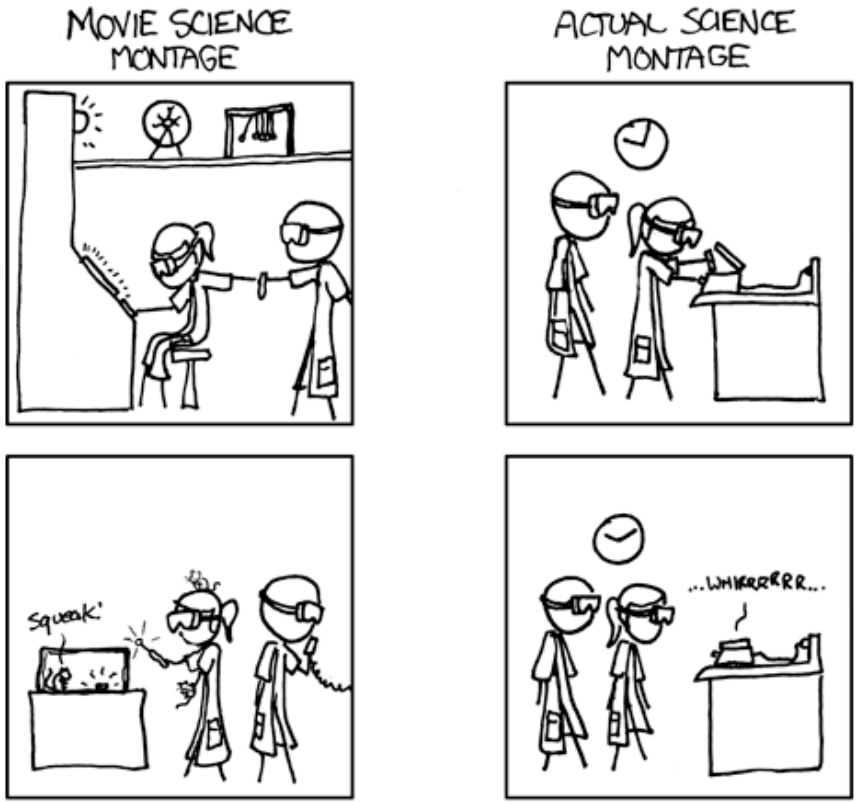
CHM1311 A
Final Exam Review



Disclaimer

- The material covered in this review is REPRESENTATIVE of the material for which you will be responsible on the midterm.

- You are responsible for any material covered in lecture or in homework problems REGARDLESS of whether it is covered in this review.

Topic 0: The Fundamentals (Ch. 1)

- know the SI units and their prefixes
- be reasonable when using significant figures
- understand the atomic model of matter
- be able to give the standard notation for any element or isotope knowing Z and A

e.g. Sodium: $^{23}_{11}Na$

How many protons, neutrons, and electrons?

- be able to recognize most inorganic compounds

Topic 1: Stoichiometry (Ch 1)

- Identify and convert between MF and EF:

  e.g. H_2O_2 molecular formula
  HO empirical formula

- Determine an EF from % composition.
- Determine a MF from an EF knowing the MM
- Conversions between mass, moles, and numbers of atoms and molecules using MM and N_A
- Where does the atomic mass on the periodic table come from and how is it related to the masses of the isotopes?

Topic 1: Stoichiometry (Ch 1)

- Understand the components of a chemical equation:
  - reactants, products, stoichiometric coefficients
  - physical state annotations (s), (l), (g), (aq)
- The law of conservation of mass
- Be able to balance a chemical equation
- Know what the products of a combustion reaction are
- Determine amounts of products or reactants either produced or consumed using a balanced chemical equation
- Same as above when there is a *limiting reagent*
- Calculation of % yields

Topic 1: Solutions and Redox

Section 9.1

- Calculating concentrations in molarity, molality, mole fraction, and %composition
- Be able to convert between units

Sections 17.1 and 17.2

- Be able to determine oxidation states
- Be able to balance redox reactions (acidic and basic conditions)

Topic 2: Gases (Ch 2)

- Conversions between units of measurement:
  - Temperature: Celsius and Kelvin
  - Pressure: atm, kPa, torr, mmHg
- P and V at constant T (Boyle's Law)
- V and T at constant P (Charles's Law)
- P or V and n (Avogadro's Law)
- Using the ideal gas law (both forms)
- Calculation of molar mass or density of an ideal gas

Topic 2: Gases (Ch 2)

- Know and be able to use Dalton's Law of Partial Pressures
- Determine partial pressure of a gas from the mole fraction of the gas and vice versa
- Application of gas laws to reaction stoichiometry in the gas phase. (e.g. determine mass of reactant from volume or pressure of gaseous product)
- Quantifying gases by liquid displacement

Topic 2: Gases (Ch 2)

- Know the fundamental assumptions of Kinetic Molecular Theory.
- RMS and its relationship to MM and T
- Diffusion and Effusion: Qualitative understanding and mathematical application of Graham's Law
- Understand why PV=nRT breaks down under certain conditions

Topic 3: Chemical Equilibrium (Ch 14)

- Define equilibrium and know the properties of equilibrium
- Know when it is appropriate to use a one-way arrow and when it is appropriate to use a two-way arrow in writing chemical equations
- Be able to write an equilibrium expression for any chemical equation
- Know the difference between K_P and K_c and know how one can be calculated from the other
- Know the rules for writing and manipulating equilibrium expressions

Topic 3: Chemical Equilibrium (Ch 14)

- Know what it means if $K >> 1$ or if $K << 1$
- Determine the reaction quotient Q for reactions not in equilibrium.
- By comparing the values for K and Q for a specific reaction, know whether a reaction will shift to the right or left or stay where it is.
- What does it mean for a reaction to shift to the right or to the left?

