Chemistry Program of Study

Semester 2

Conceptual Statement 3: Chemical Reactions

Chemical reactions occur when atoms, molecules, and ions interact. These interactions follow definite patterns of change with measurable rates.

Supporting Ideas:

1. The role of energy in chemical reactions is typically in terms of the Laws of Thermodynamics, activation energy, and the Law of Conservation of Matter and Energy.
6. The rate of a reaction is affected by changes in temperature, by the use of a catalyst, by changes in surface area, and by agitation.

Suggested Activities for Students

- Design and conduct an experiment to identify factors that affect the rate of a reaction.
- Topics to discuss with students prior to their experimental design segment of the project include temperature changes, energy in or out, catalysts, surface area, concentration, and stirring.
- Design a controlled investigation of the factors that affect rate of reaction.

Resources for Teachers

- Many chemistry texts include activities that give students a starting place for designing an conducting an experiment to identify factors that affect the rate of a reaction.
- *Iodine Clock* reactions are an appropriate way to introduce this concept to students. Students are able to see qualitative changes as well as make quantitative measurements.

On-line resources:

- American Institute of Chemical Engineers www.aiche.org

SG,CAS,CFS: 11A1-3; 11B1-14; 11C6; 12A5-6; 12C4

Supporting Ideas:

2. The Laws of Thermodynamics explain chemical phenomena (e.g., heats of reaction, calorimetry, and chemical reactions).
3. The Law of Conservation of Matter and Energy is expressed in terms of balanced chemical equations (e.g., the mole concept, reaction categories, and oxidation reduction).
4. Stoichiometric relationships can be expressed in terms of ratios: mole-mole, mass-mass, mole-mass, volume-volume, etc.
5. Oxidation is characterized as the loss of electrons whereas reduction is the gain of electrons.
7. Atomic arrangement leads to the formation of new chemical bonds resulting in products and more stable structures.

Suggested Activities for Students

- Predict what happens when chemicals combine.
- Perform a variety of chemical reactions in the laboratory (including single and double replacement, decomposition, synthesis, acid-base, redox, endothermic, and exothermic).
- Predict the products and write balanced equations for a series of chemical reactions.

Resources for Teachers

- Many chemistry textbooks have *predict the product* lab activities.
- Every chemistry laboratory manual includes the author's own favorite examples to use for the reaction types. Teachers, as always, are encouraged to make decisions about which chemicals to use based on safety, disposal, and cost factors.

On-line resources:

- http://antoine.frostburg.edu/chem/senese/101/thermo/index.shtml
- http://www.chemtutor.com/mols.htm
- http://cator.hsc.edu/%7Ekmd/caveman/projects/stoich/
- http://www.chemistry.co.nz/chemequa.htm
- http://library.thinkquest.org/10429/high/redox/redox.htm

SG,CAS,CFS: 11B5; 11C6; 12C1,4

Conceptual Statement 4: Solutions

The most commonly used unit of concentration is molarity (moles/liter). Molarity is used to express the degree of acidity/ basicity of an aqueous solution in terms of hydronium ion concentration.

Supporting Ideas:

1. The pH, a measure of the hydronium ion concentration, is determined by calculating the –log [hydronium ion].
2. The pH is measured on a scale of 0-14.
3. Dilution of a solution of known molarity results in a new solution with a different molarity.
4. The product of hydronium and hydroxide remains a constant at constant temperature.

Suggested Activities for Students

- Design and conduct an experiment to measure, compare, and analyze acids and bases.
- Use proper laboratory procedures to make solutions of different molarities.
- Titrate student-made solutions to determine exact molarity of student solutions.
- Measure and compare the effects of acid rain on living and non-living materials.
- Evaluate the effectiveness of a variety of antacids.
- Write balanced equations that describe how the active chemical ingredients in each antacid react with stomach acid. Perform a titration.
- Collect information from a variety of sources such as class notes, textbooks, periodicals, on-line sources, reference books, local experts, etc. Use this information to create a final product that describes the role of acids and bases in their world. In addition to a research paper, consider alternative formats such as: make a brochure; create a display board; create a cartoon strip; write a song/ poem; create a game; use graphic organizers such as Venn diagrams, V-maps, concept maps, etc.

Resources for Teachers

- The following units in *ChemCom* address this topic: Supplying Our Water Needs; Living in a Sea of Air; Chemistry and the Atmosphere; and Personal Chemistry and Choices.
- *Chemistry in the Environment* (Woodrow Wilson National Fellowship Foundation) has several activities of this type.
- *SEPUP Issues, Evidence, and You* has a variety of activities that give students a starting place for this type of activity.

