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ODYSSEY Molecular Explorer

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Correlation with the

Utah Core Curriculum

Secondary Science

2003

Chemistry

Science Benchmark

Matter on Earth and in the universe is made of atoms that have structure, mass, and a common origin. The periodic table is used to organize elements by structure. A relationship exists between the chemical behavior and the structure of atoms. The periodic table reflects this relationship.

The nucleus of an atom is a tiny fraction of the volume of the atom. Each proton or neutron in the nucleus is nearly 2,000 times the mass of an electron. Electrons move around the nucleus.

The modern atomic model has been developed using experimental evidence. Atomic theories describe the behavior of atoms as well as energy changes in the atom. Energy changes in an isolated atom occur only in discrete jumps. Change in structure and composition of the nucleus result in the conversion of matter into energy.

STANDARD I: Students will understand that all matter in the universe has a common origin and is made of atoms, which have structure and can be systematically arranged on the periodic table.

Objective 2: Relate the structure, behavior, and scale of an atom to the particles that compose it.

a. Summarize the major experimental evidence that led to the development of various atomic models, both historical and current.

b. Evaluate the limitations of using models to describe atoms.

c. Discriminate between the relative size, charge, and position of protons, neutrons, and electrons in the atom.

d. Generalize the relationship of proton number to the element's identity.

e. Relate the mass and number of atoms to the gram-sized quantities of matter in a mole.

→ **Lab** *Atoms* "Nuclei and Electrons"

→ **Lab** *Atoms* "Isotopes"

→ **Lab** *Atoms* "The Electron Cloud of an Argon Atom"

Objective 3: Correlate atomic structure and the physical and chemical properties of an element to the position of the element on the periodic table.

a. Use the periodic table to correlate the number of protons, neutrons, and electrons in an atom.

b. Compare the number of protons and neutrons in isotopes of the same element.

c. Identify similarities in chemical behavior of elements within a group.

d. Generalize trends in reactivity of elements within a group to trends in other groups.

e. Compare the properties of elements (e.g., metal, nonmetallic, metalloid) based on their position in the periodic table.

→ **LAB** *Atoms* "Nuclei and Electrons"

→ **LAB** *Atoms* "Isotopes"

→ **MISCELLANEOUS** *Main Groups* "Alkali Metals"

→ **MISCELLANEOUS** *Main Groups* "Alkaline Earth Metals"

→ **MISCELLANEOUS** *Main Groups* "Boron Group"

→ **MISCELLANEOUS** *Main Groups* "Carbon Group"

→ **MISCELLANEOUS** *Main Groups* "Nitrogen Group"

→ **MISCELLANEOUS** *Main Groups* "Oxygen Group"

→ **MISCELLANEOUS** *Main Groups* "Halogens"

→ **MISCELLANEOUS** *Main Groups* "Noble Gases"

→ **MISCELLANEOUS** *Transition Metals* "Elements of the d- and f-Blocks"

Science language students should use:

atom, element, nucleus, proton, neutron, electron, isotope, metal, nonmetal, metalloid, malleable, conductive, periodic table, quanta, wavelength, radiation, emit, absorb, spectrum, half-life, fission, fusion, energy level, mole

Science Benchmark

Atoms form bonds with other atoms by transferring or sharing electrons. The arrangement of electrons in an atom, particularly the valence electrons, determines how an atom can interact with other atoms.

The types of chemical bonds holding them together determine many of the physical properties of compounds. The formation of compounds results in a great diversity of matter from a limited number of elements.

STANDARD III: Students will understand chemical bonding and the relationship of the type of bonding to the chemical and physical properties of substances.

Objective 1: Analyze the relationship between the valence (outermost) electrons of an atom and the type of bond formed between atoms.

a. Determine the number of valence electrons in atoms using the periodic table.

b. Predict the charge an atom will acquire when it forms an ion by gaining or losing electrons.

c. Predict bond types based on the behavior of valence (outermost) electrons.

d. Compare covalent, ionic, and metallic bonds with respect to electron behavior and relative bond strengths.