Topic 3: Chemical Equilibrium (Ch 14)

- Type 1 problems: use concentrations/pressures to find K
- Type 2 problems: use K to find concentrations/pressures
- Simplifying quadratic equations:
  - take the square root of both sides
  - make the "x is small" assumption

Topic 3: Chemical Equilibrium (Ch 14)

- Know Le Chatelier's Principle
- Apply Le Chatelier's Principle to chemical reactions that are subjected to changes concentration, temperature, and pressure or volume (for gas)
- Determine new equilibrium concentrations for a reaction after an additional amount of a given species is added

Topic 4: Kinetics (Ch 13)

- Be able to determine rate laws, reaction order, and k's from the following information:
  - A table of concentrations of reactants and the corresponding rates of reaction.
  - Plots of the following: [A] vs. time ln[A] vs. time 1/[A] vs. time
- When given a mechanism be able to do the following:
  - Identify reaction intermediates and catalysts
  - Write the overall reaction
  - Write the rate law for the overall reaction
  - Determine whether a given mechanism is valid
- Or, given various clues, derive a possible reaction mechanism that matches all available data

Topic 4: Kinetics (Ch 13)

- Determine half-life from k, or determine k from half-life for a given reaction order
- Know which integrated rate law corresponds to zero, first, pseudo-first and second order reactions
- Be able to draw an energy profile diagram for a given reaction and label it
- Be able to determine activation energy for a reaction from the rate constants for the reaction at two different temperatures.
- Understand how catalysts increase the rate of a reaction

Topic 5: Acids and Bases (Ch 15)

- Arrhenius vs. Bronsted-Lowry theories
- Define strong and weak acids and bases in terms of percent dissociation in water
- Define conjugate acid and conjugate base
- Be able to recognize conjugate acid-base pairs
- know the 6 STRONG acids

Topic 5: Acids and Bases (Ch 15)

- Know when it is appropriate to use a one-way or two-way arrow in writing acid base reactions
- Write an equilibrium expression for the autoionization of water
- Know what ranges of $[OH^-]$, $[H_3O^+]$, pH, and pOH are indicative of acidic, basic, or neutral solutions
- Know how to calculate pH and pOH from $[OH^-]$ or $[H_3O^+]$
- Know how to calculate $[OH^-]$ and $[H_3O^+]$ from pH or pOH
- Know the relationship between K_a, K_b and K_w

Topic 6: Thermochemistry (Ch 3)

- law of conservation of energy and using sign conventions
- $\Delta E = q + W$, enthalpy and ΔH
- Calorimetry
- Calculations involving heat:
  - $q = mc\Delta T$ for changing temperatures
  - $q = \Delta H \times n$ for processes/reactions
- Calculations involving work:
  - $W = -P\Delta V$ for known volume changes
  - $W = -\Delta nRT$ for known stoichiometry
- Bond energies, Hess's Law and ΔH_f°

Topic 7: Aqeuous Equilibria (Ch 16)

- Be able to calculate the pH and the concentrations of all species in a solution in the following situations:
  - Dissociation of a strong acid or strong base in water
  - Dissociation of a weak acid or weak base in water
  - Dissociation of a polyprotic acid in water
- Hydrolysis of salts
  - predict pH/calculate pH
- Buffer solutions
  - know when to use the HH equation
  - know how to use the HH equation

Topic 7: Aqeuous Equilibria (Ch 16)

- change in pH of a buffer solution to which a strong acid or base has been added
- During titrations: before, at, and after the equivalence point
  a) A strong acid and strong base
  b) A strong acid and weak base
  c) A weak acid and strong base

Topic 7: Aqeuous Equilibria (Ch 16)

- Define the common ion effect and know how it affects the pH of a solution.
- Know how the common ion effect is related to buffer solutions.
- Be able to determine whether or not a given solution is a buffer solution based on the acid or base and salt that are used in the solution.
- Understand how buffers work.
- Choose an appropriate conjugate acid-base pair and determine the necessary concentrations of each for making a buffer of a given pH.

Topic 7: Aqeuous Equilibria (Ch 16)

- drawing titration curves
- How indicators work
- Definition of end point vs. equivalence point

Topic 7: Aqeuous Equilibria (Ch 16)

- Define solubility and molar solubility
- Write a mathematical expression for Ksp of a given salt upon dissociation in water
- Type 1: Determine K_{sp} from ion concentrations.
- Type 2: Determine ion concentrations from the K_{sp}.
- Calculate the concentration of an added species that will be necessary to precipitate a given ion.
- Know how Q is related to K_{sp} for a saturated, supersaturated, or unsaturated solution.
- For a solution containing more than one ion, know how much of another ion must be added to cause each ion to precipitate based on K_{sp} values.
- Know how the common ion effect affects solubility
- Know how pH affects solubility of insoluble acids and bases

Topic 8: Electrons in Atoms (Ch 4 & 5)

- From the Bohr model of the hydrogen atom, calculate the wavelength of light emitted when an electron relaxes from an excited state to a ground state.
- Identify the names of the four quantum numbers, n, l, m_l, and m_s and what they represent
- Know which values are allowed for each quantum number
- Identify the possible quantum numbers for an electron in a particular
- For a given atom or ion, be able to write the electron configuration and draw the orbital energy diagram with proper adherence to Pauli exclusion principle, Aufbau principle, and Hund's rule.
- Determine the magnetism of an atom/ion