Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Subsidiary Level In Chemistry (WCH13)
Paper 01
Unit 3: Practical Skills in Chemistry I

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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.

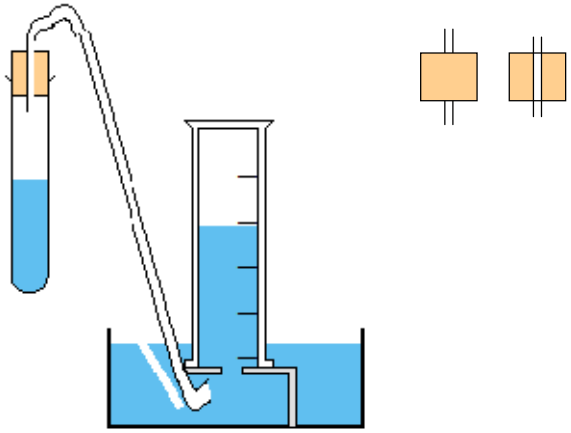
Question Number	Answer	Additional Guidance	Mark
1(a)(i)	A description that makes reference to the following points:		**(3)**
	• use of nichrome / platinum / Pt wire **(1)**	Allow nickel-chromium / Ni-Cr Allow silica rod Allow rod for wire Do not award just 'nickel' / just 'chromium' Do not award wooden splint	**Expert**
	• use of (concentrated) hydrochloric acid / HCl(aq) **(1)**	Allow any mention of HCl(aq) e.g. cleaning or mixing solid and acid or making a paste / solution Allow HCl for HCl(aq) Ignore dilute Do not award other acids	
	• flame test method **(1)**	(wire then) dipped in solid **and** (placed) in (hot / roaring / colourless / blue-cone /non-luminous) (Bunsen) **flame** Allow salt / compound / substance / paste / sample / solution for 'solid' Allow on / over / under / near / show / above for 'in' Allow spirit / ethanol burner Do not award 'metal' for solid Do not award fire for flame Do not award yellow / luminous flame Ignore 'burn'	

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	An answer that makes reference to the following points: • statement of both flame colours **(1)** • identification of Ba^{2+} **(1)**	 Na^+ = (persistent) yellow Allow gold / orange / yellow-orange K^+ = lilac Allow (pale) purple Do not award violet Ignore barium / barium ion Do not award Cu^{2+}	**(2)** **Graduate**

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	An answer that makes reference to the following: • chloride / Cl^- **and** bromide / Br^- **and** iodide / I^-	 Allow omission of the charge once Ignore chlorine ion, bromine ion or iodine ion Do not award just chlorine, bromine or iodine	**(1)** **Graduate**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	An answer that makes reference to the following points: EITHER • addition of **dilute** (aqueous) ammonia **(1)** • only silver chloride / chloride (precipitate) dissolves **(1)** • addition of **concentrated** (aqueous) ammonia **(1)** • only silver iodide / iodide is insoluble **(1)** OR • addition of **concentrated** sulfuric acid /H_2SO_4 **(1)** • silver chloride / chloride precipitate gives steamy / misty / white fumes only **(1)** • silver bromide / bromide precipitate gives brown fumes **(1)** • silver iodide / iodide precipitate gives purple vapour fumes / gas **(1)**	Penalise use of halogen for halide once only Allow use of halogen ion / anion The sequence suggested must allow the ions to be distinguished Allow bromide and iodide do not dissolve Accept only silver bromide / bromide precipitate dissolves if chloride has been eliminated and conc ammonia added to remaining precipitates If no other mark is scored 'addition of (aqueous) ammonia scores (1) Allow addition to A, B and C for this set of tests Allow choking gas evolved / choking smell Allow black / grey solid or 'bad eggs' smell Allow yellow solid (of sulfur) Ignore choking gas evolved / choking smell If no other mark is scored, silver chloride is white, **and** silver bromide is cream **and** silver iodide is yellow scores (1)	**(4)** Expert

