# Chemistry 2019 v1.4

IA1 sample marking scheme

August 2022

## Data test (10%)

This sample has been compiled by the QCAA to model one possible approach to allocating marks in a data test. It matches the examination mark allocations as specified in the syllabus (~ 30% apply understanding, ~ 30% analyse evidence and ~ 40% interpret evidence) and ensures that a balance of the objectives are assessed.

### Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

2. apply understanding of chemical equilibrium systems or oxidation and reduction to given algebraic, visual or graphical representations of scientific relationships and data to determine unknown scientific quantities or features
3. analyse evidence about chemical equilibrium systems or oxidation and reduction to identify trends, patterns, relationships, limitations or uncertainty in datasets
4. interpret evidence about chemical equilibrium systems or oxidation and reduction to draw conclusions based on analysis of datasets.

**Note:** Objectives 1, 5, 6 and 7 are not assessed in this instrument.

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# Instrument-specific marking guide (ISMG)

## Criterion: Data test

### Assessment objectives

2. apply understanding of chemical equilibrium systems or oxidation and reduction to given algebraic, visual or graphical representations of scientific relationships and data to determine unknown scientific quantities or features
3. analyse evidence about chemical equilibrium systems or oxidation and reduction to identify trends, patterns, relationships, limitations or uncertainty in datasets
4. interpret evidence about chemical equilibrium systems or oxidation and reduction to draw conclusions based on analysis of datasets

| The student work has the following characteristics: | Cut-off | Marks |
|---|---|---|
| • consistent demonstration, across a range of scenarios about chemical equilibrium systems or oxidation and reduction, of<br>– selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications<br>– correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data<br>– correct and appropriate use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty<br>– correct interpretation of evidence to draw valid conclusions. | > 90% | 10 |
| | > 80% | 9 |
| • consistent demonstration, in scenarios about chemical equilibrium systems or oxidation and reduction, of<br>– selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications<br>– correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data<br>– correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty<br>– correct interpretation of evidence to draw valid conclusions. | > 70% | 8 |
| | > 60% | 7 |
| • adequate demonstration, in scenarios about chemical equilibrium systems or oxidation and reduction, of<br>– selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications<br>– correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data<br>– correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty<br>– correct interpretation of evidence to draw valid conclusions. | > 50% | 6 |
| | > 40% | 5 |

| | | |
|---|---|---|
| • demonstration, in scenarios about chemical equilibrium systems or oxidation and reduction, of elements of<br>– selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications<br>– correct calculation of quantities through the use of algebraic, visual or graphical representations of scientific relationships or data<br>– correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations or uncertainty<br>– correct interpretation of evidence to draw valid conclusions. | > 30% | 4 |
| | > 20% | 3 |
| • demonstration, in scenarios about chemical equilibrium systems or oxidation and reduction, of elements of<br>– application of scientific concepts, theories, models or systems to predict outcomes, behaviours or implications<br>– calculation of quantities through the use of algebraic or graphical representations of scientific relationships and data<br>– use of analytical techniques to identify trends, patterns, relationships, limitations or uncertainty<br>– interpretation of evidence to draw conclusions. | > 10% | 2 |
| | > 1% | 1 |
| • does not satisfy any of the descriptors above. | ≤ 1% | 0 |

# Task

See the sample assessment instrument for IA1: Data test (10%) (available on the QCAA Portal).

# Sample marking scheme

| Criterion | Marks allocated | Provisional marks |
| --- | --- | --- |
| **Data test**<br>Assessment objectives 2, 3, 4 | 10 | — |
| **Total** | **10** | **—** |

