# Mark Scheme (Results)

## Summer 2019

Pearson International Advanced Subsidiary Level
In Chemistry (WCH13) Paper 01 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.

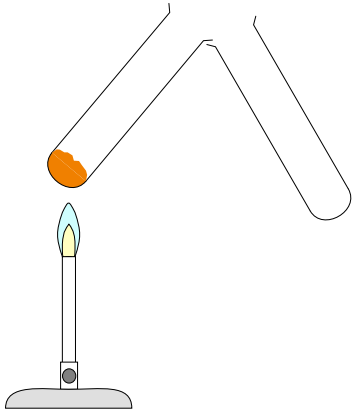
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

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.

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **1(a)** | • correct balanced equation | Example of correct equation:<br>$(NH_4)_2CO_3 \rightarrow 2NH_3 + H_2O + CO_2$<br>Allow multiples<br>$H_2CO_3$ for $H_2O + CO_2$<br>Ignore state symbols even if incorrect | **(1)** |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 1(b) | | For all the tests ignore indicators<br>If name and formula given both must be correct<br>Observation marks are dependent on test | (6) |
| | **For ammonia**<br>• test: reaction with hydrogen chloride / HCl(g) **(1)** | Allow (add /introduce / place next to) HCl<br>If HCl(aq) / conc HCl is used a suitable method is needed e.g. dipping a glass rod into HCl(aq) or opening a bottle of HCl(aq) close to the ammonia.<br>Do not award 'add hydrochloric acid' / HCl(aq) / other hydrogen halides but allow the result mark | |
| | • result: white smoke **(1)** | Allow white fumes / white solid<br>Do not award steamy / misty fumes / precipitate /cloud | |
| | **For water**<br>• test: add (anhydrous) copper((II)) sulfate or cobalt((II)) chloride **(1)** | Accept $CuSO_4$ / $CoCl_2$ | |
| | • result: white to blue or blue to pink **(1)** | If start & finish colours are given both must be correct<br>Allow just $CuSO_4$ turns blue or $CoCl_2$ turns pink<br>Allow observation mark if $CuSO_4$ / $CoCl_2$ solutions are used<br>Do not award $CoCl_2$ turns red | |
| | **For carbon dioxide**<br>• test: (add / add to) lime water or (saturated) solution of calcium hydroxide **(1)** | Ignore boiling temperature measurement<br>Accept $Ca(OH)_2$((aq)) | |
| | • result: any indication that a white suspension is formed **(1)** | turns cloudy / turns milky<br>/ white precipitate forms | |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 1(c) | Diagram showing collecting test tube angled down with mouth of the tube close to and below that of the heated test tube | Example of diagram:<br>  <br>ALLOW angles to the vertical 0—75°<br>Ignore lime water in collecting tube<br>Do not award if additional apparatus used e.g. delivery tube.<br>Do not award if horizontal distance between test tube lips >1cm | (1) |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **1(d)(i)** | An answer that makes reference to the following points:<br><br>• white **and** precipitate (forms) **(1)**<br>• identifies the precipitate as barium carbonate **(1)** | Ignore subsequent tests in (i) and (ii)<br><br>Allow white solid / crystals<br>Accept formula $BaCO_3$<br>If name and formula are given, both must be correct<br>Ignore<br>ammonium chloride (and water) if the precipitate is clearly identified | **(2)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **1(d)(ii)** | An answer that makes reference to the following points:<br>• effervescence (precipitate dissolves) **(1)**<br><br>• carbon dioxide (is evolved) **(1)** | <br>Accept bubbling / bubbles / fizzing<br>Ignore gas evolves<br>Accept formula $CO_2$<br>Ignore<br>barium chloride / $BaCl_2$ (product)<br>ammonium chloride / $NH_4Cl$<br>water / $H_2O$ | **(2)** |

