

Chemistry Comes Alive
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Matter

- The “stuff” of the universe
- Anything that has mass and takes up space
- States of matter
 - Solid – has definite shape and volume
 - Liquid – has definite volume, changeable shape
 - Gas – has changeable shape and volume

Energy

- The capacity to do work (put matter into motion)
- Types of energy
 - Kinetic – energy in action
 - Potential – energy of position; stored (inactive) energy

Forms of Energy

- Chemical – stored in the bonds of chemical substances
- Electrical – results from the movement of charged particles
- Mechanical – directly involved in moving matter
- Radiant or electromagnetic – energy traveling in waves (i.e., visible light, ultraviolet light, and X rays)

Energy Form Conversions

- Energy is easily converted from one form to another
- During conversion, some energy is “lost” as heat

Composition of Matter

- Elements – unique substances that cannot be broken down by ordinary chemical means
- Atoms – more-or-less identical building blocks for each element
- Atomic symbol – one- or two-letter chemical shorthand for each element

Properties of Elements

- Each element has unique physical and chemical properties
 - Physical properties – those detected with our senses
 - Chemical properties – pertain to the way atoms interact with one another

Major Elements of the Human Body

- Oxygen (O)
- Carbon (C)
- Hydrogen (H)
- Nitrogen (N)

Lesser and Trace Elements of the Human Body

- Lesser elements make up 3.9% of the body and include:
 - Calcium (Ca), phosphorus (P), potassium (K), sulfur (S), sodium (Na), chlorine (Cl), magnesium (Mg), iodine (I), and iron (Fe)
- Trace elements make up less than 0.01% of the body
 - They are required in minute amounts, and are found as part of enzymes

Atomic Structure

- The nucleus consists of neutrons and protons
 - Neutrons – have no charge and a mass of one atomic mass unit (amu)
 - Protons – have a positive charge and a mass of 1 amu
- Electrons are found orbiting the nucleus
 - Electrons – have a negative charge and $\frac{1}{2000}$ the mass of a proton (0 amu)

Models of the Atom

- Planetary Model – electrons move around the nucleus in fixed, circular orbits
- Orbital Model – regions around the nucleus in which electrons are most likely to be found

Models of the Atom

Identification of Elements

- Atomic number – equal to the number of protons
- Mass number – equal to the mass of the protons and neutrons
- Atomic weight – average of the mass numbers of all isotopes
- Isotope – atoms with same number of protons but a different number of neutrons
- Radioisotopes – atoms that undergo spontaneous decay called

radioactivity

Identification of Elements

Identification of Elements

Molecules and Compounds

- Molecule – two or more atoms held together by chemical bonds
- Compound – two or more different kinds of atoms chemically bonded together

Mixtures and Solutions

- Mixtures – two or more components physically intermixed (not chemically bonded)
- Solutions – homogeneous mixtures of components
 - Solvent – substance present in greatest amount
 - Solute – substance(s) present in smaller amounts

Concentration of Solutions

- Percent, or parts per 100 parts
- Molarity, or moles per liter (M)
- A mole of an element or compound is equal to its atomic or molecular weight (sum of atomic weights) in grams

Colloids and Suspensions

- Colloids, or emulsions, are heterogeneous mixtures whose solutes do not settle out
- Suspensions are heterogeneous mixtures with visible solutes that tend to settle out

Mixtures Compared with Compounds

- No chemical bonding takes place in mixtures
- Most mixtures can be separated by physical means
- Mixtures can be heterogeneous or homogeneous
- Compounds cannot be separated by physical means
- All compounds are homogeneous

Chemical Bonds

- Electron shells, or energy levels, surround the nucleus of an atom
- Bonds are formed using the electrons in the outermost energy level
- Valence shell – outermost energy level containing chemically active electrons
- Octet rule – except for the first shell which is full with two electrons, atoms interact in a manner to have eight electrons in their valence shell

Chemically Inert Elements

- Inert elements have their outermost energy level fully occupied by electrons

Chemically Reactive Elements

- Reactive elements do not have their outermost energy level fully occupied by electrons

Types of Chemical Bonds

- Ionic
- Covalent
- Hydrogen

Ionic Bonds

- Ions are charged atoms resulting from the gain or loss of electrons
- Anions have gained one or more electrons
- Cations have lost one or more electrons

Formation of an Ionic Bond

- Ionic bonds form between atoms by the transfer of one or more electrons
- Ionic compounds form crystals instead of individual molecules
- Example: NaCl (sodium chloride)

Formation of an Ionic Bond

Formation of an Ionic Bond

Covalent Bonds

- Covalent bonds are formed by the sharing of two or more electrons
- Electron sharing produces molecules

Single Covalent Bonds

Double Covalent Bonds

Triple Covalent Bonds

Polar and Nonpolar Molecules

- Electrons shared equally between atoms produce nonpolar molecules
- Unequal sharing of electrons produces polar molecules
- Atoms with six or seven valence shell electrons are electronegative
- Atoms with one or two valence shell electrons are electropositive

Comparison of Ionic, Polar Covalent, and Nonpolar Covalent Bonds

Hydrogen Bonds

- Too weak to bind atoms together
- Common in dipoles such as water
- Responsible for surface tension in water

- Important as intramolecular bonds, giving the molecule a three-dimensional shape

Hydrogen Bonds

Chemical Reactions

- Occur when chemical bonds are formed, rearranged, or broken
- Are written in symbolic form using chemical equations
- Chemical equations contain:
 - Number and type of reacting substances, and products produced
 - Relative amounts of reactants and products

Examples of Chemical Reactions

Patterns of Chemical Reactions

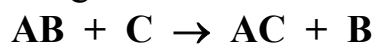
- Combination reactions: Synthesis reactions which always involve bond formation



- Decomposition reactions: Molecules are broken down into smaller molecules



- Exchange reactions: Bonds are both made and broken



Oxidation-Reduction (Redox) Reactions

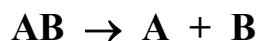
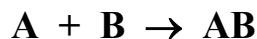
- Reactants losing electrons are electron donors and are oxidized
- Reactants taking up electrons are electron acceptors and become reduced

Energy Flow in Chemical Reactions

- Exergonic reactions – reactions that release energy
- Endergonic reactions – reactions whose products contain more potential energy than did its reactants

Reversibility in Chemical Reactions

- All chemical reactions are theoretically reversible



- If neither a forward nor reverse reaction is dominant, chemical equilibrium is reached

Factors Influencing Rate of Chemical Reactions

- Temperature – chemical reactions proceed quicker at higher temperatures
- Particle size – the smaller the particle the faster the chemical reaction

- Concentration – higher reacting particle concentrations produce faster reactions
- Catalysts – increase the rate of a reaction without being chemically changed
- Enzymes – biological catalysts