Course Syllabus: 120-Hour Honors Chemistry and Chemistry/Saint Joseph High School

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Resources:

- Textbook: *Introductory Chemistry Essentials*, 3rd Edition; Nivaldo J. Tro, Pearson/Prentice Hall, Upper Saddle River, NJ; 2009.
- Flinn Pogils; Flinn Scientific
- PhET interactive simulations (https://phet.colorado.edu/en/simulations)
- Laboratory Exercises adapted from *Laboratory Experiments for World of Chemistry* (Zumdahl, Zumdahl and DeCoste); internet sources; Flinn Scientific, Carolina Biological, AACT Teacher Resources

Student Assessments:

- Formative: Written work (Homework assignments, worksheets; lab writeups), quizzes, presentations
- Summative: Unit tests; Comprehensive Final Exam

NGSS Standards:

Structure and Properties of Matter

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

Chemical Reactions:

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction

Course Topics:

Lab Safety & Equipment

Rules of safety
Common lab equipment: uses and names

Lab: Identification of equipment by name and purpose

Measurement and Problem solving:

Scientific Notation
Significant Figures
Basic Units of Measurement
Conversions between units
Problem-solving strategies (Dimensional analysis); estimating

Lab:

Precision and accuracy of measurements

Matter and Energy

Classifying matter based on state and composition: pure vs. mixture; homogeneous vs. heterogeneous
Physical and chemical changes
1^{st} and 2^{nd} Laws of Matter
Energy and chemical and physical change
Heat Capacity of a substance

Lab(s):

- Heat capacity of a known metal/identification of unknown metal
- Inquiry activity on endothermic vs. exothermic dissolutions of salts/energy transfer
- Identification of Chemical and Physical Changes: Station Lab

Atoms and Molecules

History of the atomic model
Atomic Structure (including the Bohr
Model) Characteristics of subatomic
particles
Defining characteristics of the Elements: atomic symbol, number of protons, neutrons, electrons; average atomic mass; electron configuration
Periodic Table: organization (periods, groups/families; classes of elements) and trends (atomic mass, atomic radius, ionization energy, electronegativity, valence number, ion charges)
Ions and their
formation Isotopes
Electromagnetic spectrum and energy of light

Labs:

PHet inquiry of atom composition: locations of particles, affect of particle count on charge and mass; affect of particle count on stability of the atom

Periodic trends: Ionization Energy and Electronegativity of metals; Electron affinity of nonmetals

Isotopes: Penny Isotope Half-Life Lab

Molecules and Compounds

Chemical formulas: atomic symbols;
subscripts Monatomic and diatomic elements
Particle representations of elements and compounds
Chemical nomenclature: Binary Ionic compounds (including transition metals and polyatomic ions); binary covalent compounds; acids; bases

Chemical Bonding

Four Bonding Models: Metallic, Ionic, Molecular and Network
Covalent Lewis Structures (including resonance)
VSEPR Theory: Molecular and electron Geometries (Tetrahedral, Bent, Trigonal Pyramidal, Trigonal Planar, Linear)
Polarity of bonds
Influence of geometry and electronegativity on polarity of molecules and molecule behavior

Labs:

Four bonding models and physical and chemical properties; identify the bonding in two unknowns and present in the form of claim, evidence, reasoning (CER)

VSEPR: Build molecular models/PHet Student inquiry on molecule shapes

Chemical Composition/Quantities in Chemical Reactions

The mole concept and molar mass calculations
Stoichiometry: Numerical calculations (grams to moles, moles to grams, grams to grams) from balanced equations
Empirical Formula/Molecular Formula calculations from mass percent data Limiting and excess reactants in a chemical reaction
Theoretical and % Yield in a chemical reaction
Enthalpy of reaction

Labs:

Percentage of water in a hydrate

Using enthalpy changes to determine the stoichiometric ratio of two reactants

Inquiry activity: Determine limiting reactant based on yield of a reaction

Chemical Reactions

Defining characteristics of a chemical reaction
Classifying chemical reactions: 5 types (Decomposition, Synthesis, Combustion, Single and Double replacement)
Writing a chemical equation: Complete balanced from words to formulas; from formulas to words; use of proper chemical abbreviations (s, l, aq, g, heat and catalyst symbols); complete ionic; net ionic
Balancing a chemical equation
Specialized types of chemical reactions: Acid-Base Neutralizations; oxidation-reduction

Labs:

Survey Station Lab of Types of reactions

Inquiry lab: Decomposition of Baking soda

Kinetic Molecular Theory

Properties and Characteristics of Solids, Liquids and Gases
Gas Laws (Boyle, Charles, Gay-Lussac, Avogadro; Ideal Gas)
Intermolecular forces (London Dispersion, Dipole-dipole, Hydrogen bonds) and effects on substance behavior: surface tension, viscosity, solubility, volatility, vapor pressure
Phase changes and their energetics (heating and cooling curves; enthalpy of fusion, enthalpy of vaporization)

Labs:

Molar volume of a gas

Polarity and its effects on a substance's physical properties:

- Rates of Evaporation of alcohols (how does length of carbon chain affect rate of evaporation, what is the effect of straight-chain vs. branched structure on rate of evaporation)
- Dipole Nature of Water
- Viscosity Races

Solution Chemistry

Concentration Calculations: Molarity, Molality, % mass, % volume calculations
Dilutions
Solution Stoichiometry
Colligative properties: freezing point depression, boiling point elevation, osmosis

Labs:

Preparation of solutions and dilutions
Inquiry: Kool-Aid/Powdered drink by taste
Making ice cream

Chemical Equilibrium

Collison Theory: factors that affect the rate of a chemical reaction (concentration, temperature, activation energy)
Concept of dynamic equilibrium
Writing a chemical equilibrium expression
Calculating and using equilibrium constants
LeChatelier's Principle: effects of concentration, volume changes
Effect of temperature changes on Equilibrium Constant
Specialized Equilibria: Acids and Bases; Salt solubility product constant

Labs:

Factors that affect the rate of reaction: temperature, particle size

Water Transfer Simulation for equilibrium

Inquiry: Identification of chemical equilibrium reaction of Copper (II) Chloride
Claim evidence reasoning (CER) write up

Acids and Bases

Definitions: Arrhenius, Bronstead-Lowry (conjugate pairs)
Classes of Acids and Bases: strong vs. weak; particle representations
Characteristics of acids and bases
pH scale and calculations
Water as an amphoteric substance
Acid-Base Neutralization Reactions: Titrations
Buffers
pH indicators

Labs:

pH of solutions/use of indicators

Titration: Strong acid and strong base
Titration: Weak acid and strong base
Titration: Determine the % acetic acid in a given sample

Electrochemistry

Single Replacement Reactions and Metal Activity Series; metal activity series and standard reduction potential values

Oxidation reduction reactions: oxidation states of an atom, balancing redox equations using half-reaction method

Electrochemical applications: Energy-producing galvanic cells; electrolysis; batteries

Labs:

Activity series of Metals: Using Redox reactions to determine a metal's position on activity series

Preparation of a 4-way galvanic cell

Electroplating