**(Total for Question 1= 12 marks)**

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(a)** | An answer that makes reference to the following points:<br>• suitable reagent **(1)**<br><br>• observation **(1)** | <br>Phosphorus(V) chloride / phosphorus pentachloride / $PCl_5$ (solid)<br>Allow thionyl chloride / $SOCl_2$<br>Do not award $PCl_5$ / $SOCl_2$ **solution** but allow the result mark<br><br>Steamy fumes / (dense) white fumes / misty fumes<br>Do not award white smoke<br>Allow<br>add sodium (1) and effervescence / fizzing / bubbles (1)<br>add named carboxylic acid **and** strong acid catalyst (1) gives fruity smell (1)<br>Do not award acidified dichromate and orange to green | **(2)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(b)(i)** | • potassium dichromate(VI) / $K_2Cr_2O_7$ / sodium dichromate(VI) / $Na_2Cr_2O_7$<br>**and**<br>sulfuric acid / $H_2SO_4$ | Allow<br>omission of the oxidation number<br>Just 'acid / acidified'<br>$Cr_2O_7^{2-}/H^+$<br>Ignore heat / reflux / concentrated<br>Do not award<br>Potassium manganate (VII)<br>potassium chromate((VI))<br>Incorrect oxidation number<br>e.g. potassium dichromate(IV)<br>hydrochloric acid / HCl / Nitric acid / $HNO_3$ | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(b)(ii)** | An answer that makes reference to the following points:<br>• choice of apparatus 1 **(1)**<br>• the ease of oxidation of the aldehyde **(1)** | Example of a justification:<br><br>The aldehyde is easily oxidised (to a carboxylic acid) / more easily oxidised than the alcohol<br>Allow<br>To prevent further oxidation<br>Partial oxidation occurs<br>Use of reflux (apparatus 2) results in further oxidation<br>M1 and M2 are standalone | **(2)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(b)(iii)** | An answer that makes reference to the following points:<br>• suitable reagent **(1)**<br>• result of the selected test **(1)** | **Route 1**<br>(warm with)<br>(blue) Fehling's / (blue) Benedict's reagent<br>Red / brown<br>**and**<br>precipitate / solid<br><br>**Route 2**<br>(warm with)<br>Tollens' reagent<br>Silver mirror or grey/ black precipitate<br><br>Ignore Brady's reagent<br>Do not award potassium dichromate(VI)<br>No observation TE on incorrect reagent | **(2)** |

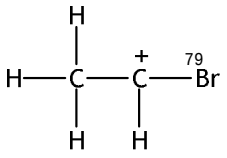
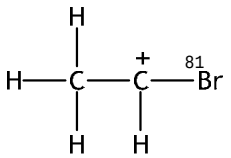
| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(b)(iv)** | An answer that makes reference to the following points:<br>• The alcohol cannot be identified **and** because there are two primary alcohols with the molecular formula $C_4H_{10}O$ | Accept<br>Alcohol could be<br>butan-1-ol / $CH_3CH_2CH_2CH_2OH$<br>or<br>2-methylpropan-1-ol / $(CH_3)_2CHCH_2OH$<br>both alcohols needed<br>Allow any clear structural / displayed / skeletal formulae<br>Ignore<br>just 'carbon chain could be straight or branched'<br>just 'there are isomers' | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(b)(v)** | An answer that makes reference to the following points:<br>• choice of apparatus 2 **(1)**<br>• ensuring complete reaction / oxidation **(1)** | M2 dependent on M1<br>Ignore subsequent distillation<br>Ignore<br>reference to preventing loss of volatile reagents or products.<br>Just 'because the ketone does not oxidise further'<br>Just 'reaction is slow' | **(2)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(c)(i)** | An answer that makes reference to any **two** of the following points:<br><br>• the mineral wool holds the alcohol in place (at the end of the tube) **(1)**<br><br>• the alcohol vapour would not pass over the catalyst slowly enough to react (without the mineral wool) **(1)**<br><br>• the mineral wool is chemically inert / does not react with the alcohol **(1)** | Ignore large surface area / high melting temperature / good absorbant / prevents evaporation (of the alcohol)/ slow reaction<br><br>Allow prevents the alcohol mixing with the aluminium oxide / $Al_2O_3$ / catalyst<br><br>Allow so the alcohol is not heated directly (by the Bunsen)<br><br>Ignore<br><br>Any reference to alcohol burning<br><br>Allow mineral wool does not burn | **2**<br><br>**exp** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(c)(ii)** | An explanation that makes reference to the following points:<br>• the possibility of suck-back **(1)**<br><br>EITHER<br>• explanation of the cause of suck-back **(1)**<br><br>OR<br>• description of the consequences of suck-back **(1)** | Examples of correct responses:<br>Suck-back will occur / Water will be drawn up into the reaction tube (from the water bath)<br>Do not award suck-back of anything other than water<br><br>(On cooling) the pressure in the tube drops and atmospheric pressure acting on the water in the water bath which causes a pressure difference (resulting in suck-back)<br><br>Allow just drop in pressure / vacuum formed in the reaction tube.<br><br>Do not award<br>just 'cooling causes suck-back'<br>just 'due to pressure differences'<br><br>Cold water causes hot tube to crack<br>Allow just test tube cracks/shatters<br>Do not award<br>water will react with the aluminium oxide / tube explodes | **(2)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(d)(i)** | Red-brown / brown to colourless | Both needed<br>Allow orange to colourless<br>Allow orange-brown to colourless<br>Allow yellow to colourless<br>Ignore 'clear'<br>Do not award red | **(1)** |

