AP CHEMISTRY CHEAT SHEET

Unit 9 : APPLICATIONS OF THERMODYNAMICS

Quick Overview

- **Focus:** electrochemistry, redox reactions, galvanic vs electrolytic cells, cell potential, and thermodynamics connections.

- **Exam Lens:** identify redox process → calculate cell potential → connect E°, ΔG°, and K.

Oxidation–Reduction Review

- Oxidation: loss of electrons
- Reduction: gain of electrons

Mnemonic: OIL RIG

- Oxidation occurs at the anode.
- Reduction occurs at the cathode.

Electrochemical Cells

Two main types:

Galvanic (Voltaic) Cells

- Spontaneous reactions
- Convert chemical energy → electrical energy
- $\Delta G < 0$, $E_{cell} > 0$

Electrolytic Cells

- Nonspontaneous reactions
- Require external electrical energy
- $\Delta G > 0$, $E_{cell} < 0$

Mnemonic: “Galvanic gives, Electrolytic eats.”

Cell Potential (Ecell)

Measures the driving force of electron flow.

Mini formula box

$$E_{cell} = E_{cathode} - E_{anode}$$

- Use standard reduction potentials (E°).
- Never multiply E° values by coefficients.

Standard Reduction Potentials

- Measured under standard conditions (1 M, 1 atm, 25°C).
- More positive E° → greater tendency to be reduced.
- The strongest oxidizing agent has the highest E°.

Spontaneity & Electrochemistry

- $E_{cell} > 0$ → spontaneous
- $E_{cell} = 0$ → equilibrium
- $E_{cell} < 0$ → nonspontaneous

This mirrors ΔG behavior.

Free Energy & Cell Potential

Mini formula box

$$\Delta G^\circ = -nFE^\circ_{cell}$$

Where:

- n = moles of electrons transferred
- F = 96,485 C/mol e^-

Negative ΔG° means the reaction is spontaneous.

Cell Potential & Equilibrium

Electrochemistry connects directly to equilibrium.

Mini formula box

$$\Delta G^\circ = -RT \ln K$$

Combine with electrochemistry:

Mini formula box

$$\ln K = \frac{nFE^\circ_{cell}}{RT}$$

Large E°_{cell} → large K → product-favored reaction.

Electrochemical Cell Diagrams

Written as:

Anode | anode solution || cathode solution | cathode

- Single line = phase boundary
- Double line = salt bridge

Example:

Zn | Zn^{2+} || Cu^{2+} | Cu

Electron Flow & Current

- Electrons flow from anode to cathode through wire.
- Conventional current flows opposite to electron flow.
- Salt bridge maintains charge balance.

Electrolysis

- Electrical energy drives nonspontaneous reactions.
- Used for electroplating, metal purification, water splitting.

Key idea:

- Amount of substance produced ∝ charge passed.

Mini formula box

$$q = It$$

$$\text{moles } e^- = q / F$$

Faraday’s Laws of Electrolysis

- Mass deposited is proportional to charge passed.
- More electrons required → less product for same charge.