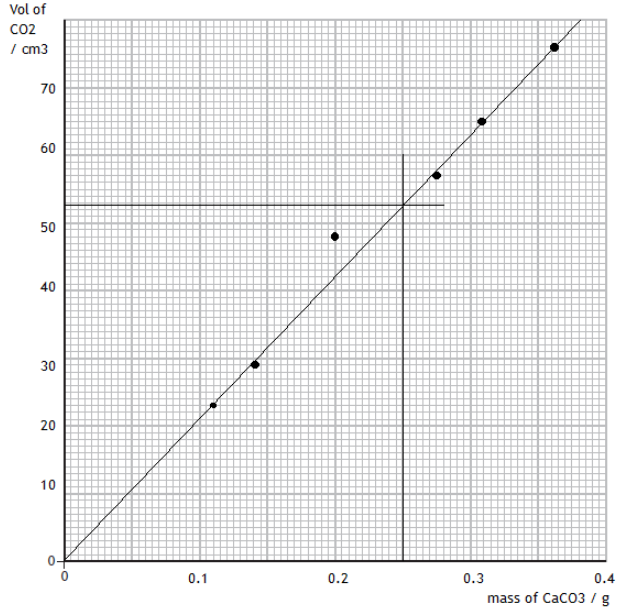
(Total for Question 1 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)	Diagram showing the following points • boiling tube • delivery tube above the level of the liquid in the boiling tube if shown or above half the height of the tube • sealed connection between reaction vessel and delivery tube • inverted measuring cylinder containing some water (shown as a line or an annotation indicating it is full) • water level in trough over the bottom of the measuring cylinder • end of delivery tube below or in the measuring cylinder 6 points scores 3 marks; 5 or 4 points scores 2 marks; 2 or 3 points scores 1 mark	Allow any reaction apparatus that can be fitted with a bung and delivery tube Allow any part of a delivery tube shown Allow bung not shown as cross-section Allow measuring cylinder shown not vertical Allow other collecting vessels with graduations Ignore omission of graduations on measuring cylinder Ignore omission of beehive shelf Ignore gas syringe Ignore the delivery tube passing through the wall of the trough Alternative allowed bungs  Ignore apparatus labels including 'heat'	**(3)** **Expert**

Question Number	Answer	Additional Guidance	Mark
2(b)	An explanation that makes reference to the following points: • ethanoic acid is a weak acid (and hydrochloric acid is a strong acid) **(1)** • (with hydrochloric acid) gas would escape before the boiling tube was sealed **(1)**	Allow 'hydrochloric acid is a **stronger** acid' Allow reaction would be slow Allow reaction would be less vigorous Allow reaction would not be violent Allow reverse arguments Ignore just 'hydrochloric acid is a strong acid' Allow just (with ethanoic acid) 'less gas would escape'	**(2)** Expert

Question Number	Answer	Additional Guidance	Mark
2(c)	An answer that makes reference to the following point: • to take account of any calcium carbonate left in the weighing bottle	Ignore just 'gives the mass of $CaCO_3$ that reacts' Ignore just 'gives exact amount of $CaCO_3$'	**(1)** Expert

Question Number	Answer	Additional Guidance	Mark
2(d)(i)	• correct axes with at least 50% of the grid used in both directions **(1)** • axes labelled with correct units **(1)** • all points plotted correctly **(1)**	mass on x axis; volume on y axis Allow scale 0.10 g = 1 big square Allow grammatical errors e.g. use of brackets rather than '/' before units Allow mass / g and vol / cm^3 for labels Allow plotting to within half a small square TE for M2 and M3 if axes wrong way round	**(3)** **Clip with d(ii) and (d)(iii)** **Expert**

Question Number	Answer	Additional Guidance	Mark
2(d)(ii)	An answer that makes reference to the following points: • best fit line drawn through five points **and** passes through the origin **(1)** • structure line from 0.25 g to graph **and** line to 52.5 cm^3 **(1)**	Do not award BFL drawn to include value at 0.2 g Allow TE on points plotted in (d)(i) even if it does not go through origin Accept line that stops at 0.11 g data point but would pass through the origin if extrapolated Ignore extrapolation beyond 0.36 / 76 Allow just the horizontal structure line if 0.25 g is on a major grid line. Allow vol at 0.25 g clearly marked on BFL by a cross or circle. Allow 51.5-53.5 cm^3 TE only on any **straight** line covering **all** the points  Ignore **calculation** of volume	**(2)** **Clip with d(i) and (d)(iii)** Expert

