AP CHEMISTRY CHEAT SHEET

Unit 6 : THERMODYNAMICS

Quick Overview

- **Focus:** energy transfer, enthalpy, entropy, Gibbs free energy, and spontaneity.

- **Exam Lens:** connect energy changes → entropy → temperature → reaction feasibility.

System vs Surroundings

- **System:** part of the universe being studied.
- **Surroundings:** everything else.
- **Universe:** system + surroundings.

Energy flow:
- **Exothermic**: energy released to surroundings ($\Delta H < 0$).
- **Endothermic:** energy absorbed from surroundings ($\Delta H > 0$).

Heat, Work & Energy

- **Heat (q):** energy transferred due to temperature difference.
- **Work (w):** energy from force acting over distance.

Mini formula box

$q = mC\Delta T$
$w = -P\Delta V$
$\Delta E = q + w$

Enthalpy (ΔH)

- ΔH = Hproducts - Hreactants
- Negative ΔH → exothermic
- Positive ΔH → endothermic

Standard enthalpy of formation ($\Delta H°f$):
- Enthalpy change when 1 mol of compound forms from elements in standard states.
- $\Delta H°f$ for elements in standard state = 0.

Mini formula box

$\Delta G° = -RT \ln K$
- $R = 8.314\ J\cdot mol^{-1}\cdot K^{-1}$
- Large K → negative $\Delta G°$

Calorimetry

Used to measure heat changes experimentally.
- qreaction = -qsolution
- Constant pressure calorimeter → measures ΔH.

Mini formula box

$q = mC\Delta T$
C = specific heat capacity

Hess's Law

- Overall ΔH is independent of reaction pathway.
- Reverse reaction → flip sign of ΔH.
- Multiply reaction → multiply ΔH.

Mnemonic: "Flip flips, scale scales.

Entropy (ΔS)

Entropy = measure of disorder or randomness.
- $\Delta S > 0$ → disorder increases.
- $\Delta S < 0$ → disorder decreases.

Entropy increases when:
- Solids → liquids → gases
- Number of gas particles increases
- Temperature increases
- Mixing occurs

Common AP shortcut:
More gas particles = higher entropy.

Gibbs Free Energy (ΔG)

Predicts spontaneity.
- $\Delta G < 0$ → spontaneous
- $\Delta G = 0$ → equilibrium
- $\Delta G > 0$ → nonspontaneous

Mnemonic: "Good Horses Take Sugar" ($G = H - T\cdot S$).

Mini formula box

$\Delta G = \Delta H - T\Delta S$

Temperature & Spontaneity

- At equilibrium: $\Delta G = 0$.
- Standard free energy change relates to equilibrium constant.

Spontaneity

ΔH	ΔS	Spontaneity
−	+	Always spontaneous
+	−	Never spontaneous
−	−	Low temperature
+	+	High temperature

Free Energy & Equilibrium

- At equilibrium: $\Delta G = 0$.
- Standard free energy change relates to equilibrium constant.

Reaction Energy Diagrams

- Peak height = activation energy (E_a).
- Difference between products and reactants = ΔH.
- Catalyst lowers E_a, not ΔH or ΔG.

Key distinction:
- Thermodynamics → if reaction occurs.
- Kinetics → how fast it occurs.