

Cells, cell potential and electrolysis

AP Chemistry · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test covers cell potentials, free energy, equilibrium, the Nernst equation and Faraday's law. Show all working and give units. A data table is allowed. The paper is worth 20 marks.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 9

Time: 40 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Anode and cathode (2 marks)

- State the process that occurs at the anode of any cell. (1 mark)
- State the sign of the anode in a galvanic cell and in an electrolytic cell. (1 mark)

Question 2 Magnesium and nickel cell (3 marks)

$E^\circ(\text{Mg}^{2+}/\text{Mg}) = -2.37 \text{ V}$; $E^\circ(\text{Ni}^{2+}/\text{Ni}) = -0.25 \text{ V}$. A cell is built from these half-cells.

- Identify the cathode and write its half-reaction. (1 mark)
- Calculate E°_{cell} . (1 mark)
- Write the balanced overall equation. (1 mark)

Question 3 Free energy and K for tin and copper (3 marks)

$\text{Sn} + \text{Cu}^{2+} \rightarrow \text{Sn}^{2+} + \text{Cu}$. $E^\circ(\text{Cu}^{2+}/\text{Cu}) = +0.34 \text{ V}$, $E^\circ(\text{Sn}^{2+}/\text{Sn}) = -0.14 \text{ V}$. Use $F = 96\,485 \text{ C/mol}$ and $\log K = nE^\circ/0.0592$.

- Calculate E°_{cell} . (1 mark)
- Calculate ΔG° in kJ/mol. (1 mark)
- Calculate K. (1 mark)

Question 4 Voltage away from standard (2 marks)

A Zn/Cu cell has $[\text{Zn}^{2+}] = 0.010 \text{ mol/dm}^3$ and $[\text{Cu}^{2+}] = 1.0 \text{ mol/dm}^3$ at 25°C . $E^\circ = 1.10 \text{ V}$ and $n = 2$.

- Calculate Q. (1 mark)
- Calculate E using the Nernst equation. (1 mark)

Question 5 Silver plating (3 marks)

A current of 0.500 A flows for 30.0 min through silver nitrate solution, $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$. $M(\text{Ag}) = 107.87 \text{ g/mol}$.

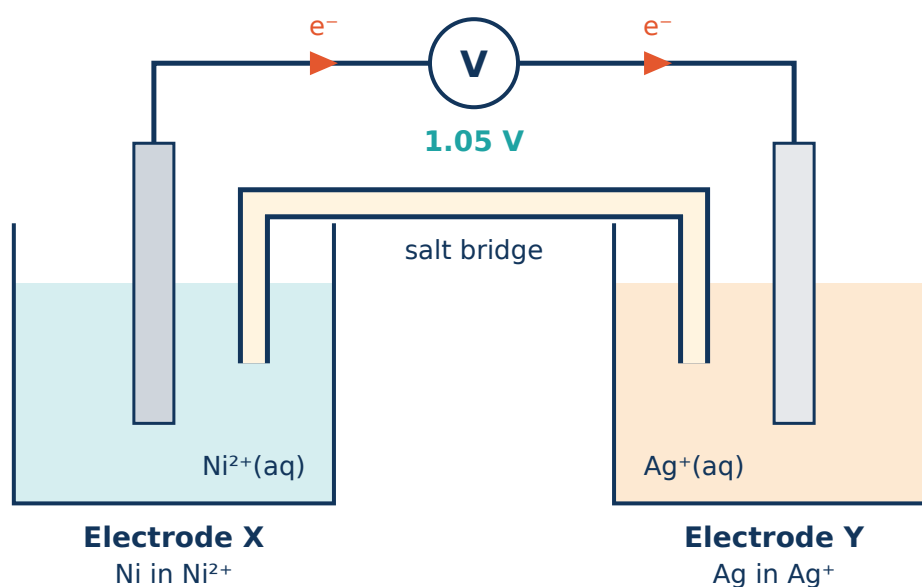
- Calculate the charge passed. (1 mark)
- Calculate the moles of electrons. (1 mark)
- Calculate the mass of silver deposited. (1 mark)

Question 6 Brine electrolysis (2 marks)

Explain why electrolysis of concentrated aqueous sodium chloride gives hydrogen, not sodium, at the cathode. $E^\circ(\text{Na}^+/\text{Na}) = -2.71 \text{ V}$; $E^\circ(\text{H}_2\text{O}/\text{H}_2, \text{neutral to basic})$ is about -0.83 V .

Question 7 Reading a nickel-silver cell (3 marks)

The diagram shows a standard nickel-silver cell.



Cell for Question 7.

- Identify the anode and state the direction of electron flow. (1 mark)
- State how the mass of each electrode changes as the cell runs. (1 mark)
- Explain what happens to the voltage when $[\text{Ag}^+]$ falls. (1 mark)

Question 8 Free energy to potential (2 marks)

A reaction transfers 2 mol of electrons and has $\Delta G^\circ = -193 \text{ kJ}$ per mole of reaction.

- Calculate E° . (1 mark)
- Say whether K is greater than 1 or less than 1 and justify. (1 mark)