Question Number	Answer	Additional Guidance	Mark
2(d)(iii)	• calculation of molar mass of $CaCO_3$ **(1)** • calculation of amount of $CaCO_3$ **(1)** • scale volume of CO_2 to 1 mol **(1)**	Example of calculation molar mass = 40.1 + 12 + 16 × 3 = 100.1 (g mol^{-1}) mol ($CaCO_3$) = 0.25 ÷ 100.1=2.4975 × 10^{-3} / 0.0024975 1 mol CO_2 occupies 52.5 ÷ 2.4975 × 10^{-3} = 21021 (cm^3) / 21.021 dm^3 Units must be correct if given but accept cm^3 mol^{-1} / dm^3 mol^{-1} TE at each stage and on volume in (d)(ii) Ignore SF except 1 SF Correct answer with some working scores (3) Allow use of M_r ($CaCO_3$) = 100 (V_m = 21) Use of 51.5 gives 20621 cm^3 (20600 for M_r = 100) Use of 52 gives 20821 cm^3 (20800 for M_r = 100) Use of 53 gives 21221 cm^3(21200 for M_r = 100) Use of 53.5 gives 21421 cm^3(21400 for M_r = 100) Calculation of moles of acid (0.030) divided by 2 (0.015) Vol of CO_2 ÷ 0.015 e.g. 52.5 ÷ 0.015 = 3500 cm^3 scores M3 only	**(3)** **Clip with d(i) and (d)(ii)** **Expert**

Question Number	Answer	Additional Guidance	Mark
2(e)	An answer that makes reference to the following points: • some carbon dioxide / CO_2 / gas will escape before the boiling tube can be sealed **(1)** • some carbon dioxide / gas will dissolve in the water **(1)**	Allow Some CO_2 / gas will escape in Step 5 Allow Some CO_2 / gas will escape when the solid is added Allow reaction starts before the boiling tube can be sealed Ignore just 'Some carbon dioxide / gas will escape' Accept carbon dioxide is soluble (in water) Ignore reference to temperature or pressure not rtp Ignore 'some CO_2 remains in apparatus' Ignore 'incomplete reaction' Do not award references to measurement errors loss of reactant apparatus damaged or not working properly	**(2)** **Expert**

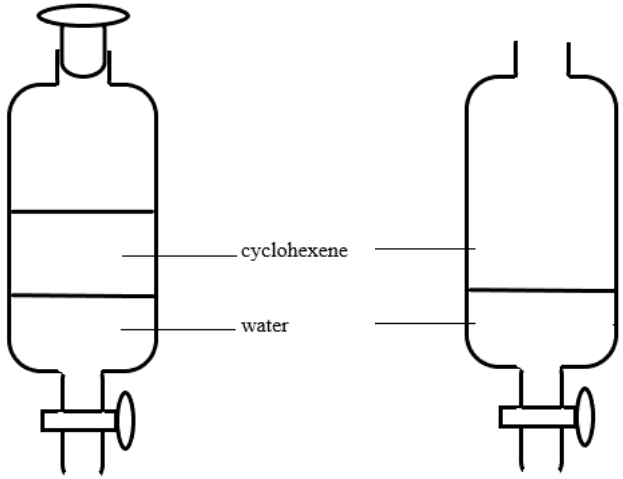
(Total for Question 2 = 16 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	An answer that makes reference to the following points: • flammable symbol identified **and** harmful to the environment symbol identified	 Allow inflammable Ignore combusts / burns easily Allow alternatives to 'harmful to' e.g. 'damages' / 'bad for' / 'poisonous' / 'toxic' / 'hazard' to the environment Allow 'living things' / 'organisms' for 'the environment' Ignore type of environment e.g. aquatic Ignore pollutes the environment Do not award 'biohazard' Do not award symbols the wrong way round Do not award just 'toxic' / 'poisonous' / 'harmful'	**(1)** **Clip with (a)(ii)** **Expert**

