

Galvanic cells, electrode potentials and electrolysis

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Lab answers

Model answers use the sample class data. Your own readings may differ slightly because of surface oxide, solution age and the salt bridge, but the order of the metals and the downward trend with dilution should match.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB R3.2

Question 1 Order of reactivity

Larger emf against copper means a stronger reducing agent: **magnesium (2.60 V), then zinc (1.08 V), then iron (0.74 V), then tin (0.46 V).**

Question 2 Electrode potentials

$E^\circ(\text{M}) = 0.34 - \text{emf}$: $\text{Mg} = 0.34 - 2.60 = \mathbf{-2.26\text{ V}}$; $\text{Zn} = \mathbf{-0.74\text{ V}}$; $\text{Fe} = \mathbf{-0.40\text{ V}}$; $\text{Sn} = \mathbf{-0.12\text{ V}}$. These are close to the data-book values (-2.37 , -0.76 , -0.44 , -0.14).

Question 3 Comparing with the data book

Mg : $(2.71 - 2.60) \div 2.71 \times 100 = \mathbf{4.1\%}$. Zn : $(1.10 - 1.08) \div 1.10 \times 100 = \mathbf{1.8\%}$.

Question 4 Why results differ

Three reasons: the solutions were 0.10 mol/dm^3 rather than 1.00 mol/dm^3 ; magnesium had an oxide layer; a filter-paper salt bridge has resistance (the temperature was also not 298 K and the voltmeter draws a small current).

Question 5 Concentration trend

The emf **falls steadily** as $[\text{Cu}^{2+}]$ falls. From 1.10 V to 1.02 V over three tenfold dilutions: $0.08 \div 3 = \mathbf{0.027\text{ V per dilution}}$ (about 0.03 V).

Question 6 Explaining the trend

Lowering $[\text{Cu}^{2+}]$ moves the equilibrium to the left, so reduction of Cu^{2+} at the cathode is less favourable. The copper electrode becomes less positive and the difference from zinc shrinks, so **the emf is lower**.

Question 7 Equipment and improvement

A high-resistance voltmeter draws almost no current, so the reading is close to the true emf and the concentrations do not change during the reading. To improve reliability, **repeat each cell with fresh solutions and fresh salt bridges**, and average the readings.