

Chapter 20 – Things to Know

1. What is oxidation? Reduction? An oxidizing agent? A reducing agent?
2. Know how to find oxidation numbers
3. Balancing redox equations (any method)
4. Be able to sketch and label a voltaic (galvanic) cell. Direction of electron flow, + and – electrodes, anode, cathode, salt bridge, direction of ion flow, etc.
5. Standard cell notation: anode||cathode
6. $1 \text{ V} = 1 \text{ J/C}$
7. What are standard conditions?
8. Determining E°_{cell} : if it's spontaneous, E°_{cell} must be positive overall. One substance must be oxidized, the other must be reduced. Find the half-reactions and their corresponding E° 's, and add them. (Make sure to reverse the anode reaction first.)
9. Comparing the strengths of oxidizing and reducing agents, given a table of reduction potentials: remember, the most positive (or least negative) potential is the easiest or most favorable. For oxidizing agents, look at reductions (oxidizing agents get reduced). For reducing agents, look at oxidations – you have to reverse the reactions and their E° values.
10. $\Delta G^\circ = -nFE^\circ$, $\Delta G = -nFE$ (positive overall E means spontaneous)
11. For nonstandard conditions:

$$E = E^\circ - \frac{0.0257 \text{ V}}{n} \ln Q$$

Understand and be able to explain how changes in concentrations of reactants or products will affect the voltage. (Explain both mathematically and in terms of chemical principles.)

Types of problems using this equation:

- 1) Given actual concentrations, calculate E_{cell} (must first get overall reaction, find E° , get setup of Q, determine n)
 - 2) Given actual voltage and some concentrations, calculate the missing concentration (first get overall rxn, E° , n, Q setup)
 - 3) Given K_{sp} and certain other concentrations, get actual voltage (use K_{sp} to calculate the missing concentration, then proceed as above.)
 - 4) Given actual voltage and certain other concentrations, calculate K_{sp} (get rxn, E° , n, Q. Calculate missing concentration. Then use K_{sp} expression to get K_{sp}).
12. Also: concentration cells – know how to determine the voltage or one of the concentrations.
 13. Relationship of E° and K:
$$E^\circ_{\text{cell}} = \frac{0.0257 \text{ V}}{n} \ln K$$
 14. Batteries – what are they? How do they work? What are the electrodes in a car battery? Why is a car battery rechargeable? How is a fuel cell different from a battery? What is the main advantage of fuel cells?

15. How can corrosion be prevented? What is a sacrificial anode? Why doesn't Al corrode?
16. Predict the half reactions that would occur at each electrode in aqueous electrolysis. Remember water can also react. Choose the easiest oxidation and the easiest reduction, and remember that the predicted half reactions aren't always the ones that actually occur. (Why?)
 Rxns for water: $2 \text{H}_2\text{O} + 2 \text{e}^- \rightarrow \text{H}_2 + 2 \text{OH}^-$ $E^\circ = -0.83 \text{ V}$
 $2 \text{H}_2\text{O} \rightarrow \text{O}_2 + 4 \text{H}^+ + 4 \text{e}^-$ $E^\circ = -1.23 \text{ V}$
17. Electrolysis stoichiometry – use conversion factors
 1) Given current, time, how much will react? (be used up or plate out)
 2) Given amount reacted, current, how much time?
 3) Given amount, time, how much current? Etc.
 For all of these, you need a half-reaction to determine n. Also use $1 \text{ A} = 1 \text{ C/sec}$,
 $1 \text{ F} = 96485 \text{ C/mole e}^-$
18. $w_{\text{max}} = -nFE$.
 For a nonspontaneous reaction being driven by a power supply, $w = nFE_{\text{applied}}$.
 In this case, E is the voltage applied by the power supply, and w is the amount of energy needed in J/mole (for the reaction as written).

Chapter 21 – Things to Know

1. What are some important differences between nuclear reactions and chemical reactions?
2. Symbols of nuclear particles and types of radiation: alpha, beta, gamma, positron, electron, neutron, proton
3. How to write and/or balance and/or complete a nuclear equation (mass number and atomic number must balance)
4. Writing equations for different types of decay (alpha emission, beta emission, positron emission, electron capture)
5. Band of stability – general characteristics
6. Be able to predict the likely type of decay for a given radioactive nucleus.
7. How are elements artificially produced? What type of transmutations require a particle accelerator? Given the summary notation for a transmutation, be able to write the nuclear reaction. Neutrons are easily absorbed by nuclei, but protons are not. Why?
8. Half-life: definition and use, be able to sketch a graph of how the amount changes as time goes on, be able to reason out conceptually the amount left after a certain number of half lives or a certain amount of time.
9. First order rate equations:

$$\ln\left(\frac{N_t}{N_0}\right) = -kt \qquad \ln\left(\frac{A_t}{A_0}\right) = -kt \qquad t_{\frac{1}{2}} = \frac{0.693}{k}$$
10. Activity – rate of decay $\text{Rate} = kN_t$ units of activity: dps, dpm, Ci