Question Number	Answer		Additional Guidance	Mark
3(a)(ii)	An answer that makes reference to the following points: • (cyclohexanol(flammable)) use an electric heater • (cyclohexene (harmful to the environment)) use an organic waste bottle / separate container	**(1)** **(1)**	Ignore use of fume cupboard, goggles, lab coat Accept isomantle Allow water bath / oil bath Allow 'no (naked) flame / fire' Ignore 'keep away from oxidising agents' Ignore keep away from Bunsen burner Accept do **not** pour the (organic) waste down the sink / drain Allow do not release into the environment Allow one use of 'use small amounts' in M1 or M2 No TE on incorrect identification of hazard symbols	**(2)** **Expert**

Question Number	Answer	Additional Guidance	Mark
3(b)	An answer that makes reference to the following: • (anti-bumping granules) provides a nucleus on which gas bubbles grow	Accept provide a surface /site for bubbles to form on Allow prevent local heating / superheating Allow 'distribute the heat' Allow prevent the (sudden) production of large gas bubbles (which cause bumping) Allow ensures that gas bubbles are small Ignore stir the reaction mixture Ignore prevent flash boiling / sudden boiling	**(1)** **Expert**

Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to the following points: • (fractional distillation) gives better separation of the substances in the reaction flask (than simple distillation) **(1)** • (fractional distillation column) gives longer reaction time **(1)** OR • ' better separation of cyclohexene and water' scores 2 marks	Allow (fractional distillation) is more effective / efficient (than simple distillation) Allow just 'better separation' is achieved Allow purer product obtained Ignore reference to increased yield Ignore 'more accurate' Ignore 'similar boiling temperatures' Accept fractional distillation column acts like a reflux condenser Accept cyclohexanol has a higher boiling temperature (than cyclohexene) so is returned to the flask, increasing reaction time / yield Allow to give (more) complete reaction Just ' separation of cyclohexene and water' scores (1)	**(2)** **Expert**

Question Number	Answer	Additional Guidance	Mark
3(d)	A diagram that shows the following: • separating funnel **(1)** • top layer labelled cyclohexene / organic **and** lower layer labelled water / aqueous **(1)**	The funnel must have a tap **and** have a **neck** capable of being closed with a stopper or a bung Allow round separating funnel Allow bung / stopper not shown Ignore tap at the top Do not award a filter funnel Do not award funnel without some sort of tapering at the neck Allow for (2)  Allow minor error in organic name e.g. cyclohexane Ignore 'inorganic lower layer' Do not award if cyclohexanol is in the lower layer	**(2)** **Expert**

Question Number	Answer		Additional Guidance	Mark
3(e)	An explanation that makes reference to the following points:			**(2)**
	• (the organic layer) changes from cloudy to clear	**(1)**	Allow just 'becomes clear / transparent' Ignore 'less cloudy', clearer, more transparent Ignore white Ignore colourless Ignore the drying agent clumps together Ignore layers disappear	**Expert**
	• (anhydrous calcium chloride) removes the (traces of) water	**(1)**	Accept (anhydrous calcium chloride) dries the cyclohexene Allow (anhydrous) calcium chloride is a drying agent Ignore calcium chloride becomes hydrated	

Question Number	Answer	Additional Guidance	Mark
3(f)	An answer that makes reference to the following point:		**(1)**
	• lower temperature within a suitable range **and** upper temperature within a suitable range	79−82 (°C) 84−88 (°C) Do not award a range which starts or ends with 83 (°C)	**Graduate**