⟶ **LAB** *Chemical Bonding* "Electron Sharing in Molecules"

⟶ **LAB** *Chemical Bonding* "Energetics of Covalent Bonding"

⟶ **LAB** *Chemical Bonding* "Polar Bonds and Molecules"

⟶ **LAB** *Chemical Bonding* "Classifying by Bond Polarity"

Objective 2: Explain that the properties of a compound may be different from those of the elements or compounds from which it is formed.

a. Use a chemical formula to represent the names of elements and numbers of atoms in a compound and recognize that the formula is unique to the specific compound.

b. Compare the physical properties of a compound to the elements that form it.

c. Compare the chemical properties of a compound to the elements that form it.

d. Explain that combining elements in different proportions results in the formation of different compounds with different properties.

⟶ **MISCELLANEOUS** *Chemical Matter* "The Types of Compounds"

⟶ **LAB** *Chemical Matter* "Chemical and Physical Properties"

⟶ **DEMONSTRATION** *Main Groups & Transition Metals* "How different are the allotropes of carbon?"

Objective 3: Relate the properties of simple compounds to the type of bonding, shape of molecules, and intermolecular forces.

a. Generalize, from investigations, the physical properties (e.g., malleability, conductivity, solubility) of substances with different bond types.

b. Given a model, describe the shape and resulting polarity of water, ammonia, and methane molecules.

c. Identify how intermolecular forces of hydrogen bonds in water affect a variety of physical, chemical, and biological phenomena (e.g., surface tension, capillary action, boiling point).

⟶ **LAB** *Chemical Bonding* "Exploring Ionic Interactions"

⟶ **MISCELLANEOUS** *Chemical Bonding* "Dipole Moments"

⟶ **LAB** *Chemical Bonding* "VSEPR Theory"

⟶ **LAB** *Chemical Bonding* "Comparing Conceivable Shapes for a Molecule"

→ **LAB** *Liquids & Solids* "Intermolecular Forces"

→ **MISCELLANEOUS** *Liquids & Solids* "Elements with HydrogenBonding"

→ **DEMONSTRATION** *Liquids & Solids* "How different are ice and liquid water?"

Science language students should use:

chemical property, physical property, compound, valence electrons, ionic, covalent, malleability, conductivity, solubility, intermolecular, polarity

Science Benchmark

In a chemical reaction new substances are formed as atoms and molecules are rearranged. The concept of atoms explains the conservation of matter, since the number of atoms stays the same in a chemical reaction no matter how they are rearranged; the total mass stays the same. Although energy can be absorbed or released in a chemical reaction, the total amount of energy and matter in it remains constant. Many reactions attain a state of equilibrium. Many ordinary activities, such as baking, involve chemical reactions.

The rate of chemical reactions of atoms and molecules depends upon how often they encounter one another, which is a function of concentration, temperature, and pressure of the reacting materials. Catalysts can be used to change the rate of chemical reactions. Under proper conditions reactions may attain a state of equilibrium.

STANDARD IV: Students will understand that in chemical reactions matter and energy change forms, but the amounts of matter and energy do not change.

Objective 1: Identify evidence of chemical reactions and demonstrate how chemical equations are used to describe them.

a. Generalize evidences of chemical reactions.

b. Compare the properties of reactants to the properties of products in a chemical reaction.

c. Use a chemical equation to describe a simple chemical reaction.

d. Recognize that the number of atoms in a chemical reaction does not change.

e. Determine the molar proportions of the reactants and products in a balanced chemical reaction.

f. Investigate everyday chemical reactions that occur in a student's home (e.g., baking, rusting, bleaching, cleaning).

→ **DEMONSTRATION** *Kinetics* "What does a chemical reaction look like at the molecular level?"

→ **LAB** *Kinetics* "Reactive Collisions Between Molecules"

→ **LAB** *Kinetics* "Examining a Reaction Mechanism"

Objective 2: Analyze evidence for the laws of conservation of mass and conservation of energy in chemical reactions.

a. Using data from quantitative analysis, identify evidence that supports the conservation of mass in a chemical reaction.

b. Use molar relationships in a balanced chemical reaction to predict the mass of product produced in a simple chemical reaction that goes to completion.

c. Report evidence of energy transformations in a chemical reaction.

d. After observing or measuring, classify evidence of temperature change in a chemical reaction as endothermic or exothermic.

e. Using either a constructed or a diagrammed electrochemical cell, describe how electrical energy can be produced in a chemical reaction (e.g., half reaction, electron transfer).

f. Using collected data, report the loss or gain of heat energy in a chemical reaction.

