Immersive Introduction to Chemistry

The learning outcomes of Introduction to Chemistry are for learners to be comfortable with the periodic table of the elements and also with using the notation of chemistry. In the first half of the course, we learn the basic theory of how tiny atoms, ionic compounds, and molecules fit together. In the second half of the course, we apply these concepts to understand what atoms do in a variety of chemical reactions. The course concludes by introducing "stoichiometry," a fancy word for "ratios," in which we use the periodic table to predict the outcome of an experiment. There is an hour-long experiment during the last class, in which we learn to write proper lab reports. Learners are encouraged to repeat the experiments with parental supervision by watching the class recording.

Assignments: The written assignment for each class requires about 1-2 hours out of class.

Prerequisite: Know arithmetic including addition, subtraction, multiplication and division.

week 1: Welcome, how to learn chemistry

week 2: The periodic table of the elements, subatomic particles, charge

week 3: Neutrons, isotopes, average mass

week 4: Aufbau diagrams, ionic compounds

week 5: Electron dot diagrams for molecules

week 6: Polarity, with Balloon 3D Shapes Experiment

week 7: Reactions: acid-base neutralization

week 8: Reactions: precipitation and states of matter

week 9: Reactions: reduction-oxidation (RedOx)

week 10: Ratios: mole ratios

week 11: Ratios: molar mass and grams

week 12: Ratios: Baking Soda-Vinegar Limiting Reactant Experiment

Immersive Chemistry, First Semester

There are two learning outcomes for the First Semester. In the first half of the course, learners will understand how molecular structure can impact the bulk matter that we can see and touch. Second, learners will become comfortable with ratio (stoichiometric) calculations that link the theory embedded the periodic table to the real world. The course covers topics traditionally presented in the first semester of chemistry at the high school, AP, and first-year college level. (These different levels essentially cover the same generalized topics, in very different levels of detail and rigor.) The course is geared towards chemistry that takes place in a "wet lab," and there will be various laboratory demonstrations and experiments which the learners may perform at home with parental supervision.

Assignments: The written assignment for each class requires about 1-3 hours out of class.

Prerequisites: Be familiar with the periodic table to the extent of counting protons, neutrons, electrons, charge, and simple ionic bonding. Draw simple electron dot structures. Know how to write chemical reactions. Arithmetic skills and a calculator are required.

week 1: Binary ionic compounds, emission spectra, EM spectrum, colored light

week 2: Ionic bonding: polyatomic ions (the 5 "-ates"), acids, bases

week 3: Covalent bonding: electronegativity, Lewis structures

week 4: Covalent bonding: resonance, polarity

week 5: Covalent bonding: 3D molecule geometry (VSEPR) with Balloons Experiment

week 6: Solutions: dissolution, homogeneity, states of matter with Sand/Salt Separation Experiment

week 7: Solutions: Intermolecular forces (IMFs) with Mixing Liquids Experiment

week 8: Solutions: water, hydrogen bonding, boiling points, with Freezing Time for Water Experiment

week 9: Stoichiometry: balancing chemical reactions

week 10: Designing experiments, writing lab reports, Volume Change of Water/Ice Experiment

week 11: Stoichiometry: mole ratios, introduction to biochemistry, Soap IMFs Experiment

week 12: Stoichiometry: limiting reactants, ICE tables

week 13: Lab reports

week 14: Stoichiometry: molarity, acid/base reactions, pH, gas producing neutralizations

week 15: Stoichiometry: titration calculations with Neutralization & pH Indicator Experiments

Immersive Chemistry, Second Semester

The learning outcome for the Second Semester is to understand how the theory of chemistry can be applied to understand a wide variety of real-world phenomenon, both in the laboratory as well as everyday life. The course covers "applied chemistry" topics traditionally presented in the second semester of chemistry at the high school, AP, and first-year college level. (These different levels essentially cover the same generalized topics, in very different levels of detail and rigor.) The course is geared towards practical aspects of chemistry. Learners will be able to provide conceptual explanations and simple calculations reflecting the chemistry that creates the world around them. There will be laboratory demonstrations, and longer laboratory experiments will be performed in an optional online lab group arranged separately.

Assignments: The written assignment for each class requires about 1-3 hours out of class.

Prerequisites: Be familiar with the periodic table and have some experience with stoichiometric calculations. Understand chemical bonding. Arithmetic skills and a calculator are required.

week 1: Thermodynamics: heat vs. temperature, heat equation

week 2: Thermodynamics: heat of reaction

week 3: Gasses: pressure, vapor pressure, absolute temperature

week 4: Equilibrium: Eq constant, Le Chatelier principle

week 5: Equilibrium: acid dissociation constants (Ka) with Titration Curves Experiment

week 6: Equilibrium: pH and pOH with pH Indicator Experiment

week 7: Equilibrium: buffer solutions, Henderson-Hasselbalch equation

week 8: Equilibrium: titration curves, half-equivalence point method

week 9: Kinetics: power laws for rates of reactions

week 10: Kinetics: Integrated Rate Laws

week 11: Kinetics: Method of Initial Rates

week 12: Kinetics: Reaction mechanisms, elementary steps

week 13: Electrochemistry: reduction-Oxidation (RedOx) reactions, oxidation states

week 14: Electrochemistry: voltaic/Galvanic cells with Build a Battery Project

week 15: Electrochemistry: Electrolytic cells, electrolysis of water