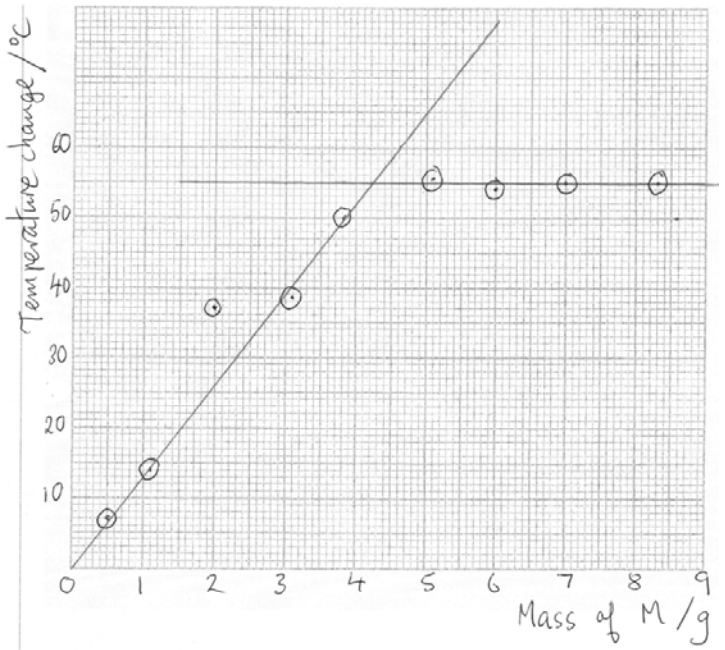
| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **2(d)(ii)** | An explanation that makes reference to the following points:<br>• identification of the peaks by molecular formula or structure **(1)**<br>• only 2,3-dibromobutane can produce the fragments at *m* / *z* = 107 and *m* / *z* = 109 **(1)**<br>• Identifies butan-2-ol as the **only** alcohol that can form but-2-ene (as a product of dehydration and only but-2-ene can form 2,3-dibromobutane) **(1)** | Do **not** penalise omission of charges<br>$C_2H_4{}^{79}Br^+$ and $C_2H_4{}^{81}Br^+$<br>OR<br>  <br>  <br>Allow peaks due to $C_2H_4Br^{(+)}$<br>Allow identifies $C_4H_8Br_2$ as 2,3-dibromobutane<br>Do not award<br>Just 'alcohol must be butan-2-ol'<br>Just a sequence of structures | **(3)** |

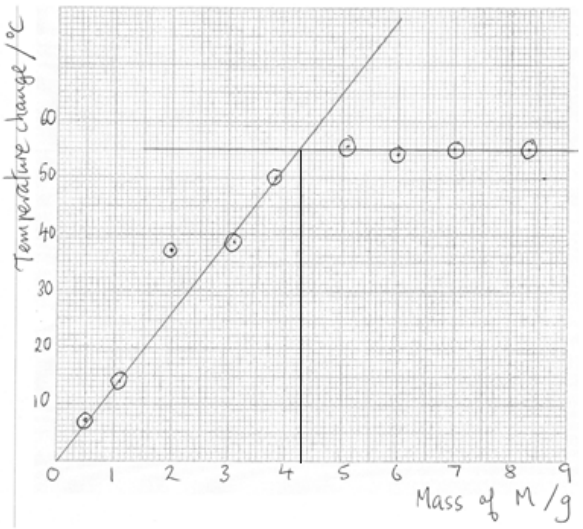
**(Total for Question 2= 18 marks)**

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3(a)(i)** | An answer that makes reference to the following:<br>• the stability of the polystyrene cup | To ensure that the polystyrene cup does not tip over<br>Because the cup is so light, it tips over easily<br>Allow<br>Just 'to provide support'<br>So if the polystyrene cup is damaged the reaction mixture will go into the beaker<br><br>Do not award<br>To prevent heat loss<br>To provide insulation<br>Because the polystyrene cup gets hot<br><br>Ignore<br>Just 'to prevent spillage' | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3(a)(ii)** | • pipette | Accept<br>50 $cm^3$ pipette<br>25 $cm^3$ pipette (twice)<br>graduated pipette<br>Allow<br>burette / measuring cylinder<br>/ volumetric flask<br>Do not award beaker / flask | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3(a)(iii)** | • heat loss is similar for all the experiment runs | Allow to minimise heat loss<br>Allow no heat loss<br>Allow reverse argument e.g. heat loss greater with filings<br>Do not award<br>so reaction goes to completion<br>Ignore<br>References to reaction rate<br>References to temperature | **(1)**<br>**exp** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 3(b)(i) | • suitable choice of scale and correct choice of axes **(1)**<br>• axes labelled, with units **(1)**<br>• all points plotted correctly **(1)** | Example of graph below<br>  <br><br>Points plotted should cover at least 50% of the graph in both directions. Allow 2 g per large square on x-axis with y-axis scale as shown.<br>Allow 'temperature' and 'T' for 'temperature change'<br>Ignore punctuation errors e.g. (g) instead of /g<br>Ignore scale errors that lie outside the range of the points plotted | **(3)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 3(b)(ii) | • two best fit lines **(1)**<br><br>• correct reading of the mass at the intersection of the best fit lines **(1)** |  <br>Allow reasonable best fit line close to points 1, 2, 4 and 5<br>If the line is continued to the axis it must be within one small square of the origin<br>Do not award a BFL that includes point 3<br>Second line should be horizontal at about 55°C<br>Do not award if horizontal line deviates 2 small squares from extreme left to extreme right<br>4.1—4.5 (g)<br>TE on lines drawn but do not award unless value is obtained from the intersection of a **straight**, angled best fit line and a straight best fit line through the last four points | **(2)** |