→ **LAB** *Kinetics* "Reactive Collisions Between Molecules"

→ **LAB** *Kinetics* "Examining a Reaction Mechanism"

→ **LAB** *Equilibria* "Equilibrium and Temperature"

STANDARD V: Students will understand that many factors influence chemical reactions and some reactions can achieve a state of dynamic equilibrium.

Objective 1: Evaluate factors specific to collisions (e.g., temperature, particle size, concentration, and catalysts) that affect the rate of chemical reaction.

a. Design and conduct an investigation of the factors affecting reaction rate and use the findings to generalize the results to other reactions.

b. Use information from graphs to draw warranted conclusions about reaction rates.

c. Correlate frequency and energy of collisions to reaction rate.

d. Identify that catalysts are effective in increasing reaction rates.

→ **LAB** *Gases* "The Distribution of Kinetic Energies"

→ **LAB** *Kinetics* "Reactive Collisions Between Molecules"

Objective 2: Recognize that certain reactions do not convert all reactants to products, but achieve a state of dynamic equilibrium that can be changed.

a. Explain the concept of dynamic equilibrium.

b. Given an equation, identify the effect of adding either product or reactant to a shift in equilibrium.

c. Indicate the effect of a temperature change on the equilibrium, using an equation showing a heat term.

→ **DEMONSTRATION** *Liquids & Solids* "How does temperature affect the vapor pressure?"

→ **MISCELLANEOUS** *Equilibria* "The Dynamic Nature of Equilibria"

→ **LAB** *Equilibria* "Equilibrium and Temperature"

→ **LAB** *Equilibria* "Equilibrium and Pressure"

Science language students should use:

chemical reaction, matter, law of conservation of mass, law of conservation of energy, temperature, electrochemical cell, entropy, chemical equation, endothermic, exothermic, heat, rate, catalyst, concentration, collision theory, equilibrium, half reaction

Science Benchmark

Solutions make up many of the ordinary substances encountered in everyday life. The relative amounts of solutes and solvents determine the concentration and the physical properties of a solution. Two important categories of solutions are acids and bases.

STANDARD VI: Students will understand the properties that describe solutions in terms of concentration, solutes, solvents, and the behavior of acids and bases.

Objective 1: Describe factors affecting the process of dissolving and evaluate the effects that changes in concentration have on solutions.

a. Use the terms solute and solvent in describing a solution.

b. Sketch a solution at the particle level.

c. Describe the relative amount of solute particles in concentrated and dilute solutions and express concentration in terms of molarity and molality.

d. Design and conduct an experiment to determine the factors (e.g., agitation, particle size, temperature) affecting the relative rate of dissolution.

e. Relate the concept of parts per million (PPM) to relevant environmental issues found through research.

→ **DEMONSTRATION** *Solutions* "How do salts dissolve in water?"

→ **LAB** *Solutions* "Specifying the Molarity"

→ **MISCELLANEOUS** *Solutions* "Molarity vs. Molality"

→ **MISCELLANEOUS** *Solutions* "Energetics of Solutions"

Objective 3: Differentiate between acids and bases in terms of hydrogen ion concentration.

a. Relate hydrogen ion concentration to pH values and to the terms acidic, basic or neutral.

b. Using an indicator, measure the pH of common household solutions and standard laboratory solutions, and identify them as acids or bases.

c. Determine the concentration of an acid or a base using a simple acid-base titration.

d. Research and report on the uses of acids and bases in industry, agriculture, medicine, mining, manufacturing, or construction.

e. Evaluate mechanisms by which pollutants modify the pH of various environments (e.g., aquatic, atmospheric, soil).

→ **LAB** *Acids & Bases* "Strong Acids"

→ **MISCELLANEOUS** *Acids & Bases* "Oxoacids"

Science language students should use:

solution, solute, solvent, concentration, molarity, percent concentration, colligative property, boiling point, freezing point, acid, base, pH, indicator, titration, hydrogen ion, neutralization, parts per million, concentrated, dilute, dissolve