

AP Chemistry Daily Videos

9.8 Cell Potential and Free Energy

Video #1

1. What is voltage?

2. What is a half cell?

3. Describe what information can be obtained by looking at the table of half-reactions. Make sure your answer includes standard conditions, the symbol for standard conditions, what a reduction potential is, and how you can obtain the voltage for an oxidation process.

| Half-reaction | | E° (V) |
|--|---|---------------|
| $\text{F}_2(\text{g}) + 2\text{e}^-$ | $\rightarrow 2\text{F}^-$ | 2.87 |
| $\text{Co}^{3+} + \text{e}^-$ | $\rightarrow \text{Co}^{2+}$ | 1.82 |
| $\text{Au}^{3+} + 3\text{e}^-$ | $\rightarrow \text{Au}(\text{s})$ | 1.50 |
| $\text{Cl}_2(\text{g}) + 2\text{e}^-$ | $\rightarrow 2\text{Cl}^-$ | 1.36 |
| $\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^-$ | $\rightarrow 2\text{H}_2\text{O}(\text{l})$ | 1.23 |
| $\text{Br}_2(\text{l}) + 2\text{e}^-$ | $\rightarrow 2\text{Br}^-$ | 1.07 |
| $2\text{Hg}^{2+} + 2\text{e}^-$ | $\rightarrow \text{Hg}_2^{2+}$ | 0.92 |
| $\text{Hg}^{2+} + 2\text{e}^-$ | $\rightarrow \text{Hg}(\text{l})$ | 0.85 |
| $\text{Ag}^+ + \text{e}^-$ | $\rightarrow \text{Ag}(\text{s})$ | 0.80 |
| $\text{Hg}_2^{2+} + 2\text{e}^-$ | $\rightarrow 2\text{Hg}(\text{l})$ | 0.79 |
| $\text{Fe}^{3+} + \text{e}^-$ | $\rightarrow \text{Fe}^{2+}$ | 0.77 |
| $\text{I}_2(\text{s}) + 2\text{e}^-$ | $\rightarrow 2\text{I}^-$ | 0.53 |
| $\text{Cu}^+ + \text{e}^-$ | $\rightarrow \text{Cu}(\text{s})$ | 0.52 |
| $\text{Cu}^{2+} + 2\text{e}^-$ | $\rightarrow \text{Cu}(\text{s})$ | 0.34 |
| $\text{Cu}^{2+} + \text{e}^-$ | $\rightarrow \text{Cu}^+$ | 0.15 |
| $\text{Sn}^{4+} + 2\text{e}^-$ | $\rightarrow \text{Sn}^{2+}$ | 0.15 |

4. Why are substances with the most positive values favored in reduction reactions? (Hint: What are electrons attracted to?).

5. Describe what is E°_{cell} and how it can be calculated.

6. @ 4:24, go back to 9.7 and complete the table on page.

7. While balancing half reactions, what happens to E° value when you multiple a half reaction? What happens to E° when you reverse a reaction?

8. Try the problem on your own. Then evaluate your work and identify any errors you may have made.

| Half-reaction | E° (V) |
|--|---------------|
| $\text{Zn}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Zn}(\text{s})$ | -0.76 V |
| $\text{Al}^{3+}(\text{aq}) + 3e^- \rightarrow \text{Al}(\text{s})$ | -1.66 V |

a. Write the balanced equation for the reaction occurring in the cell.

b. Determine the standard cell potential, E°_{cell} .

9. Try the problem on your own. Then evaluate your work and identify any errors you may have made.

| Half-reaction | E° (V) |
|---|---------------|
| $\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4e^- \rightarrow 2\text{H}_2\text{O}(\text{l})$ | 0.70 V |
| $2\text{H}_2\text{O}(\text{l}) + 2e^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$ | -0.83 V |

A sample of water is electrolyzed under standard conditions, as shown in the diagram at right.

a. Write the balanced equation for the water electrolysis reaction.

b. Calculate the standard cell potential

10. Summarize the 5 main points from this video.

Video #2

11. Describe each variable in this equation.

$$\Delta G^\circ = -n\mathcal{F}E^\circ_{\text{cell}}$$

12. How does ΔG relate to E°_{cell} ?

13. Try part c from #9's problem.

c. Determine the standard free energy of reaction for this reaction.

14. Try the problem on your own.
Then evaluate your work and identify any errors you may have made.

| Half-reaction | E° (V) |
|---|---------------|
| $\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$ | -0.45 V |
| $\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$ | -1.66 V |

- Write the balanced equation for the reaction occurring in the cell.
- Determine the standard cell potential, E°_{cell} .
- Does the concentration of Al^{3+} in the solution increase, decrease, or remain the same as the cell operates? Explain your answer.
- Calculate the standard free energy of reaction, ΔG° .
- Is the value of the equilibrium constant (K_{eq}) at 25°C greater than, less than, or equal to 1? Explain your answer.

