Chemistry 123/130 Formula Sheet

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1   Constants and Conversion Factors

$$R = \frac{8.314 \text{ J}}{\text{mol} \cdot \text{K}}$$

$$R = \frac{0.08206 \text{ J}}{\text{mol} \cdot \text{K}}$$

$$101.33 \text{ L} \cdot \text{atm} = 1 \text{ J}$$

2   Acids and Bases

Henderson Hasselbalch Equation - Acidic

$$\text{pH} = \text{pK}_a + \log\left(\frac{[\text{conjugate base}]}{[\text{weak acid}]}\right)$$

Henderson Hasselbalch Equation - Basic

$$\text{pOH} = \text{pK}_b + \log\left(\frac{[\text{conjugate acid}]}{[\text{weak base}]}\right)$$

3   Thermodynamics

Ideal Gas Law

$$PV = nRT$$

First Law of Thermodynamics

$$\Delta E = Q + W$$

Work

$$W = -P_{ext}\Delta V$$

Internal Energy

$$\Delta U = nC_v\Delta T$$

Heat/Energy at Constant Volume (Bomb Calorimeter)

$$\Delta E = q + \cancel{w} = q_v$$

Molar Heat Capacity (per mol kg)

$$\Delta U = nC_n\Delta T$$

Specific Heat Capacity (per kg)

$$\Delta U = mC_{sp}\Delta T$$

Heat at Constant Pressure (Enthalpy)

$$\Delta H = q_p$$

$$\Delta H \neq \Delta E$$

Hess's Law

$$\Delta H^{\text{o}}_{\text{rxn}} = \sum \Delta H^o_f \text{ products} - \sum \Delta H^o_f \text{ reactants}$$

Second Law of Thermodynamics

$$\Delta S_{\text{universe}} = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}} \geq 0$$

Spontaneous Reaction

$$\Delta S_{\text{universe}} > 0$$

Reversible/Equilibrium

$$\Delta S_{\text{universe}} = 0$$

Impossible

$$\Delta S_{\text{universe}} < 0$$

Boltzmann Equation

$$S = k \ln W$$

Where $k = 1.38 \cdot 10^{-23} \frac{J}{K}$

Enthalpy of Formation?

$$\Delta S^{\text{o}}_{\text{rxn}} = \sum \Delta S^o_f \text{ products} - \sum \Delta S^o_f \text{ reactants}$$

Gibbs Free Energy

$$G = H - TS$$

Gibbs Free Energy – Constant Temperature

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

Standard Energy Change of a Reaction

$$\Delta G^o_{\text{rxn}} = \Delta H^o_{\text{rxn}} - T\Delta S^o_{\text{rxn}}$$

Free Energy at Equilibrium

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

Where K is the equilibrium constant

Other Formula

$$\Delta G = \Delta G^o + RT \ln Q$$

$$Q$$

$$Q = \frac{[\text{products}]}{[\text{reactants}]}$$

$$K$$

$$K = \frac{[\text{products at equilibrium}]}{[\text{reactants at equilibrium}]}$$

Van't Hoff Plot

$$\ln K = \frac{-\Delta H^o}{RT} + \frac{\Delta S^o}{R}$$

Van't Hoff Plot Slope Analysis

$$\frac{\Delta \ln K}{\Delta \frac{1}{T}} = \frac{-\Delta H^o}{R}$$

Entropy Change of the Universe

$$\Delta S_{\text{universe}} = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}}$$

or

$$\Delta S_{\text{universe}} = \Delta S_{\text{rxn}} + \Delta S_{\text{surroundings}}$$

Saw this one in a problem set once soo uhhhh

$$\Delta H = \Delta E + nR\Delta T$$

Enthalpy, Always

$$H = E + PV$$

Enthalpy, Constant Pressure

$$\Delta H = \Delta E + P\Delta V$$

$$\Delta H = q_p$$

Enthalpy, Constant Temperature

$$\Delta E = \Delta H = 9$$

Enthalpy
Heat transfer resulting from the transformation of reactants at some temperature and pressure to produts at the same temperature and pressure.

Percentage Calculation

$$\frac{A}{A+B} \cdot 100 = \% \text{ of } A$$

Priority of Entropy

1. Number of Moles of Gas

2. Phase Changes

3. Changes in Temperature

4. Increases in Complexity

Sign Conventions – Enthalpy

Endothermic: $\Delta H > (+)$

Exothermic: $\Delta H < (-)$

Sign Conventions – Entropy

Spontaneous: $\Delta S_{\text{universe}} > 0$

Reversible/Equilibrium: $\Delta S_{\text{universe}} = 0$

Impossible: $\Delta S_{\text{universe}} < 0$

Entropy in Reversible Processes

$$\Delta S = \frac{\Delta Q_{\text{rev}}}{T}$$

Other:

$$Q = C\Delta T$$

$$\Delta G_{t,p} = -TS_{\text{univ}}$$

4 Reaction Kinetics

Arrhenius Equation

$$k = Ae^{\frac{-E_a}{RT}}$$

Arrhenius Plot Equation

$$\frac{\Delta \ln k}{\Delta \left(\frac{1}{T}\right)} = \frac{-E_a}{R}$$