Chem101 Summary (Fall 2015)

Part I: Molecular Structure and Chemical Bonding (approximately 45%)

1. Units and measurement: S.I. units, conversions, simple calculations, definition and calculation of density.
2. Phases of matter: molecular picture, macroscopic properties (shape, volume), change of phase when P and T change, competition of attractive forces between particles and kinetic energy of particles; draw and explain phase diagrams of water and CO_2.
3. Definitions: atom, element, molecule, compound; physical and chemical changes; homogeneous/heterogeneous mixtures and how to separate them; naming compounds.
4. Types of Energy and how they are related.
5. Atomic Structure: three subatomic particles and their properties; Thomson Experiment and discovery of the electron; Rutherford experiment and model of the atom; definitions: atomic number, mass number, isotope; relative abundance of isotopes; ${}^{Z}_{A}X$ notation.
6. Nuclear Chemistry: three types of radiation and their properties; balance nuclear equations; half-life (definition, calculations); explain belt of stability; recognize applications of radioisotopes (radiometric dating, radiotherapy, tracers); definitions of nuclear fission and fusion; pros and cons of nuclear energy.
7. General features of the Periodic Table: locate metals and nonmetals; what rows and columns represent in the table; how atomic size, ionization energy and electronegativity change down a row and across a column; definition of effective nuclear charge; noble gases and stability.
8. Electronic Structure: electromagnetic (EM) spectrum; features of a wave and the relationship between wavelength, frequency and energy of EM waves; Bohr model of the atom and its limitations; relating line spectra to energy transitions; core and valence electrons.
9. Ionic Bonding: how and why ionic bonds form; formulae of ionic compounds; describe the four properties of ionic compounds and explain from structure.
10. Covalent Bonding: how and why covalent bonds form; draw Lewis structures; predict molecular shape based on VSEPR theory; predict if molecule has a net dipole (making use of shape and electronegativity); giant covalent networks (diamond, graphite) and their properties; greenhouse gases and their effect.
11. Metallic Bonding: picture of bonding in metals; describe three properties of metallic compounds and explain from structure.
12. Intermolecular Forces: identify and explain the origin of temporary dipole forces, permanent dipole forces, hydrogen bonding, and relate them to boiling points and phase of matter; explain effect of size and polarity on intermolecular forces and boiling points.
13. Liquids and Solutions: explain properties of water (liquid and ice) and list applications where applicable; identify energy changes when water changes phase; explain how P and T affect phase, melting points, boiling points; explain shape of meniscus and droplets; explain how ionic solids affect melting and boiling points; explain miscibility of solutions; explain solubility of gases and solids in water and the effect of temperature; explain how soap works.

Part II: Discussions of Science, the Scientific Method, and Pseudoscience (approximately 5%)
In-class discussions throughout the semester.

Part III: Chemical Equations and Reactions (approximately 20%)

1. Stochiometry: Balance chemical equations; conservation of matter; calculations involving mole/Avogadro's number, molar mass, # of molecules or atoms; identifying the limiting reactant and calculating the amount of products formed in a chemical reaction.
2. Energetics of reactions: Conservation of energy; endothermic and exothermic reactions; draw energy diagrams; calculations using bond energies; applications: hot/cold packs and fuel efficiency.
3. Entropy: Disorder in a system relating to intermolecular forces, number of atoms in a molecule, temperature; definition of Free Energy as a balance between changes in enthalpy and entropy.
4. Kinetics: how fast a reaction takes place; what is necessary for a reaction to take place; how to increase the rate of a reaction; reaching equilibrium; draw energy diagrams and identify activation energy barrier; effect of a catalyst.
5. Acids and Bases: Arrhenius and Bronsted definitions; Identify and differentiate strong/weak acids and bases; electrolytic power of an acid/base; calculate molarity of a solution; calculate pH of a solution; pH scale; neutralization reactions; definition of buffer solutions; applications of acids/bases (antacids, baking, acid rain).
6. Redox: identify what is being oxidized, reduced, and the oxidising and reducing agents; write simple half equations; galvanic cells (electrodes and electron flow); applications of redox reactions (electrolysis, rust, batteries, electroplating).

Part IV: Organic Chemistry and the Molecules of Life (approximately 30%)

1. Name and draw simple organic molecules and line structures; identify functional groups in compounds (alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, amides); explain trends in boiling point and solubility.
2. Isomerism: Name and draw structural isomers of alkanes; recognize cis-trans isomerism in alkenes; define optical isomers and identify chiral centers.
3. Reactions of organic molecules: addition in alkenes, condensation in many of the other functional groups, acid/base and/or oxidation/reduction in some functional groups.
4. Applications and characteristics mentioned in class (e.g., fuels, fractional distillation, octane rating, smells, CFCs, precursors to polymers, etc.).
5. Polymers: addition polymers (name, draw); condensation polymers (identify starting monomers for polyesters and polyamides); applications mentioned in class.
6. Lipids: recognize steroids; explain how triglycerides are formed, fat and oil differences, and the different types (saturated, unsaturated, cis/trans) along with their physical properties.
7. Proteins: draw generic amino acid; defining characteristics (20 natural, L-enantiomers, different flavors of side-chains); condensation polymerization to form polypeptides; four levels of structure in proteins; importance of specific 3-dimensional shape for function of protein and the forces that hold the specific shape in place; enzymes.
8. Carbohydrates: monosaccharide building block; condensation to disaccharides and polymerization of glucose to form starch and cellulose.
9. Nucleic Acids: three parts of a nucleotide; base-pairing rules; structure of DNA; differences between DNA and RNA; replication of DNA; protein synthesis (transcription, translation).
10. Definitions of Metabolism, catabolism, anabolism; the use of ATP as the energy shuttle.