Name_____ Class_____ Date _____

Summary

2–1 The Nature of Matter

The basic unit of matter is the atom. The subatomic particles that make up atoms are protons, neutrons, and electrons. Protons and neutrons have about the same mass. Protons are positively charged particles (+), and neutrons carry no charge. Protons and neutrons together form the nucleus, at the center of the atom. The electron is a negatively charged particle (–). Atoms have equal numbers of electrons and protons, and therefore atoms do not have a charge.

A chemical element is a pure substance that consists entirely of one type of atom. The number of protons in an atom of an element is the element's atomic number. Atoms of an element can have different numbers of neutrons. Atoms of the same element that differ in the number of neutrons they contain are known as isotopes. Because all the isotopes of an element have the same number of electrons, they all have the same chemical properties.

A chemical compound is a substance formed by the chemical combination of two or more elements in definite proportions. Atoms in compounds are held together by chemical bonds. An ionic bond is formed when one or more electrons are transferred from one atom to another. A covalent bond forms when electrons are shared between atoms. The structure that results when atoms are joined together by covalent bonds is called a molecule. Unequal sharing of electrons creates regions of positive and negative charges in molecules. Slight attraction can develop between the oppositely charged regions of nearby molecules. Such intermolecular forces of attraction are called van der Waals forces.

2–2 Properties of Water

The water molecule (H_2O) is neutral. Yet, the oxygen end of the molecule has a slight positive charge, and the hydrogen end has a slight negative charge.

A molecule in which the charges are unevenly distributed is called a polar molecule. Polar molecules can attract each other. The attraction between the hydrogen atom on one water molecule and the oxygen atom on another water molecule is called a hydrogen bond. Cohesion is an attraction between molecules of the same substance. Adhesion is an attraction between molecules of different substances.

A mixture is a material composed of two or more elements or compounds that are physically mixed together—the substances are not chemically combined. A solution is a mixture in which all the components are evenly distributed throughout the mixture. In a solution, the substance that is dissolved is called the solute. The substance in which the solute dissolves is called the solvent. Water is the greatest solvent on Earth.

A water molecule can react to form ions. A water molecule (H_2O) can form a hydrogen ion (H^+) and a hydroxide ion (OH^-). The pH scale indicates the concentration of H^+ ions in a solution. Pure water has a pH of 7. An acid is any compound that forms H^+ ions in solution. Acidic solutions contain higher concentrations of H^+ ions than pure water. A base is a compound that produces OH^- ions in solution. Basic, or alkaline, solutions contain lower concentrations of H^+ ions than pure water and have pH values above 7.

2–3 Carbon Compounds

Organic chemistry is the study of all compounds that contain bonds between carbon atoms. Carbon compounds are also called organic compounds. Many of the molecules in living things are so large that they are known as macromolecules. Macromolecules are formed in a process called polymerization. Smaller units, called monomers, join together to form macromolecules, or polymers.

Four groups of organic compounds found in living things are carbohydrates, lipids, nucleic acids, and proteins. Carbohydrates are compounds made up of carbon, hydrogen, and oxygen atoms. Living things use carbohydrates as their main source of energy. Plants and some animals use carbohydrates in structures. Starches and sugars are examples of carbohydrates.

Lipids are made mostly from carbon and hydrogen atoms. Fats, oils, and waxes are lipids. Lipids are used in living things to store energy. Some lipids are important parts of biological membranes and waterproof coverings. Lipid molecules are made up of compounds called fatty acids and glycerol.

Nucleic acids contain hydrogen, oxygen, nitrogen, carbon, and phosphorus. Nucleotides are the monomers that make up nucleic acids. Each nucleotide consists of a 5-carbon sugar, a phosphate group, and a nitrogenous base. Nucleic acids store and transmit hereditary, or genetic, information. There are two kinds of nucleic acids: ribonucleic acid (RNA) and deoxyribonucleic acid (DNA).

Proteins contain nitrogen as well as carbon, hydrogen, and oxygen. Proteins are polymers of molecules called amino acids. Some proteins control the rate of reactions and regulate cell processes. Some are used to form bones and muscles. Others transport substances into or out of cells or help to fight disease.

2–4 Chemical Reactions and Enzymes

A chemical reaction is a process that changes one set of chemicals (reactants) into another set of chemicals (products). Chemical reactions always involve the breaking of bonds in reactants and the formation of new bonds in products.

Some chemical reactions release energy, and other reactions absorb energy. Chemical reactions that release energy often occur spontaneously. Every chemical reaction needs energy to get started, and that starting energy is called activation energy.

A catalyst is a substance that speeds up the rate of a chemical reaction. Catalysts work by lowering a reaction's activation energy. Enzymes are proteins that act as biological catalysts. Enzymes speed up chemical reactions by lowering activation energies. In an enzyme-catalyzed reaction, the reactants are known as substrates. The substrates bind to a site on the enzyme called the active site.