Question Number	Answer	Additional Guidance	Mark
3 (g)	• calculation of mass of cyclohexene formed from 3.96 g of cyclohexanol with 100% yield **(1)** • calculation of percentage yield **(1)**	Example of calculation 100 g of cyclohexanol forms 82 g of cyclohexene and (so) 3.96 g forms $3.96 \times 82 \div 100 = 3.2472$ (g) % yield = $100 \times 2.09 \div 3.2472 = 64.363\%$ Method using calculation of moles mol of cyclohexanol = $3.96 \div 100$ $= 3.96 \times 10^{-2} / 0.0396$ = mol cyclohexene mass of cyclohexene for 100% yield $= 82 \times 0.0396 = 3.2472$ (g) (1) % yield = $100 \times 2.09 \div 3.2472$ $= 64.363\%$ (1) Ignore SF except 1 SF TE for **numerical** errors in M1 unless %>100 Allow any correct method Correct answer with some working scores (2) 100 x 2.09 ÷3.96 = 52.778% scores zero	**(2)** **Expert**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>3(h)</td>
<td>An answer that makes reference to the following points:

• any three correct observations (1)

• fourth correct observation (1)</td>
<td>
<table>
<tr><th rowspan="2">Test</th><th colspan="2">Observations</th></tr>
<tr><th>cyclohexanol</th><th>cyclohexene</th></tr>
<tr><td>addition of phosphorus(V) chloride</td><td>steamy / misty / white fumes</td><td>no change / no reaction / no observation</td></tr>
<tr><td>addition of bromine water</td><td>brown /orange / yellow $Br_2(aq)$ unchanged</td><td>brown / orange / yellow $Br_2(aq)$ turns colourless</td></tr>
</table>
For PCl_5 do not award white smoke

For $Br_2(aq)$ and cyclohexanol allow no change / no reaction / no observation

For $Br_2(aq)$ and cyclohexene allow just ‘decolourised’ / ‘turns colourless’
Do not award red or red-brown for colour of $Br_2(aq)$

Do not award additional incorrect observations
</td>
<td>(2)

Expert</td>
</tr>
</table>

(Total for Question 3 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following points: • (from) yellow **(1)** • (to) orange **(1)**	Do not award 'red / pink' From orange to yellow scores (1)	**(2)** **Graduate**

Question Number	Answer	Additional Guidance	Mark
4(b)	An answer that makes reference to the following: • 23.40 (cm^3)	Allow 23.4 (cm^3)	**(1)** **Expert**

Question Number	Answer	Additional Guidance	Mark
4(c)	A description that makes reference to the following points: • add the acid (quickly) until just short of the rough end-point **(1)** • add the acid drop-by-drop **(1)** • with swirling **and** until the indicator colour (just) changes **(1)**	Accept within 1– 4 cm^3 (any value in this range) before the rough titre Allow to a value in the range 19.4 – 22.4 cm^3 Allow 'until close to the rough value' Ignore 'carbonate added' Do not award 'until the rough value is reached' Standalone mark (award even if M1 not given) Allow 'dropwise' Allow 'a few drops at a time' Ignore 'add very slowly' Allow any indication of mixing Allow shaking Allow stirring Allow until the end-point Allow any stated final colour Ignore references to filling the burette, use of the pipette, white tiles	**(3)** Expert **Clip with (b)**

Question Number	Answer	Additional Guidance	Mark
4(d)	• calculation of moles of sodium carbonate **(1)** • use of 2:1 ratio to gives moles of HCl in 22.65 cm^3 **(1)** • concentration of hydrochloric acid in mol dm^{-3} **(1)**	Example of calculation mol Na_2CO_3 = 25.0 × 0.105 ÷ 1000 = 2.625 × 10^{-3} / 0.002625 2 × 2.625 × 10^{-3} = 5.25 × 10^{-3} 5.25 × 10^{-3}× 1000 ÷ 22.65 = 0.23179 / 2.3179 × 10^{-1} (mol dm^{-3}) The reacting volumes transposed gives the final concentration of hydrochloric acid = 0.19026 (mol dm^{-3}). This scores (2) The same volume used twice will give the final concentration of hydrochloric acid = 0.2100 (mol dm^{-3}). These score (2) TE at each stage Ignore SF except 1 SF Allow any correct method Correct answer with some working scores (3)	**(3)** Expert

(Total for Question 4 = 9 marks)
(Total for Paper = 50 marks)

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