

5.1.1 Choose cell direction and interpret electrode data

Name: _____ Class: _____ Date: _____

Total: 19 marks

KEY WORDS evidence • conditions

Objective

Choose cell direction and interpret electrode data. All questions and marking guidance are original.

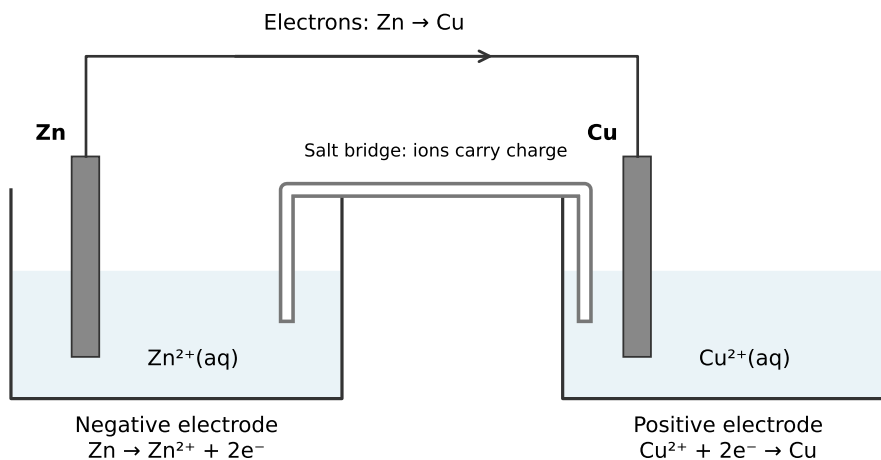
1 Key knowledge and worked examples

Reduction potentials compare half-cells with the standard hydrogen electrode: 298 K, 100 kPa gas pressure and 1.00 mol dm⁻³ solute concentrations. A metal solid can be its own electrode; an all-solution pair needs an inert conductor such as platinum. The salt bridge carries ions, while the wire carries electrons.

■ Worked method

For $\text{Zn}^{2+}/\text{Zn} = -0.76 \text{ V}$ and $\text{Cu}^{2+}/\text{Cu} = +0.34 \text{ V}$, copper(II) is reduced and zinc oxidised. $E_{\text{cell}}^{\circ} = 0.34 - (-0.76) = 1.10 \text{ V}$. Cell diagram: $\text{Zn(s)} \mid \text{Zn}^{2+}(\text{aq}) \parallel \text{Cu}^{2+}(\text{aq}) \mid \text{Cu(s)}$. Multiply half-equations to cancel electrons, but never multiply voltages. Positive E° predicts standard thermodynamic feasibility, not rate or the result under every concentration.

Spontaneous zinc-copper cell: schematic



2 Practice

2.1 State the standard hydrogen electrode materials and conditions.

[4]

2.2 For $\text{Ag}^{+}/\text{Ag} = +0.80 \text{ V}$ and $\text{Cu}^{2+}/\text{Cu} = +0.34 \text{ V}$, identify the positive electrode and calculate E°_{cell} .

[2]

2.3 Explain why an $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell uses platinum and a salt bridge. Identify what carries charge in each part.

[3]

3 Exam-style questions

3.1 Combine Ag^+/Ag and Cu^{2+}/Cu into a spontaneous equation. Explain why doubling the silver half-equation does not double its potential. [4]

3.2 A proposed reaction has positive E°_{cell} but shows no visible change. Give two distinct reasons why this need not contradict the standard prediction. [2]

3.3 Hypothetical $\text{A}^{3+}/\text{A}^{2+}$ is +0.20 V and A^{2+}/A is +0.60 V. Test disproportionation of A^{2+} . Give the balanced equation, voltage and relation to K for that reaction. [4]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 Platinum and hydrogen/ H^+ contact, 298 K, hydrogen at 100 kPa, H^+ at 1.00 mol dm^{-3} .

2.2 Silver is positive, with Ag^+ reduced; $E^\circ = 0.80 - 0.34 = +0.46 \text{ V}$.

2.3 Platinum provides an inert electron contact because neither couple member is a conducting solid. Bridge ions complete the circuit/maintain charge balance; electrons move in the external wire.

3.1 $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$; $2\text{Ag}^+ + 2\text{e}^- \rightarrow 2\text{Ag}$. Overall $\text{Cu} + 2\text{Ag}^+ \rightarrow \text{Cu}^{2+} + 2\text{Ag}$. Voltage is energy transfer per charge; scaling reaction and charge together leaves it unchanged.

3.2 A high activation barrier can make it too slow. Actual concentrations/temperature may differ from standard conditions, changing potentials.

3.3 $3\text{A}^{2+} \rightarrow 2\text{A}^{3+} + \text{A}$. Reduction is A^{2+} to A, oxidation reverses $\text{A}^{3+}/\text{A}^{2+}$; $E^\circ = 0.60 - 0.20 = +0.40 \text{ V}$. Positive voltage corresponds to $K > 1$ under the stated standard model.