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Queensland Curriculum and Assessment Authority

Chemistry 2025 v1.2

IA1: Sample assessment instrument

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Student name	sample only
Student number	sample only
Teacher	sample only
Exam date	sample only

Marking summary

Criterion	Marks allocated	Provisional marks
Data test (10%)	10	
Overall	**10**	

Conditions

Technique	Data test
Unit	Unit 3: Equilibrium, acids and redox reactions
Topic/s	Topic 1: Chemical equilibrium systems Topic 2: Oxidation and reduction
Time	1 hour + 5 minutes perusal
Seen / Unseen	Unseen questions and data sets
Other	QCAA-approved graphics or scientific calculator permitted.

Instructions

Use the datasets to respond to the associated questions in the spaces provided. Each question is associated with the dataset that immediately precedes it.

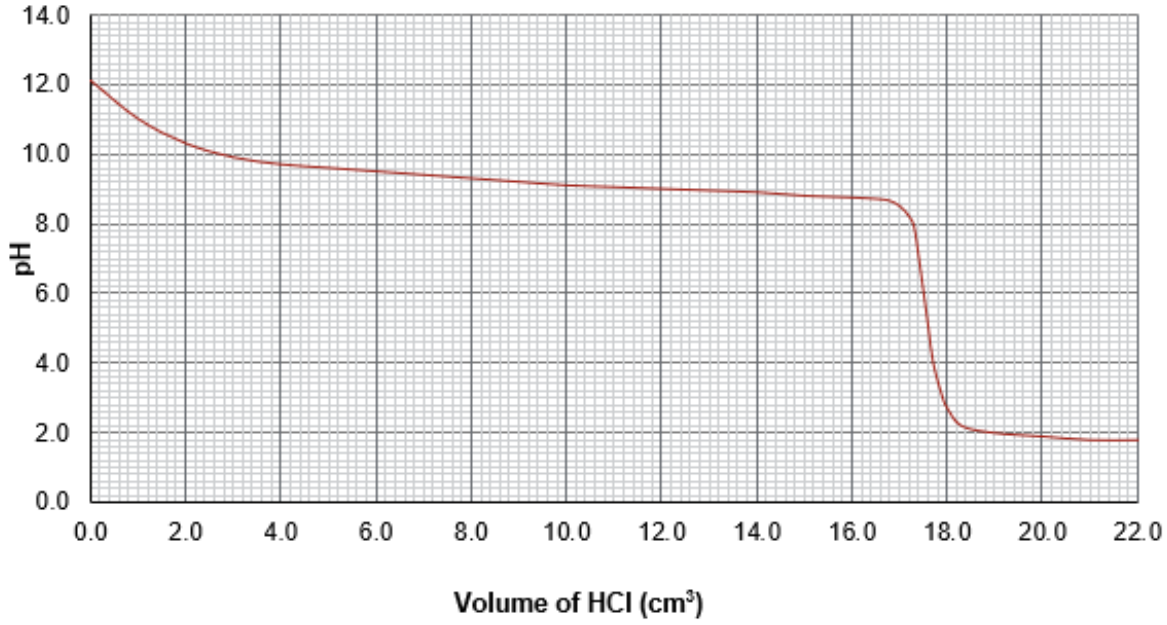
Dataset 1

An experiment was carried out to determine the concentration of ammonia in a cleaning product. Ammonia dissociates in water to give ammonium and hydroxide according to the following equilibrium:

$$NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

A cleaning product was diluted 1:50. A 25.00 cm^3 sample of the diluted cleaning product was titrated with 0.100 M HCl. The results are shown in Figure 1.

Figure 1: Ammonia solution titrated with HCl



Question 1 (1 mark)

Determine the pH at the half-equivalence point.

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Question 2 (1 mark)

Determine the pK_b for ammonia.

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Question 3 (2 marks)

Contrast the half-equivalence point and the equivalence point in terms of pH and volume. Use data from Figure 1 to support your response.

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Question 4 (2 marks)

Deduce which indicator from the *Chemistry formula and data booklet* would be most appropriate for this titration. Give a reason for your conclusion.

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Question 5 (3 marks)

Calculate the concentration of ammonia (NH_3) in the cleaning product. Show your working.

Dataset 2

An experiment was conducted to address the following research question:

What is the relationship between the reactivity series of metals and the voltage produced by a voltaic cell?

Four unknown metals, labelled A, B, C and D, were each placed into four different 1.0 M metal nitrate solutions. The qualitative results are shown in Table 1.

Samples of metals A, B, C and D were combined with their metal ion solutions to create half-cells. Pairs of half-cells were then combined to construct voltaic cells. The voltages for each voltaic cell are shown in Table 2.

Table 1: Reactions of metals

	Metal ion nitrate solution (1.0 M)			
Metal	**$A(NO_3)_{2(aq)}$**	**$B(NO_3)_{2(aq)}$**	**$C(NO_3)_{(aq)}$**	**$D(NO_3)_{(aq)}$**
$A_{(s)}$	NR	Coating on metal	Coating on metal	Coating on metal
$B_{(s)}$	NR	NR	NR	Coating on metal
$C_{(s)}$	NR	Coating on metal	NR	Coating on metal
$D_{(s)}$	NR	NR	NR	NR

NR = no reaction

Table 2: Potential difference, in volts, for each voltaic cell with anode metal $A_{(s)}$

Voltaic cell	Cathode metal	Potential difference (± 0.05 V)			Mean potential difference (V)	Absolute uncertainty of the mean (± V)
		Trial 1	Trial 2	Trial 3		
1	$B_{(s)}$	2.25	2.40	2.20	2.28	0.10
2	$C_{(s)}$	1.30	1.28	1.37	1.32	0.45
3	$D_{(s)}$	3.11	3.15	3.04	3.10	0.55

Question 6 (3 marks)

Sequence the metals from most reactive to least reactive. Use the data in Table 1 to support your reasoning.

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Question 7 (1 mark)

Identify the voltaic cell that produced the greatest potential difference.

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Question 8 (1 mark)

Identify the relationship between the difference in reactivity of the metals used to construct a voltaic cell and the potential difference produced by the cell.

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Question 9 (2 marks)

Deduce whether a voltaic cell constructed using metals B and C as electrodes would produce a greater or smaller potential difference than voltaic cell 1. Use data from Table 1 to support your reasoning.

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Question 10 (2 marks)

Predict which metal would be oxidised in a voltaic cell constructed using metals B and C as electrodes. Use data from Dataset 2 to support your reasoning.

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Question 11 (2 marks)

Deduce the balanced equation for the voltaic cell constructed using metals B and C as electrodes.

Instrument-specific marking guide (IA1): Data test (10%)

Data test	Cut-off	Marks
The student response has the following characteristics:		
• consistent demonstration, across a range of scenarios, of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct and appropriate use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions	>90%	10
	>80%	9
• consistent demonstration of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions	>70%	8
	>60%	7
• adequate demonstration of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions	>50%	6
	>40%	5
• demonstration of elements of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual or graphical representations of scientific relationships or data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations or uncertainty – correct interpretation of evidence to draw valid conclusions	>30%	4
	>20%	3
• demonstration of elements of – application of scientific concepts, theories, models or systems to predict outcomes, behaviours or implications – calculation of quantities through the use of algebraic or graphical representations of scientific relationships and data – use of analytical techniques to identify trends, patterns, relationships, limitations or uncertainty – interpretation of evidence to draw conclusions.	>10%	2
	>1%	1

Data test	Cut-off	Marks
The student response does not match any of the descriptors above.		0