On-line resources:

- http://www.shodor.org/UNChem/basic/ab/
- http://www.rjclarkson.demon.co.uk/junior/junior4.htm

  http://www.towson.edu/%7Eladon/eqab.html
- http://www.innovativesensors.com/ph.asp
- http://library.thinkquest.org/10429/high/acidbase/acidbase.htm

SG,CAS,CFS: 11A1-3; 1 B1-14; 11C6; 12C1,4,5; 13A3; 13B1,4

Conceptual Statement 5: Gas Laws and PVT

The movement of matter and energy through systems is seen in the relationships that exist between pressure, volume, temperature, and the number of particles present. Gases exhibit these relationships best in the gas laws.

Supporting Ideas:

1. Conditions of Standard Temperature and Pressure (STP) are 1 atmosphere or 101.3 kPa or 760mm of mercury for pressure and 0^o Celsius or 273 Kelvin for temperature.
2. An Ideal Gas is a gas composed of particles with mass but no volume or attraction between molecules.
3. A Real Gas has mass, a finite volume, and an attraction between molecules (Van Der Waals Forces) and behaves like an Ideal Gas under conditions of low pressure and high temperature.
5. The average speed of gas particles is dependent on the temperature and the mass of the particles (Graham's Law).
6. The volume of a gas, at constant pressure, will increase/decrease with a change in temperature (Charles' Law).
7. The volume of a gas, at constant temperature, will increase/decrease with a change in pressure (Boyle's Law).
8. The total pressure in a container is the sum of the partial pressures of all the gases in the container (Dalton's Law of Partial Pressures).
9. The volume of a gas changes according to the dictates of the Combined Gas Law (Boyle's Law, Charles' Law, and Gay-Lussac's Law).

Suggested Activities for Students

- Develop and use models (both mathematical and descriptive in nature) to describe the relationships between volume, temperature, and pressure of a gas and use those models to explain practical applications in the biological or geosciences.
- Develop mathematical models to explain the Combined Gas Laws.
- Use mathematical models to solve Combined Gas Law problems.

Resources for Teachers

- The *ChemCom* unit, Petroleum: To Burn? To Build?, presents this topic from a geochemical perspective.
- Many chemistry textbooks include activities and demonstrations that help students visualize the Combined Gas Laws relationships.
- *ChemMatters* (12/93) describes the hot air balloon activity.
- *Science Matters* (Doubleday). Chapter 2: Energy is written from the science literacy perspective that *energy is conserved and always goes from more useful to less useful forms*.

Suggested Activities for Students

- Build and launch a hot air balloon and evaluate the success of the flight using an explanation of Charles' Law.
- Collect and use information from a variety of sources such as class notes, textbooks, periodicals, on-line sources, reference books, local experts, etc., to relate the Combined Gas Laws to biological or geoscientific phenomenon (diffusion of gases across cell membranes, the problem of immature lung development in premature babies, life near deep sea vents, formation of petroleum deposits, weather and climate, solar energy and motion in the atmosphere, scuba-diving precautions, etc.).
- Make a brochure, create a display board, create a cartoon strip, write a story, write a song/poem, create a game, or use graphic organizers such as Venn Diagrams, V-maps, concept maps, etc., to describe Combined Gas Law relationships.

Resources for Teachers

- *Scientific American's The Biosphere* (W.H. Freeman and Co.). Chapter 2: The Energy Cycle of the Earth; Chapter 10: Human Energy Production as a Process in the Biosphere take an interdisciplinary look at this topic.

On-line resources:

- http://antoine.frostburg.edu/chem/senese/101/gases/index.shtml
- http://library.thinkquest.org/10429/high/gaslaws/gaslaws.htm

SG,CAS,CFS: 11A1-3; 11B1-14; 11C5-6; 12C5; 12D2; 13C2; 13D4

Supporting Idea:

4. Molecules, atoms, and ions are in constant motion and undergo collisions with each other. The Kinetic Theory makes the assumption that these collisions are elastic, resulting in no change in total kinetic energy.

Suggested Activities for Students

- Compare and contrast properties of solids, liquids, and gases using Kinetic Theory.
- Design and build a model that can be used to simulate the Kinetic Theory. Use the model to describe properties of solids, liquids, and gases.
- Use class notes, textbooks, on-line searches, and other resources to gather information about the properties of solids, liquids, and gases. Use graphic organizers such as Venn diagrams, V-maps, concept maps, etc. to demonstrate relationships based on the Kinetic Theory.

Resources for Teachers

- Materials for building a self-made model include: a cage of chicken wire, ping pong balls, and a blow dryer.

SG,CAS,CFS: 11A1-3; 11C6; 12C1,3; 12D2