AP Chemistry Prep Session
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Oxidation-Reduction

Electrolysis and Faraday's Laws

Nonspontaneous Reactions

- We must do work on nonspontaneous reactions for them to occur;
- How can we do reactions like;
- $2NaCl_{(s)} \rightarrow 2Na_{(s)} + Cl_{2(g)}$
- $2H_2O_{(l)} \rightarrow 2H_{2(s)} + O_{2(g)}$
- By adding energy!

Look at oxidation-reduction

- $2NaCl_{(s)} \rightarrow 2Na_{(s)} + Cl_{2(g)}$
- $2Na^+ + 2Cl^- \rightarrow 2Na_{(s)} + Cl_{2(g)}$

- $2Na^+ + 2e^- \rightarrow 2Na_{(s)}$ (reduction)
- $2Cl^- \rightarrow Cl_{2(g)} + 2e^-$ (oxidation)

Look at oxidation-reduction

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- $2Na^+ + 2e^- \rightarrow 2Na_{(s)}$ (reduction)
- $2Cl^- \rightarrow Cl_{2(g)} + 2e^-$ (oxidation)

- $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$
- $E^\circ_{cell} = -2.71\ v - (+1.36\ v) = -4.07\ v$

Electrolyze an aquesous solution of $NaCl_{(aq)}$

- Electrolyze $NaCl_{(aq)}$

- What reactions could occur?
- At the anode (oxidation):
- $2Cl^- \rightarrow Cl_{2(g)} + 2e^-$ $E^\circ = 1.36\ v$
- or
- $2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+ + 2e^-$ $E^\circ = 1.23\ v$

Electrolyze an aqueous solution of NaCl*(aq)*

- Electrolyze NaCl*(aq)*
- What reactions could occur?
- At the cathode (reduction):
- $2Na^+ + 2e^- \rightarrow 2Na_{(s)}$ $E^\circ = -2.71$ v
- or
- $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-$ $E^\circ = -0.83$ v

Electrolyze an aqueous solution of NaCl*(aq)*

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- or
- $2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+ + 2e^-$ $E^\circ = 1.23$ v
- At the cathode (reduction):
- $Na^+ + e^- \rightarrow Na_{(s)}$ $E^\circ = -2.71$ v
- or
- $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-$ $E^\circ = -0.83$ v

Electrolyze an aqueous solution of NaCl*(aq)*

- At the anode (oxidation):
- $2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+ + 4e^-$ $E^\circ = 1.23$ v
- At the cathode (reduction):
- $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-$ $E^\circ = -0.83$ v
- $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$
- $E^\circ_{cell} = -0.83\text{ v} - (+1.23\text{v}) = -2.06$ v

2007 Q3a and Q3b, 2005 Q8d

Faraday's Laws

The amount of solid or gas formed at an electrode is directly proportional to the amount of charge that flows through the electrical circuit.

Faraday's Laws

A balanced half-reaction contains all the information we need to investigate the stoichiometry of electrolysis reactions.

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- This half reaction indicates 2 moles of electrons (charge) must pass through the circuit to plate out 1 mol of $Cu_{(s)}$.

Faraday's Laws

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}$

- This half reaction indicates 2 moles of electrons (charge) must pass through the circuit to plate out 1 mol of Cu*(s)*.
- We can use Faraday's constant to find charge; 96,500 C/mol e^-
- Measure current (ampere) = coulombs/s to find charge that has flowed.

Faraday's Laws

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}$

- So current (ampere) * time = coulombs
- 96,500 coulomb/mol e^-
- Stoichiometry from the balanced half-reaction to determine mass of metal

2007 Q3e, 2007 (B) Q3c, 2000 2c