Honor's Chemistry: Final Exam Study Topics

Introduction to Chemistry

- law of conservation of mass
- law of conservation of energy
- pure science vs. technology
- organic / inorganic compounds
- scientific law
- theory
  - phlogiston vs. combustion theory of burning
- hypothesis
- properties of acids and bases
- the scientific method
  - controlled experiment
  - avoid bias (Drunken Goldfish book)
  - conclusions must follow logically from data
- quantitative and qualitative observations
- graphing (line, bar, pie)
- laboratory equipment
- SI System (Metric System)
  - base units [meter, second, liter, gram]
  - derived units
  - prefixes [kilo-, base, deci-, centi, milli-, micro, atomo-]
- Measurement
  - scientific notation
- Accuracy vs. precision
- Conversion Factors
- safety
  - Material Safety Data Sheet
  - Chronic vs. Acute exposure
    - LD_{50} values

Matter and Energy

- reactants and products
- chemical and physical properties
  - extensive vs. intensive properties
  - color, boiling point, density, mass
- chemical and physical changes
- states of matter (solid, liquid, gas)
  - phase diagram
  - sublimation (solid --> gas)
- energy: potential and kinetic
  - $KE = \frac{1}{2} mv^2$
- endothermic and exothermic reactions
  - effect of catalyst (activation energy)
- Nuclear energy
  - fission (splitting atoms) & fusion (joining nuclei)
  - half-life (radioactive decay)
- heat vs. temperature
  - temperature scales (Celcius, Kelvin, Farenheit)
    - $^{o}F - 32 = 1.8\ ^{o}C$ & $^{o}C + 273 = K$
    - absolute zero
  - calorimetry problems – heating curve
    - (specific heat, latent heat, heat of fusion, heat of vaporization)
    - latent heat
- Classification of Matter
  - pure substances: elements and compounds vs. mixtures
    - heterogeneous and homogeneous mixtures
      - solution (alloys), colloid, suspension
- atoms – HOBrFINCl twins (diatomic), P_4 S_8 (polyatomic), allotropes
- SI base units
- conversions
- density
  - Archimedes Principle – water displacement method
- metals, nonmetals, metalloids
- Separation techniques
  - magnetism, distillation, chromatography, centrifugation, decant, evaporation, electrolysis
- Problem solving
  - Fermi approximations

Atomic Structure

- development of model of atom
  - Greek, Dalton, Thomson, Rutherford, Bohr, Quantum mechanical model
    - Cathode Ray tube – electrons
    - Gold-foil experiment – nucleus (atom mostly empty space)
      - alpha particles (He^{2+} nucleus) deflected away
      - Geiger-counter
    - Bohr model – electrons in fixed orbit
    - Quantum mechanical model – electrons in orbitals (*s*, *p*, *d*, and *f*-orbitals)
    - electrons, protons, neutrons
- electron configuration
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10}$ [shorthand configuration]
  - excited state vs. ground state
- Filling order of electrons in atom
  - Aufbau Principle (bottom to top);
  - Pauli Exclusion Principle (two electrons per orbital);
  - Hund's Rule (most unfilled orbitals)
- light (dual nature...particle & wave)
  - electromagnetic spectra ...IR...ROYGBIV...UV...
    - high frequency...short wavelength (high energy)
    - $c = f / \lambda$ ($c = 3 \times 108$ m/s) $E = h f$ ($h = 6.6 \times 10^{-34}$ J/Hz)
  - continuous vs. quantized energy
  - emission spectra
    - lyman series (UV), balmer series (visible), paschen series (IR)
- periodic table
- atomic number (# protons), mass number (# protons + # neutrons)
  - isotopes (same element (# protons) but different # neutrons)
    - isotope notation: C-12 vs. C-14
  - ions (same element (# protons) but different number of electrons
    - cations (+) charge: formed from metals that lose electrons
    - anions (-) charge: formed from non-metals that gain electrons
- average atomic mass
  - AAM = (% A)(mass A) + (%B)(mass B) + ...

Periodicity (Periodic Table Trends)

- Mendeleev & Mosely
  - atomic mass vs. atomic number
- group, period
- names of elements (Greek, location, planets, people, Latin, synthetic)
- names of families and groups...alkali metals, alkaline earth metals, transition metals, halogens, noble gases, lanthanide and actinide series, coinage metals, metalloids, essential elements
- trends in atomic / ionic radius
  - down a column (family) atoms get larger due to increasing shielding effect
  - across a period (horizontally) atoms get smaller due to increased coulombic attraction
- valence electrons
- ionization energy
- cations, anions
- electronegativity

- nuclear fission and nuclear fusion

- Avogadro's number
- molar mass, moles, atoms
- properties of metals
- salts – metal & non-metal
- properties of ionic compounds
  - strong bonds, high melting points, rigid

Nomenclature & Chemical Formulas

- oxidation number
- apparent charge
- finding formulas from oxidation number
- naming compounds
  - binary (with fixed charge – Group 1, 2, Ag, Zn, Al)
  - binary (with variable charge)
    - Stock system (uses Roman numeral to signify charge on metal ion)
    - Old system "*-ic*" (higher oxidation state) & "*-ous*" (lower oxidation state)
  - polyatomic ions
    - memorize "*–ates*" PO_4^{3-}, SO_4^{2-}, CO_3^{2-}, NO_3^{1-} & CN^{1-}, OH^{1-}
      - "*-ites*" one less oxygen
      - "*hypo* ___*-ite*" two less oxygen
      - "*per*___*-ate*" one more oxygen
- percentage composition (by mass)
- formula of a hydrate $MN \cdot XH_2O$
- properties of covalent compounds
- ionic (transfer electrons), covalent (share electrons), hydrogen bonds
- Lewis "dot" structures
- single, double, triple covalent bonds
- structural diagrams
- empirical formula / molecular formula
- mole island
  - 1 mole = 22.4 L @ STP = 6.02×10^{23} particles = Molar Mass

The following is a brief list of many of the topics we covered first semester. All topics covered on the final man not be listed below. Use your own notes to check for completeness.