# Marking scheme symbols and abbreviations

| Symbol or abbreviation | Meaning |
|---|---|
| ✓ | The preceding section of the expected response is worth one mark. |
| / | Separates acceptable alternative wordings in the expected response. |
| () | Terms in brackets are not necessary in the response for the mark to be awarded. |
| shaded and underlined text | Shaded and underlined text must be included in the response for the mark to be awarded. |
| Accept converse. | Award the mark even if the answer is stated in its converse form, e.g. 'A comes before B' can be stated as 'B comes after A'. |
| Accept min–max. | Award the mark for any numerical answer that falls within the specified range, e.g. 'Accept 1.5–1.9' means that any answer between 1.5 and 1.9 should be considered correct.<br>This is used in questions that involve a multi-step calculation where differences in rounding in the intermediate steps could result in slight differences in the final answer. |
| Allow for FT error … | Means 'allow for follow-through error'.<br>Initial errors should only be penalised once. Marks should be awarded for subsequent steps that are correct. |
| Allow FT error for transcription only. | Follow-through error is only allowed if the student has written down information incorrectly but processed it correctly. |
| AND | Separates two parts of the response that are both required for the mark to be awarded. |
| Correct d.p. required. | The answer must be stated to the number of decimal places indicated in the question for the mark to be awarded. |
| Correct s.f. required. | The answer must be stated to the correct number of significant figures indicated in the question for the mark to be awarded. |
| Max. # marks | The maximum number of marks that can be awarded for the question is indicated by #. |
| OR | Separates acceptable alternative wordings. |
| OWTTE | Means 'or words to that effect'.<br>This is used in questions where students are unlikely to use the exact wording given in the expected response. If the student's response has the same meaning as the expected response, then the mark should be awarded. |
| Working not required | Evidence of working, reasoning or calculations is not required for the mark to be awarded. |

The annotations are written descriptions of the expected response for each question and are related to the assessment objectives.

| Assessment objective | Marking scheme | Mark allocation<br>Note: ✓ = 1 mark |
|---|---|---|
| **Apply understanding**<br>The question uses the cognitive verb 'determine'.<br>The expected response is an unknown scientific quantity. | **Question 1 (1 mark)**<br>5.3 ✓ | 1 mark for correct pH. Accept 5.2–5.4. Working not required. |
| **Analyse evidence**<br>The question uses the cognitive verb 'distinguish'.<br>The expected response identifies a relationship. | **Question 2 (3 marks)**<br>Volume of HCl at equivalence point is 17.6 $cm^3$✓<br>Volume HCl at half equivalence point = $\frac{17.6}{2}$ = 8.8 $cm^3$<br>OR<br>The volume of HCl at the half equivalence point is 8.8 $cm^3$, which is half the volume at the equivalence point.✓<br>pH at half equivalence = 9.2<br>AND<br>The pH at the half equivalence point is higher than the pH at the equivalence point.<br>OR<br>pH at half equivalence = 9.2<br>AND<br>The pH at the half equivalence point is found on the flat 'buffer' section of the curve and the pH at the equivalence point is found on the vertical section of the curve.✓ | 1 mark for correct volume at equivalence point. Allow for FT error from Question 1. Units not required.<br>1 mark for calculating volume of HCl at the half equivalence point and showing working or reasoning that this is half the volume at the equivalence point. Units not required. Allow for FT error.<br>1 mark for determining the pH at the half equivalence point and distinguishing between it and the pH at equivalence. Allow for FT error. |
| **Apply understanding**<br>The question uses the cognitive verb 'determine'.<br>The expected response is an unknown scientific quantity. | **Question 3 (1 mark)**<br>$pK_b = 14 - 9.2 = 4.8$✓ | 1 mark for correct $pK_b$. Allow for FT error from Question 2. |
| **Interpret evidence**<br>The question uses the cognitive verb 'deduce'.<br>The expected response draws a conclusion based on analysis. | **Question 4 (2 marks)**<br>Methyl red✓<br>pH equivalence point falls within the end point / pH range of the indicator.✓<br>OWTTE | 1 mark for correct indicator. Allow for FT error from Question 2.<br>1 mark for justification of choice of indicator. |

