

Study Guide for Exam #3, Ch. 19-21

Chem1B, General Chemistry II

MEMORIZE

- $\Delta S_T = \Delta S_{\text{surr}} + \Delta S_{\text{sys}}$, $\Delta S_{\text{surr}} = (-\Delta H_{\text{rxn}})/T$
- $\Delta S^\circ_{\text{sys}} = \sum m(S^\circ_{\text{products}}) - \sum n(S^\circ_{\text{reactants}})$
- $\Delta H^\circ = \sum m(H^\circ_{\text{products}}) - \sum n(H^\circ_{\text{reactants}})$
- $\Delta G^\circ = \sum m(G^\circ_{\text{products}}) - \sum n(G^\circ_{\text{reactants}})$
- $E^\circ_{\text{cell}} = E^\circ_{\text{red, cathode}} - E^\circ_{\text{red, anode}}$
- $E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0592 \text{ V}}{n} \log Q$ when $T = 298 \text{ K}$
- Spontaneity conditions (ΔS , ΔG , E_{cell}), equilibrium condition ($\Delta G = 0$)
- Types of radioactive decay (α -decay, β -decay, positron emission, electron capture)

WILL BE PROVIDED

- $\Delta G^\circ = -RT \ln K$ ($R = 8.314 \text{ J}/(\text{mol} \cdot \text{K})$)
- $\Delta G = \Delta G^\circ + RT \ln Q$
- $\Delta G = \Delta H - T\Delta S$
- $\Delta G = -nFE_{\text{cell}}$ ($F = 96485 \text{ J}/(\text{V} \cdot \text{mol})$)
- $1 \text{ V} = 1 \text{ J/C}$; $1 \text{ amp} = 1 \text{ C/sec}$; $1 \text{ e}^- = 1.60 \times 10^{-19} \text{ C}$; $1 \text{ kWh} = 3.60 \times 10^6 \text{ J}$
- “Magic numbers”; belt of stability
- First-order half-life equation: $t_{1/2} = 0.693/k$
- $\Delta E = c^2 \Delta m$ ($c = 2.998 \times 10^8 \text{ m/s}$)
- mass of electron = $5.4858 \times 10^{-4} \text{ amu}$, mass of neutron = 1.0087 amu , mass of proton = 1.0073 amu

Chapter 19: Chemical Thermodynamics

I. Entropy (19.3-4): Know how to make qualitative predictions about the sign on ΔS . Know how to calculate ΔS_{total} , ΔS_{surr} , and/or ΔS_{sys} using entropies of formation (appendix), heat of reactions (q/T), or ΔG and ΔH values ($\Delta G = \Delta H - T\Delta S$ equation).

Examples, Ch. 19: 25-26, 37-38, 43, 54-54

II. Gibbs Free Energy (19.5-6): Be able to calculate ΔG at standard conditions with energies of formation (appendix) or at nonstandard conditions with changes in temperature (from ΔH and ΔS). Be able to use ΔG to determine whether a process is spontaneous or not.

Examples, Ch. 19: 59-62, 66, 69-72

III. Gibbs Free Energy and Equilibrium (19.7): Be able to calculate ΔG at systems not at equilibrium ($\ln Q$ equation). Be able to calculate the equilibrium constant from ΔG , or vice versa ($\ln K$ equation).

Examples, Ch. 19: 79-86, 98, 113-114

Chapter 20: Electrochemistry

I. Oxidation-Reduction (Redox) Reactions (20.1-2): Be able to identify what elements are being oxidized and which are reduced in a redox reaction. Know how to balance redox reactions in aqueous solution in both acidic and basic conditions.

Examples, Ch. 20: 21-24

II. Voltaic Cells (20.3): When given two half-reactions, be able to determine the anode and the cathode and what half-reactions will be occurring at each. Be able to balance the overall net redox reaction. Be able to identify in which directions e^- will move and to which side the ions in the salt bridge will be attracted.

Examples, Ch. 20: 27-28

III. Standard Cell Potential (20.4-5): When given reduction potentials, know how to identify the cathode and anode to determine the overall potential for the cell (E°_{cell}) in standard conditions. Know how to calculate ΔG° from E°_{cell} , or vice versa, and go on to calculate K_{eq} . Be able to use either E°_{cell} or ΔG to determine whether the process is spontaneous.

Examples, Ch. 20: 35-42, 51-58

IV. Nonstandard Conditions (20.6): Know how to use the Nernst equation to solve for E_{cell} and/or Q and/or the concentrations of species in the system at nonstandard conditions. Know how to use the Nernst equation to solve for E_{cell} and/or Q and/or concentrations of species in a concentration cell (when $E^\circ_{\text{cell}} = 0$), and relate this back to K_{sp} .

Examples, Ch. 20: 64-72, 98, 103, 118-119

V. Electrolysis (20.9): Know how to use the applied amperage and time applied to solve for grams of metal produced via electrolysis, or vice versa.

Examples, Ch. 20: 91-94, 108-110

Chapter 21: Nuclear Chemistry

I. Nuclear Equations (21.1-3): Know how to write balanced nuclear equations and identify the type of radioactive decay (α -decay, β -decay, positron emission, or electron capture). Be able to use the belt of stability in order to determine what type of radioactive decay the nuclei is most likely to undergo. Know how to balance nuclear reactions for nuclear transmutations (collisions with neutrons or other nuclei).

Examples, Ch. 21: 11-14, 17-19, 21, 24, 27-30, 59-60, 73

II. Rates of Decay (21.4): Know the half-life equation for radioactive decay (first order reaction) and be able to use it to convert between amount and time, or vice versa.

Examples, Ch. 21: 34-42, 80

III. Energy Changes (21.6): Know how to calculate the energy change for a nuclear reaction using $\Delta E = c^2 \Delta m$. Be able to calculate the binding energy for a nucleus.

Examples, Ch. 21: 43, 45-49, 85