation/ only oxidised to the aldehyde/ butanal is formed</p> <p>Allow complete oxidation is needed to get butanoic acid</p> <p>Allow reflux is required to ensure complete oxidation</p> <p>Allow reflux is required to ensure butanoic acid is formed</p> <p>Ignore just low yield of butanoic acid</p>	(2)

Question	Answer	Additional Guidance	Mark
3(a)(ii)	An answer that makes reference to the following point: <ul style="list-style-type: none">• reactants and / or products would evaporate	Allow (the vessel is open so) reactants /products/gas/ would escape Allow alcohols are flammable Ignore not safe/toxic/no condenser Ignore reference to volatile reactants/products Do not award the (butanoic) acid would escape/evaporate	(1)

Question	Answer	Additional Guidance	Mark
3 (a)(iii)	An explanation that makes reference to the following points: <ul style="list-style-type: none">• condenser is full of water/ prevents air bubbles from forming• (more) efficient condensation/ (ensuring) all/ more/most of the vapour/ gas is condensed/no or less vapour is lost	(1) Allow better contact between the water and the glass wall of the condenser. (1) Allow just (more) efficient cooling Allow reverse argument Ignore speed of condensation	(2)

Question	Answer	Additional Guidance	Mark
3(a)(iv)	An answer that makes reference to the following points: <ul style="list-style-type: none">potassium dichromate(VI) / $K_2Cr_2O_7$ and sulfuric acid (ignore concentration)	Allow acidified potassium dichromate(VI) Or $Cr_2O_7^{2-}$ and H^+ Do not award hydrochloric acid / HCl/nitric acid/ HNO_3 Do not award acidified potassium manganate(VII) / potassium permanganate If name, formula and oxidation numbers are given all must be correct	(1)

Question	Answer	Additional Guidance	Mark
3(a)(v)	An answer that makes reference to the following point: <ul style="list-style-type: none">from orange to green	Allow from orange to blue	(1)

Question	Answer	Additional Guidance	Mark
3(b)(i)	An answer that makes reference to the following points: <ul style="list-style-type: none">• (concentrated)phosphoric ((V)) acid/ H_3PO_4 Or concentrated sulfuric acid H_2SO_4	Allow $\geq 50\%$ Allow passing vapour over suitable solid catalyst such as aluminium oxide / porous pot If name, formula and oxidation numbers are given all must be correct Do not award phosphorus acid	(1)

Question	Answer	Additional Guidance	Mark
3(b)(ii)	<p>An answer that makes reference to one of the following pairs of points:</p> <ul style="list-style-type: none"> • bromine water / aqueous bromine / bromine solution / bromine in organic solvent / Br₂ (aq) • orange / yellow / brown/ red brown to colourless <p>Or</p> <ul style="list-style-type: none"> • potassium manganate(VII) / KMnO₄ and sulfuric acid / H₂SO₄ • purple to colourless 	<p>(1) Allow bromine / Br₂(l)</p> <p>(1) Allow just decolourises Ignore clear</p> <p>(1) Allow potassium permanganate and sulfuric acid Allow acidified potassium manganate(VII)</p> <p>(1) Allow just decolourises Ignore clear</p> <p>If name, formula and oxidation numbers are given all must be correct</p> <p>M2 dependent on M1 or near miss</p>	(2)

(Total for Question 3 = 10 marks)

Question	Answer	Additional Guidance	Mark
4(a)(i)	<p>An explanation that makes reference to two of the following points:</p> <p>bubbles / effervescence (1)</p> <p>goes cloudy / white precipitate / white solid (1)</p> <p>calcium/solid disappears (1)</p>	<p>Allow the gas syringe filled up/(barrel) moved Ignore gas/ hydrogen given off</p> <p>Ignore goes milky Ignores forms a colourless solution</p> <p>Allow calcium/solid dissolves Ignore Ca floats</p> <p>Mention of any coloured product (max 1) Confusion with sodium e.g. whizzing round (max 1)</p>	(2)

Question	Answer	Additional Guidance	Mark
4(a)(ii)	<ul style="list-style-type: none">• calculation of mass of Ca (1) • calculation of moles of Ca (1) • calculation of volume of one mole of hydrogen gas (1) • correct units and answer to 2 or 3 SF (1)	Example of calculation 1.783 g – 1.657 g = 0.126 (g) 0.126/40.1 = 0.0031421 / 3.1421 × 10 ⁻³ (mol) 72.0/0.0031421 = 22914 / 2.2914 × 10 ⁴ (cm ³) Or 0.072/0.0031421 = 22.914 / (dm ³) 23 / 22.9 dm ³ (mol ⁻¹) / 23 000 / 22 900 cm ³ (mol ⁻¹) Allow TE throughout Correct answer with or without working scores (4)	(4)

Question	Answer	Additional Guidance	Mark
4(b)(i)	<ul style="list-style-type: none">percentage error	Example of calculation $100 \times (23.9 - 21.8) \div 23.9 = 8.7866 (\%)$ Ignore SF except 1SF Ignore +/- Do not award 9%, 8.7% or 8.78% Correct answer with no working scores (1)	(1)