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr>
<td>3(b)(iii)</td>
<td>
<ul>
<li>calculation of amount (moles) of copper(II) sulfate (1)</li>
<li>equating of moles of copper(II) sulfate and of M via equation (1)</li>
<li>calculation of $A_r$ of M to 2 or 3 SF (1)</li>
</ul>
</td>
<td>
Example of calculation<br>
Do not penalise intermediate rounding unless incorrect or 1 SF<br>
TE on mass from 3(b)(ii) and at each stage<br>
amount of $CuSO_4$<br>
$= 50.0 \times 1.35 \times 10^{-3}$<br>
$(= 6.75 \times 10^{-2} / 0.0675$ mol)<br>
From equation<br>
4.3 g of M ≡ mol $CuSO_4$ $= 50.0 \times 1.35 \times 10^{-3}$<br>
$A_r$ of M $= 4.3 / 6.75 \times 10^{-2} = 64 / 63.7$<br>
If no working, correct answer to 3 SF using data from (b)(ii) scores (3)
<table>
<tr><th>Mass</th><th>$A_r$</th></tr>
<tr><td>4.1</td><td>61 / 60.7</td></tr>
<tr><td>4.2</td><td>62 / 62.2</td></tr>
<tr><td>4.4</td><td>65 / 65.2</td></tr>
<tr><td>4.5</td><td>67 / 66,7</td></tr>
</table>
Ignore units of g $mol^{-1}$
</td>
<td>(3)</td>
</tr>
</table>

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| 3(b)(iv) | • Mixture was not stirred (effectively)<br>Or<br>• local heating occurred | Allow<br>Temperature of the solution was not uniform<br><br>Do not award<br>incorrect quantities used<br>temperature / mass measured incorrectly<br>heat loss<br>incomplete reaction<br>reactants not mixed | (1) |

**(Total for Question 3= 12 marks)**

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **4(a)** | An answer that makes reference to the following:<br>• results that are within 0.2 $cm^3$ | Allow<br>within 0.1 $cm^3$<br>±0.1 $cm^3$ of the mean<br>results 0.2 / 0.1 ($cm^3$) apart<br>Do not award ±0.2 $cm^3$<br>Ignore<br>Omission of units<br>Reference to 'good agreement' / similar values / same values | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **4(b)** | ((24.10 + 24.30)/2) = 24.2(0) ($cm^3$) | | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **4(c)** | • from yellow **(1)**<br>• to orange **(1)** | Do not award red<br>Correct colours in reverse order scores (1) | **(2)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **4(d)** | Possible route through the calculation<br>• calculation of amount of hydrochloric acid **(1)**<br>• calculation of amount of NaOH in 250 $cm^3$ (1:1 ratio) **(1)**<br>• calculation of mass of NaOH **(1)**<br>• calculation of percentage purity of NaOH **(1)** | TE on mean titre from (b) and TE at each stage<br>mol (HCl) = $24.20 \times 0.095 \times 10^{-3}$<br>$= 2.299 \times 10^{-3} / 0.002299$<br>NaOH (in 250) = $10 \times 2.299 \times 10^{-3}$ (mol)<br>$= 2.299 \times 10^{-2} / 0.02299$ (mol)<br>Mass NaOH (in 250)<br>$= 40 \times 2.299 \times 10^{-2} = 0.9196$ (g)<br>Purity NaOH = 100 x 0.9196 / 0.95<br>= 96.8%<br>Ignore SF except 1 SF<br>Do not award purity >100% or any value based on an uncalculated mass of NaOH<br>Correct answer no working scores (4)<br>If mean titre calculated using all four titres (24.28 $cm^3$) purity = 97.12%<br>If calculated using all last three titres (24.03 $cm^3$) purity = 96.13% | **(4)** |

**(Total for Question 4 = 8 marks)**
**Total for Paper = 50 marks**

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