Electrode potentials and cells

OCR A H432 · Full A-level

Answer on your own paper. Show your working where needed.

1. The standard reference half-cell

Define standard electrode potential relative to its reference electrode. State the usual temperature, gas pressure and aqueous ion concentration used. Name the metal used in the reference electrode.

2. Follow the electrons

A cell uses $Zn^{2+} + 2e^- \rightarrow Zn$ with $E° = -0.76$ V and $Cu^{2+} + 2e^- \rightarrow Cu$ with $E° = +0.34$ V.

Identify the negative electrode, give the direction of electron flow in the wire and calculate the standard EMF.

3. Tin and iron half-cells

$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$, $E° = +0.15$ V. $Fe^{3+} + e^- \rightarrow Fe^{2+}$, $E° = +0.77$ V.

Predict the favoured direction under standard conditions. Write the overall ionic equation and calculate $E°_{cell}$.

4. Measure an unknown E°

Under standard conditions an M^{2+}/M half-cell is paired with the standard hydrogen electrode. The voltmeter reads +0.44 V with its positive lead on the hydrogen electrode. What is $E°$ for M^{2+}/M? Explain.

5. Choose a salt bridge

A cell uses a silver electrode in $AgNO_3(aq)$ and a copper electrode in $Cu(NO_3)_2(aq)$. A student can fill the salt bridge with either $KCl(aq)$ or $KNO_3(aq)$.

Choose one solution and explain your choice. Describe how a working salt bridge keeps charge moving.

6. Two potential oxidising agents

Standard reduction potentials: Fe^{3+}/Fe^{2+} +0.77 V, Sn^{4+}/Sn^{2+} +0.15 V, I_2/I^- +0.54 V.

Which of Fe^{3+} and Sn^{4+} is predicted to oxidise I^- to I_2 under standard conditions? Justify both decisions.

7. Zinc and an aqueous iron half-cell

A cell oxidises Zn(s) to $Zn^{2+}(aq)$ and reduces $Fe^{3+}(aq)$ to $Fe^{2+}(aq)$. State the electrode material to use on the iron side and explain why it works.

Sketch and label the two half-cells, the salt bridge and a high-resistance voltmeter.

8. An alkaline hydrogen-oxygen fuel cell

Alkaline fuel-cell equations: $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ and $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$.

Identify the oxidation half-equation, find the overall equation, and explain why the cell needs a continuous supply of reactants to keep working.

9. Extra challenge · Identify the polarity of an unknown half-cell

A Cu^{2+}/Cu half-cell ($E° = +0.34$ V) is connected to an aqueous X^{3+}/X^{2+} half-cell under standard conditions. The reading is +0.37 V when the positive lead is attached to the X side.

Draw and label the measuring apparatus. Find $E°$ for X^{3+}/X^{2+} and write the overall ionic equation for the favoured direction. Give one reason an experiment could show little change despite the predicted direction.

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