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| **Apply understanding**<br><br>The question uses the cognitive verb 'calculate'.<br><br>The expected response is an unknown scientific quantity. | **Question 5 (3 marks)**<br><br>Moles of ammonia in aliquot of diluted cleaning product<br>= moles of HCl at equivalence<br>= 0.100 × 17.6 / 1000<br>= 0.001 76 mol✓ ($1.76 \times 10^{-3}$ mol)<br><br>Concentration of ammonia in the aliquot of diluted cleaning product<br>= $\frac{0.001\,76}{0.025}$<br>= 0.0704 mol $dm^{-3}$✓<br><br>Concentration of ammonium in undiluted cleaning product<br>= 0.0720 × 50 (dilution factor) = 3.52 mol $dm^{-3}$✓ | 1 mark for calculating moles of HCl at equivalence point. Accept 0.00175–0.00177. Units not required.<br><br>1 mark for calculating concentration of ammonia in the aliquot. Allow for FT error. Units not required.<br><br>1 mark for calculating concentration of ammonium in undiluted cleaning product. Allow for FT error. |
| **Analyse evidence**<br><br>The question uses the cognitive verb 'sequence'.<br><br>The expected response identifies a relationship. | **Question 6 (2 marks)**<br><br>A, C, B, D ✓<br>Metal A displaces all metal ions from solution; therefore, it is the most reactive.<br><br>AND<br><br>C displaces $B^{2+}_{(aq)}$ and $D^{+}_{(aq)}$ from solution; therefore, C is more reactive than B and D.<br><br>AND<br><br>B displaces $D^{+}_{(aq)}$ from solution; therefore, B is more reactive than D.✓<br><br>OWTTE. | 1 mark for correct reactivity series.<br><br>1 mark for reasoning. Accept converse. |
| **Apply understanding**<br><br>The question uses the cognitive verb 'identify'.<br><br>The expected response is an unknown scientific feature. | **Question 7 (1 mark)**<br><br>Voltaic cell 3<br><br>OR<br><br>$A_{(s)}$ I $A^{2+}_{(aq)}$ II $D^{+}_{(aq)}$ I $D_{(s)}$✓ | 1 mark for correct voltaic cell. |
| **Analyse evidence**<br><br>The question uses the cognitive verb 'identify'.<br><br>The expected response identifies a relationship. | **Question 8 (1 mark)**<br><br>The greater the difference in the reactivity of the metals, the greater the voltage produced by the voltaic cell. ✓ | 1 mark for correct relationship. Do not allow for FT error from Question 6. |
| **Interpret evidence**<br><br>The question uses the cognitive verb 'deduce'.<br><br>The expected response draws a conclusion based on analysis. | **Question 9 (2 marks)**<br><br>A voltaic cell constructed using metals B and C as electrodes would produce a smaller potential difference than voltaic cell 1. ✓<br><br>C is less reactive than A / closer to B on the activity series than A.✓<br>OWTTE | 1 mark for deducing that the potential difference would be smaller.<br><br>1 mark for reason. Accept converse. Do not allow for FT error from Question 6. |

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| **Interpret evidence**<br><br>The question uses the cognitive verb 'predict'.<br><br>The expected response draws a conclusion based on analysis. | **Question 10 (2 marks)**<br><br>C would be oxidised (and B would be reduced). ✓<br><br>C would be oxidised because it is more reactive than B. ✓ | 1 mark for identifying that C would be oxidised.<br><br>1 mark for reason. Do not allow for FT error from Question 6. |
| **Interpret evidence**<br><br>The question uses the cognitive verb 'deduce'.<br><br>The expected response draws a conclusion based on analysis. | **Question 11 (2 marks)**<br><br>Oxidation: $C_{(s)} \rightarrow C^{+}_{(aq)} + e^{-}$<br>AND<br>Reduction: $B^{2+}_{(aq)} + 2e^{-} \rightarrow B_{(s)}$<br>OR<br>$C_{(s)} + B^{2+}_{(aq)} \rightarrow B_{(s)} + C^{+}_{(aq)}$ ✓<br><br>$2C_{(s)} + B^{2+}_{(aq)} \rightarrow B_{(s)} + 2C^{+}_{(aq)}$ ✓ | 1 mark for correct half equations or unbalanced equation. Allow for FT error from Question 10.<br><br>1 mark for balancing the equation. Do not penalise if states are missing. |

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