B16 · Unit B review: choose the method

Completed notes | Notes 1/2

Sort a problem, choose between the table, Faraday and titration, and apply Unit B ideas to corrosion, plating, refining and batteries.

1. Choose the method

Sort the problem

Choose the method before you touch a calculator. Voltage, spontaneity or the anode: use the **reduction** table. Mass, current or time at an electrode: use **Faraday**'s law.

A concentration from a volume of a reactant: use a redox **titration**. It finds a concentration by reacting a sample with a solution of known concentration.

A positive E°cell means the reaction runs by itself, so it can be a **voltaic** cell. A negative E°cell needs a power supply, so the cell is **electrolytic**.

Either way, oxidation happens at the **anode**. The electrode names follow the reaction, not the cell type.

On the diploma: many wrong options use the right numbers in the wrong method, so name the method first.

Watch: Is this equation redox or not? (Alberta Chemistry Teacher, "Electrochemistry Diploma Prep - Chemistry 30 - Part 1 of 4", 18:39)

Watch: Spotting disproportionation (Alberta Chemistry Teacher, "Electrochemistry Diploma Prep - Chemistry 30 - Part 1 of 4", 20:04)

Methods in order

Table: the anode is the **lower** value, E°cell = cathode − anode. Do not **multiply** E° values by coefficients, because voltage does not depend on the number of copies.

Faraday: q = **It** with the time in seconds, then $n(e^-) = q \div 9.65 \times 10^4$, then the mole **ratio** from the half-reaction, then the mass.

Titration: balance the **equation**, find the amount of the known reactant, use the ratio, then divide by the volume in **litres**. Divide millilitres by 1000.

The endpoint is the moment the reaction is just complete. With permanganate, it is the first lasting pale pink, so no indicator is needed.

On the diploma: a wrong mole ratio is a common wrong option, so read it from the half-reaction or the balanced equation.

Watch: Trends in the reduction table (Alberta Chemistry Teacher, "Electrochemistry Diploma Prep - Chemistry 30 - Part 1 of 4", 23:36)

Watch: Patterns: metals, halogens and multivalent ions (Alberta Chemistry Teacher, "Electrochemistry Diploma Prep - Chemistry 30 - Part 1 of 4", 24:21)

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Completed notes | Notes 2/2

2. Apply the ideas

Corrosion and industry

Magnesium (−2.37 V) is below iron (−0.45 V), so it is a stronger reducing agent. It is the **sacrificial** anode that is oxidized, and the iron is protected as the cathode.

A power supply protects iron too, by making it the cathode. Both methods stop the iron from being oxidized.

In electroplating the object is the **cathode**. In refining the impure metal is the **anode**. Oxidation is always at the anode, reduction at the cathode.

Judge a battery by voltage, mass, cost, lifetime and **disposal**. On the diploma: a wrong electrode is a common wrong choice, so label the anode and cathode first.

B16 · Worked practice

Unit B review: choose the method | Questions 1-2 of 12

State symbols: (s) solid, (aq) dissolved in water, (l) liquid, (g) gas. Use the supplied reaction and conditions. B4 values name the Alberta Chemistry 30 Data Booklet table where used.

B16-P01 · Easy · Which method do you use for a question that gives 2.00 A for 30.0 min and asks for a mass of copper? Explain.

1. Use Faraday’s law for a mass at an electrode.

2. What is given are a current and a time, and the question asks for a mass at an electrode.

B16-P02 · Easy · Given a calculated E°cell of −0.50 V. State the type of cell that can make the reaction happen and what it needs.

1. A negative E°cell means the reaction is not spontaneous.

2. It needs an electrolytic cell and a power supply that provides more than 0.50 V.

B16 · Worked practice

Unit B review: choose the method | Questions 3-4 of 12

B16-P03 · Easy · Given Al^{3+}/Al −1.66 V and Ag^{+}/Ag +0.80 V. Write the cell reaction.

1. Aluminium is the anode and gives three electrons. Each silver ion takes one, so triple the silver half.

2. The cell reaction is $Al + 3Ag^{+} \rightarrow Al^{3+} + 3Ag$.

B16-P04 · Easy · Find the voltage of the aluminium and silver cell, and explain why the silver value is not multiplied by three.

1. $E°cell = 0.80 - (-1.66) = +2.46$ V.

2. A table value does not depend on the number of copies of the half-reaction.

B16 · Worked practice

Unit B review: choose the method | Questions 5-6 of 12

B16-P05 · Medium · A current of 3.00 A runs for 25.0 min with a silver cathode in Ag^+ solution. Find the charge and the amount of electrons.

1. Time = 25.0 × 60 = 1500 s, so q = 3.00 × 1500 = 4500 C.

2. $n(e^-) = 4500 \div (9.65 \times 10^4) = 0.0466$ mol.

B16-P06 · Medium · Continue the last question and find the mass of silver deposited. M(Ag) = 107.87 g/mol.

1. The ratio is 1 to 1, so n(Ag) = 0.0466 mol.

2. m = 0.0466 × 107.87 = 5.03 g.

B16 · Worked practice

Unit B review: choose the method | Questions 7-8 of 12

B16-P07 · Medium · Given 4.00 A for 20.0 min through $Cu^{2+}(aq)$ with a copper cathode. Find the mass of copper deposited. M(Cu) = 63.55 g/mol.

1. q = 4.00 × 1200 = 4800 C. $n(e^-) = 4800 \div (9.65 \times 10^4) = 0.04974$ mol.

2. Two electrons deposit one copper atom, so n(Cu) = 0.02487 mol and m = 1.58 g.

B16-P08 · Medium · Given $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$. If 20.00 mL of 0.0150 mol/L MnO_4^- reacts with 25.00 mL of $Fe^{2+}(aq)$, find $[Fe^{2+}]$.

1. $n(MnO_4^-) = 0.02000 \times 0.0150 = 3.00 \times 10^{-4}$ mol. The ratio is 5 to 1, so $n(Fe^{2+}) = 1.50 \times 10^{-3}$ mol.

2. $[Fe^{2+}] = 1.50 \times 10^{-3} \div 0.02500 = 0.0600$ mol/L.

B16 · Worked practice

Unit B review: choose the method | Questions 9-10 of 12

B16-P09 · Challenging · Describe the end point of the permanganate titration and say why no indicator is added.

1. The end point is the first lasting pale pink.

2. Permanganate is purple and fades as it reacts, so it is its own indicator.

B16-P10 · Challenging · Explain how a magnesium block protects a steel pipe in soil. Name the role of the pipe.

1. Magnesium has a lower reduction value, so it is oxidized instead of iron.

2. The magnesium is the anode and is used up, and the pipe is the cathode.

B16 · Worked practice

Unit B review: choose the method | Questions 11-12 of 12

B16-P11 · Challenging · A spoon is plated with silver using a silver nitrate solution. Name the electrode for the spoon, the half-reaction there and the power supply connection.

1. The spoon is the cathode, where silver ions are reduced: $Ag^{+} + e^{-} \rightarrow Ag$.

2. The spoon is connected to the negative terminal of the power supply.

B16-P12 · Challenging · Choose the method and solve: 2.00 A runs for 30.0 min through molten NaCl. Find the mass of sodium at the cathode. M(Na) = 22.99 g/mol.

1. Use Faraday. $q = 2.00 \times 1800 = 3600$ C and $n(e^{-}) = 3600 \div (9.65 \times 10^{4}) = 0.0373$ mol.

2. The ratio is 1 to 1, so $m = 0.0373 \times 22.99 = 0.858$ g.