GENERAL CHEMISTRY

Course Description

Chemistry explores the universe in terms of matter and the changes that it undergoes. The course will provide a history of chemistry and enhance a student's ability to examine the role of science in the development of our industrial world.

Students will learn about and perform laboratory investigations on topics of scientific measurement, modern problem solving techniques, properties of matter, atomic structure, periodicity, percent composition, stoichiometry, and behaviors of compounds. Through laboratory experiences, students are exposed to a variety of topics that relate chemistry to real world issues. Each student designs and conducts an investigation which will lead to the formulation of opinions on the short and long term impacts of chemical issues and their effect on the environment, economy and technology.

Chemistry students work individually and in small groups in a laboratory setting. Other technologies, such as computer simulations for measuring quantities, are used to enhance the laboratory setting.

Each chemistry student must have shown proficiency in both algebra and physical science by attaining a grade of "C" or better. This course fulfills both a pre-college requirement and can lead to further study in other science courses.

Standards

Essential Standards

A student can:

1. Describe the structure of an atom (e.g., negative electrons occupy most of the space in the atom; neutrons and positive protons make up the nucleus of the atom; protons and neutrons are almost two thousand times heavier than an electron; the electric force between the nucleus and electrons holds the atom together);
2. Explain how elements are arranged in the periodic table, and how this arrangement shows repeating patterns among elements with similar properties (e.g., numbers of protons, neutrons, and electrons; relation between atomic number and atomic mass);
3. Calculate the number of electrons in an atom determines whether the atom is electrically neutral or an ion (i.e., electrically neutral atoms contain equal numbers of protons and electrons; a positively charged atom as lost one or more electrons; a negatively charged atom has gained one or more electrons);
4. Give examples of the complete mole concept and ways in which it can be used (e.g., actual mass vs. relative mass; relationship between the mole and the volume

of a mole of molecules; relevance of molar volume and Avogadro's hypothesis); and

5. Design and conduct scientific investigations (e.g., formulates testable hypotheses, identifies and clarifies the method, controls, and variables; organizes, displays, and analyzes data; revises methods and explanations; presents results; received critical response from others).

Important Standards

A student can:

1. Design and conduct an investigation through a problem-based study, service learning project, or field study by identifying scientific issues based on observations and the corresponding scientific concepts; analyzing data to clarify scientific issues or define scientific questions; and comparing results to current models, personal experience, or both;
2. Use scientific evidence to defend or refute a hypothesis in a historical or contemporary context by identifying scientific concepts found in evidence; evaluating the validity of the hypothesis in relation to the scientific information; and analyzing the immediate and long-term impact on the individual, society, or both, in the areas of technology, economics, and the environment;
3. Identify that most elements have two or more isotopes (e.g., atoms that differ in the number of neutrons in the nucleus); explain how although the number of neutrons has little effect on how the atom interacts with others, it affects the mass and stability of the nucleus;
4. Explain how the electron configuration of atoms governs the chemical properties of an element as atoms interact with one another by transferring or sharing the outermost electrons;
5. Give examples of the relationship between heat and temperature (heat energy consists of the random motion and vibrations of atoms, molecules, and ions; the higher the temperature, the greater the atomic or molecular motion);
6. Calculate how the energy associated with individual atoms and molecules can be used to identify the substances they comprise; each kind of atom or molecule can gain or lose energy only in particular discrete amounts, and thus can absorb and emit light only at wavelengths corresponding to those amounts;
7. Give example of how waves (e.g., sound, seismic, water, light) have energy and can transfer energy when they interact with matter;
8. Describe the range of the electromagnetic spectrum (e.g., radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, x-rays, gamma rays); electromagnetic waves result when a charged object is accelerated or decelerated, and the energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength;
9. Recognize that neutrons and protons are made up of even smaller constituents;
10. Give examples of chemical reactions that either release or consume energy (i.e., some changes of atomic or molecular configuration require an input of energy; others release energy);

11. Demonstrate that chemical reactions can be accelerated by catalysts (e.g., metallic surfaces, enzymes);
12. Explain how the electron configuration of atoms governs the chemical properties of an element as atoms interact with one another by transferring or sharing the outermost electrons;
13. Give examples showing that all energy can be considered to be either kinetic energy (energy of motion), potential energy (depends on relative position), or energy contained by a field (electromagnetic waves);
14. Describe how scientific knowledge changes and accumulates over time (e.g., all scientific knowledge is subject to change as new evidence becomes available; some scientific ideas are incomplete and opportunity exists in these areas for new advances; theories and continually tested, revised, and occasionally discarded);
15. Use technology (e.g., hand tools, measuring instruments, calculators, computers) and mathematics (e.g., measurement, formulas, charts, graphs) to perform accurate scientific investigations and communications; and
16. Interpret how conceptual principles and knowledge guide scientific inquiries; historical and current scientific knowledge influence and design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

Enhancing Standards

A student can:

1. Illustrate how atoms may be bonded together into molecules or crystalline solids, and compounds are formed from chemical bonds between two or more different kinds of atoms;
2. Identify how the physical properties of a compound are determined by its molecular structure (e.g., constituent atoms, distances and angles between them) and the interactions among these molecules;
3. Identify how radioactive isotopes can be used to estimate the age of materials that contain them because radioactive isotopes undergo spontaneous nuclear reactions and emit particles and/or wavelike radiation; the decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate, which can be used to estimate the material's age;
4. Illustrate that a large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms;
5. Explain radical reactions and their role in natural and human processes (e.g., ozone and green house gases in the atmosphere; burning and processing of fossil fuels; formation of polymers; explosions);
6. Calculate that chemical reactions can take place at vastly different rates (e.g., from the few femotoseconds required for an atom to move a fraction of a chemical bond distance to geologic times scales of billions of years) and reaction rates depend on a variety of factors that influence the frequency of collision of reactant molecules (e.g., shape and surface area of the reacting species, temperature, pressure, the presence or absence of a catalyst);

7. Gives examples of how throughout history, diverse cultures have developed scientific ideas and solved human problems through technology;
8. Gives examples of how the ethical traditions associated with the scientific enterprise (e.g., commitment to peer review, truthful reporting about the methods and outcomes of investigations, publication of the results of work) and that scientists who violate these traditions are censored by their peers;
9. Evaluate how science and technology are essential social enterprises, but along they can only indicate what can happen, not what should happen; and
10. Demonstrate that creativity, imagination, and a good knowledge base are all required in the work of science and engineering.