11. $1 \text{ Ci} = 3.70 \times 10^{10} \text{ dps (nuclei/sec)}$ Be able to calculate the activity of any radioactive sample, and do variations using $\text{Rate} = kN_t$. Be able to calculate the amount of radioactive isotope present given the activity and half-life.
12. If you need the molar mass of an isotope in a problem involving activity, estimate it using the mass number of that isotope.
13. ^{14}C dating: use the first order rate equation.
 A_o of $^{14}\text{C} = 15.2 \text{ dpm/g C}$, $t_{1/2} = 5715 \text{ years}$, t is how long ago it died.
14. Argon dating – be able to do problems using this. Must interpret the given ratio correctly.
15. Detection: film badge, Geiger counter, scintillation counter (advantages and disadvantages of each)
16. $\Delta E = (\Delta m)c^2$ $c = 3.00 \times 10^8 \text{ m/sec}$, Δm in kg or kg/mole, E in J
17. Given the masses of all particles involved in a reaction, calculate Δm and then ΔE_{rxn} .
18. Binding energy – what is it? How do you calculate it? What is mass defect? Use binding energy per nucleon to compare stabilities of different nuclei (higher binding energy/nucleon, more stable). Be able to sketch the graph of binding energy per nucleon vs. number of nucleons and explain the reason for the shape of the graph.
19. Fission: typical reaction, sign of ΔE , magnitude, uses, problems
What is “critical mass”? What is a chain reaction?
20. Fusion: typical reaction, sign of ΔE , magnitude, uses, problems
21. Why do both fission and fusion both give off energy?
22. Biological effects of radiation
23. “ionizing radiation” – what is it? What does it do?
24. What is a “free radical”? What does it do?
25. Background radiation: what is it? sources?)
26. Types of shielding needed for different types of radiation
27. What kinds of things affect the amount of damage done by radiation?
28. What are some uses/applications of radioactivity?

Chapter 12 – Things to Know

1. Be able to explain both the electron-sea model and band theory for metallic bonding. Explain how these theories account for properties of metals. See “additional questions” in the homework assignment.
2. Explain band theory for metalloids and nonmetals (and doped semiconductors).
3. What is an alloy? Give some examples of alloys. Why would one want to use an alloy instead of a pure metal?
4. Why doesn’t stainless steel rust?

Chapter 23 – Things to Know

1. Determining electron configurations of transition metal ions. They lose electrons from the outermost s orbital first. Example: $\text{Fe}^{3+} [\text{Ar}]3d^5$
2. Exceptions to normal filling order: Cr, Cu, etc. Why?
3. Definitions/terms: complex, complex ion, coordination compound, ligand, coordination number, bidentate, polydentate.
4. Symbols, formulas and charges of ligands
5. Experimentally determining formula of complexes – # ions per formula unit, # “free” Cl^- ions, etc.
6. How to find the oxidation number of a metal in a complex
7. Geometries of complexes – be able to sketch
8. Chelating agents – why are complexes made with chelating agents stable? What are some uses of EDTA^{4-} ?
9. What is a metalloprotein?
10. Naming or writing formulas of coordination compounds or complex ions
11. Structural isomerism (linkage or coordination-sphere isomers) vs. stereoisomerism (geometric or optical isomers): give examples to illustrate the differences between these types of isomerism. Given a complex, what type of isomerism is possible?
12. Geometric isomerism (cis/trans, fac/mer) vs. optical isomerism (chiral)
13. Be able to draw cis/trans and fac/mer isomers and enantiomers
14. Color absorbed = complementary to the color observed. Use color wheel to determine colors (sketch it yourself)
Low E, long λ ROYGBIV High E, short λ
15. Shapes and orientations of d orbitals (and s, p orbitals)
16. Crystal Field theory – what is it?
17. For each geometry (octahedral, tetrahedral, and square planar), know the splitting pattern of the d levels and which d orbital is which in the splitting pattern and why!
18. What is Δ ?
19. High spin vs. low spin – what’s the difference? How can you tell whether a complex will be high or low spin? (If it’s octahedral, you can tell by the strength of the ligand. If it’s tetrahedral, it must be high spin. Square planar must be low spin.)
20. Have a general idea of the spectrochemical series – which ligands tend to be strong, weak, medium.
21. Colors – have to do with the magnitude of Δ .
22. Higher E of light absorbed \rightarrow greater splitting, stronger ligand
23. Paramagnetic, diamagnetic, determining # unpaired electrons
24. Why is Δ_o always larger than Δ_t ?

Chapter 18 – Things to Know

1. Layers of atmosphere. Temp, pressure variations
2. Composition of atmosphere
3. photodissociation, photoionization – difference? examples?
4. How are bombarding energetic particles removed before they get to the surface of the earth?
5. Why is the ozone layer important?
6. What causes depletion of the ozone layer and how?
7. Explain the origin of acid rain. What's bad about acid rain?
8. What's dangerous about CO?
9. What is smog and where does it come from?
10. Explain the greenhouse effect. What are some greenhouse gases?
11. What are some methods of desalination? How does reverse osmosis work?
12. What processes deplete freshwater of dissolved O₂?
13. How is municipal water treated?
14. What is hard water? What problems can it cause? How is water “softened”? Explain ion-exchange.