Question	Answer	Additional Guidance	Mark
4(b)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • some (hydrogen) gas escapes before the bung is attached OR reaction starts before the bung is placed in the conical flask • some of the calcium had already formed calcium oxide 	<p>Allow there was a delay (after dropping in the Ca) before the bung could be placed on the conical flask/connecting the apparatus</p> <p>(1) Ignore hydrogen dissolves in water Ignore just the gas escaped/ bung didn't fit properly</p> <p>(1) Allow the Ca/it was not pure Allow the Ca/it did not fully react Allow the Ca/it did not fully dissolve Ignore just the reaction was incomplete Ignore any measurement errors eg some Ca left in the weighing boat Ignore non-standard conditions etc Do not award the water was limiting</p>	(2)

Question	Answer	Additional Guidance	Mark
4(c)(i)	An answer that makes reference to the following points: <ul style="list-style-type: none">• (from) yellow (1)• (to) orange (1)	Ignore shades of colours eg pale Colours reversed scores (1)	(2)

Question	Answer					Additional Guidance	Mark																									
4(c)(ii)	<table border="1"> <thead> <tr> <th data-bbox="293 197 663 276">Titration</th> <th data-bbox="663 197 851 276">1</th> <th data-bbox="851 197 1039 276">2</th> <th data-bbox="1039 197 1227 276">3</th> <th data-bbox="1227 197 1415 276">4</th> </tr> </thead> <tbody> <tr> <td data-bbox="293 276 663 354">Final burette reading / cm³</td> <td data-bbox="663 276 851 354">26.85</td> <td data-bbox="851 276 1039 354">31.25</td> <td data-bbox="1039 276 1227 354">34.55</td> <td data-bbox="1227 276 1415 354">27.15</td> </tr> <tr> <td data-bbox="293 354 663 432">Final burette reading / cm³</td> <td data-bbox="663 354 851 432">0.00</td> <td data-bbox="851 354 1039 432">5.00</td> <td data-bbox="1039 354 1227 432">8.00</td> <td data-bbox="1227 354 1415 432">1.00</td> </tr> <tr> <td data-bbox="293 432 663 510">Titre / cm³</td> <td data-bbox="663 432 851 510">26.85</td> <td data-bbox="851 432 1039 510">26.25</td> <td data-bbox="1039 432 1227 510">26.55</td> <td data-bbox="1227 432 1415 510">26.15</td> </tr> <tr> <td data-bbox="293 510 663 587">Concordant results (✓)</td> <td data-bbox="663 510 851 587"></td> <td data-bbox="851 510 1039 587">✓</td> <td data-bbox="1039 510 1227 587"></td> <td data-bbox="1227 510 1415 587">✓</td> </tr> </tbody> </table>					Titration	1	2	3	4	Final burette reading / cm ³	26.85	31.25	34.55	27.15	Final burette reading / cm ³	0.00	5.00	8.00	1.00	Titre / cm ³	26.85	26.25	26.55	26.15	Concordant results (✓)		✓		✓	<p>(1)</p> <p>(1) $\frac{26.25 + 26.15}{2}$ = 26.20 (cm³)</p> <p>Allow 26.2</p> <p>Allow TE for the mean titre on ticked boxes</p>	(2)
	Titration	1	2	3	4																											
	Final burette reading / cm ³	26.85	31.25	34.55	27.15																											
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	Concordant results (✓)		✓		✓																											
<ul style="list-style-type: none"> all 6 correct 																																
<ul style="list-style-type: none"> calculation of mean titre 																																

Question	Answer	Additional Guidance	Mark
4(c)(iii)	<ul style="list-style-type: none"> • calculation of moles of hydrochloric acid (1) • calculation of moles of calcium hydroxide in 25 cm³ (1) • calculation of moles of calcium hydroxide in 1 dm³ (1) • calculation of concentration in g dm⁻³ (1) 	<p>Example of calculation</p> $26.2 \times 0.0400 / 1000 = 0.001048 \text{ (mol)} / 1.048 \times 10^{-3} \text{ (mol)}$ <p>TE on (c)(ii)</p> $1.048 \times 10^{-3} \div 2 = 0.000524 / 5.24 \times 10^{-4} \text{ (mol)}$ $5.24 \times 10^{-4} \times 1000 \div 25 = 0.02096 \text{ (mol)}$ $= 0.02096 \times 74.1 = 1.5531 \text{ (g dm}^{-3}\text{)}$ <p>Allow = $0.02096 \times 74 = 1.5510 \text{ (g dm}^{-3}\text{)}$</p> <p>Ignore SF except 1SF</p> <p>Ignore units</p> <p>TE throughout</p> <p>Correct answer with no working score (4)</p>	(4)

Question	Answer	Additional Guidance	Mark
4(d)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • goes cloudy / white precipitate / white solid (of calcium hydroxide) • (increasing temp) moves the equilibrium in the endothermic direction so: calcium hydroxide solubility decreases/ less calcium hydroxide dissolves/ more (solid) calcium hydroxide forms Or • (increasing temp) favours the reverse direction so: calcium hydroxide solubility decreases / less calcium hydroxide dissolves/ more (solid) calcium hydroxide forms 	<p>(1) Do not award any other white ppt eg CaO, CaCl₂</p> <p>Do not award white anhydrous calcium hydroxide</p> <p>Do not award any other colour or extra observations e.g. effervesces</p> <p>Do not award any reference to water evaporating/ crystallisation</p> <p>(1) Allow (increasing temp) means: calcium hydroxide solubility decreases / less calcium hydroxide dissolves/calcium hydroxide forms</p> <p>Ignore any reference rates of dissolving</p>	(2)

(Total for Question 4 = 19 marks)

(Total for Paper = 50 marks)

