

Checklist for Exam 3

Chapter 4 Sections 4, 10, 11. Reactions in Aqueous Solutions

- I can determine the volume of one reactant needed to react with a given volume of a second reactant.
- I can classify reactions by inspection as precipitation, acid-base neutralization, or oxidation-reduction, commonly called *redox*.
- I can sketch what species is/are present in a beaker of an aqueous solution.
- I can sketch what species are present in a beaker containing a solution of strong acid, or weak acid. I know strong acids are strong electrolytes and weak acids are weak electrolytes.
- I can write chemical reactions for acid base reactions, including overall and net ionic for both weak acid + strong base and for strong acid + strong base.
- I know the rules for assigning oxidation numbers to each atom in a formula.
- I can identify what species has been oxidized and what species has been reduced. These are always the reactants, and I must be careful to be specific!
- I know that the species being oxidized is the reducing agent (or reducing reagent) and the species being reduced is the oxidizing agent (or oxidizing reagent.)
- Given a balanced oxidation-reduction reaction, I can perform mole calculations. If I am given a solution's volume and molarity, I can get to moles using $n=MV$. If I am given mass, I can get to moles, too. I can determine limiting reagent, theoretical yield and the number of moles of excess reactant, if I am given the relevant information.

Chapter 5. Quantum Chemistry and Periodicity

General ideas.

- I know how energy, wavelength and frequency are related to one another (e.g. as wavelength increases, the frequency decreases and so does the energy.) I can do this qualitatively and quantitatively using equations that will be provided. I can use the equations and know to be careful with the units!
- I know the general regions of the electromagnetic spectrum and where the visible region fits into the scheme of things. I know that violet corresponds to 380 nm and red to 780 nm
- I know what the lines in the hydrogen discharge spectrum represent. I can use the Balmer-Rydberg equation (provided) to calculate wavelength or frequency given two quantum numbers, n_f and n_i .
- I know that removing an electron corresponds to taking the electron to $n_f = \infty$.
- When considering an electron moving from one energy level to another, I know which transitions correspond to absorptions/gaining and which correspond to releases/discharges of energy.
- I know that the wavelength and frequency refer to single photon/electron events and that if I use these values to calculate energy, the energy I get (typically $\sim 10^{-19}$ J) refers to a single photon/electron event ("Tiny World"). If I want the answer in kJ/mol ("Big World"), I must multiply by Avogadro's number (and convert J to kJ, too.)
- Conversely, if I am given energy in kJ/mol, and I want wavelength or frequency, I must first divide by Avogadro's number and then convert to joules.

Quantum numbers.

- I am conversant in the four quantum numbers, n , l , m_l , and m_s . I know that the n quantum number is the energy quantum number and that n determines the allowed values for l
- I can relate the n quantum number to the rows on the periodic table.
- I know that the l quantum number is the orbital shape quantum number and that l determines the allowed values for m_l .

- I know that when $l = 0$, this is called the s-orbital and when $l = 1$, it is the p-orbitals and so on. The sequence for l is 0 (s-orbital), 1 (p-orbitals), 2 (d-orbitals), 3 (f-orbitals), 4 (g-orbitals), 5 (h-orbitals), 6 (i-orbitals), and so on through the alphabet.
- I can relate the l quantum number to the columns on the periodic table.
- I know how the notation “1s” “3p” etc. relate to the quantum numbers n and l .
- I can use quantum numbers to identify an orbital and I can assign quantum numbers to an orbital.
- I can write the general valence-shell electron configuration for each group of the periodic table, and identify the blocks in which the elements are located.
- I know that the m_l quantum number refers to specific orbitals within a value for l . Specifically, m_l ranges from $-l$ to $+l$. so if $l = 3$, m_l ranges from -3 to $+3$ (7 values)
- I can sketch and name each of the s, and p orbitals.
- I know that orbitals are designated by three quantum numbers, n , l , and m_l . Electrons are designated by these same three quantum numbers plus one more, m_s .
- I know the Pauli Exclusion Principle, Hund’s Rule and the Aufbau Principle.
- I know the periodic trend across the periodic table for effective nuclear charge, Z_{eff} .
- I can write the ground-state electron configurations for any element.
- I can use electron configurations or orbital-filling diagrams to determine the number of unpaired electrons in these species.
- I know the periodic trend both across and down for atomic radius (size). I know that Z_{eff} explains the trend in size across the periodic table and the vertical trend is explained by the fact that increasingly larger shells (bigger n values) are being filled as one descends the periodic table.

Chapter 6. Ionic Bonding and Periodic Trends

Periodic trends.

- I can predict the ground-state electron configuration for ions.
- I know that cations are smaller than their neutral counterparts due to the increase in Z_{eff} . Furthermore, +2 cations would be expected to be smaller than +1 cations, for the same reason.
- In a similar way, I know that anions are larger than their neutral atoms. Again, the lowered Z_{eff} for anions accounts for this fact.
- I know the definition for first ionization energy: $E \rightarrow E^+ + e^-$. I know the periodic trend for first ionization energy and that ionization energies are always positive — no element wants to lose an electron. I know that the left to right trend is explained largely by increasing Z_{eff} . (Notable “modifications” to the rule occur for electron configurations that possess one electron in an orbital (e.g. $2s^1$ or $4p^1$) or one more than half-filled configurations (e.g. $2p^4$ or $4d^6$). I know that the first ionization energy decreases as one goes down a column because the outermost electron is in increasingly bigger n shells and is easier to remove out to $n = \text{infinity}$ (the definition of ionization.)
- I know the definitions for second and third ionization energies (2^{nd} ionization energy: $E^+ \rightarrow E^{+2} + e^-$ and 3^{rd} ionization energy: $E^{+2} \rightarrow E^{+3} + e^-$). I know that subsequent ionization energies increase (e.g., the 2^{nd} ionization energy is always takes more energy than the first.)
- I know that subsequent ionization energies increase, but then jump substantially when an electron is being removed from a filled shell. For example, magnesium can lose two electrons, but losing the third is very difficult.
- I know the definition of electron affinity: $E + e^- \rightarrow E^-$. I know left-to-right periodic trend for electron affinity and that it is largely explained by Z_{eff} . It is important to know that filled shells have

zero or close to zero electron affinities because they have filled shells and it takes energy to promote an electron to a higher shell.

- I know the definition of lattice energy: $m A^{-n}(g) + n B^{-m}(g) \rightarrow A_m B_n(s)$. I know lattice energy is always exothermic and it increases with the charges on the cation and anion. I know that one tangible result of large lattice energy is a decrease in solubility.

General skills:

- Given the name of an ionic or covalent-molecular compound or acid, I can write its formula. (Chapter 2), and visa versa (formula \rightarrow name for ionics, covalent-moleculars and acids)
- I know the ion flashcards and how to name ionic substances and acids. (Example problem: "What mass of ammonium phosphate is needed to...")
- Given a formula, I can classify compounds as ionic, covalent-molecular or acid.
- I know that all ionic solids that dissolve dissociate 100% into ions and are thus strong electrolytes. Ionic solids that do not dissolve are non-electrolytes.
- I can answer questions about the demonstrations we have seen in class.
- For both of these chapters, I can do the "picture problems" — usually best done by rendering them into word problems.