IDX G10 CHEM H
Study Guide Issue #1
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Contents:

Intermolecular Forces: Liquids and Solids

Review: Intermolecular Forces

- **Intermolecular forces (IMFs)** are attractive forces between molecules
- **Intramolecular forces** are attractive forces within molecules
- Three types of IMFs:
    - **London Dispersion Forces (LDF)** – attraction force between induced dipoles
        - A symmetrical, spherical atom loses its spherical shape and becomes a **temporary dipole**, which has a separation of opposite charges, creating **induced dipoles** in adjacent atoms
        - LDF increases with increasing molecular/atomic size and mass, since larger electron clouds are more easily distorted (more polarizable)
        - Present in both nonpolar and polar molecules
    - **Dipole-Dipole Forces** – attraction between permanent dipoles
    - **Hydrogen Bonds** – strong dipole-dipole force between the H of one molecule (bonded to N/O/F) and the N/O/F of another molecule
        - In a covalent bond of H-N/O/F, the partial charges are extremely large due to the high difference in electronegativity
        - Large partial charges result in strong dipole-dipole forces

Use IMF to explain properties

- Physical properties of halogen (7A)
    - Colored Gas:
        - Fluorine – Pale Yellow
        - Chlorine – Green
        - Bromine – Red
        - Iodine – Purple/Black
    - Poisonous
    - Diatomic
    - Density of gas increases down the group, leading to deeper color and higher b.p.

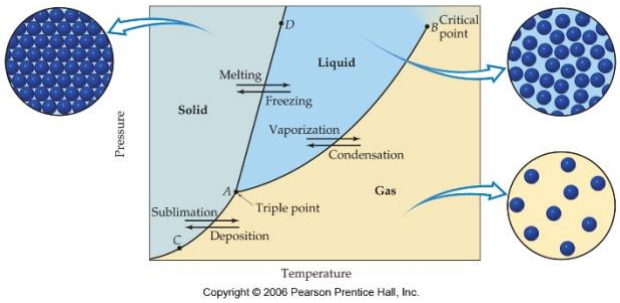
Select Properties of Liquids

- **Surface tension** is the **amount of energy needed to stretch/increase the surface of a liquid by a unit area**
    - Stronger IMFs → higher surface tension
- **Cohesion** is the intermolecular attraction between like molecules
- **Adhesion** is the intermolecular attraction between different molecules
- **Viscosity** is a measure of a fluid's resistance to flow
    - Stronger IMFs → higher viscosity
- **Volatility** is a measure of a fluid's tendency to vaporize
- **Vapor pressure** of a liquid is the pressure exerted by its vapor when the liquid and vapor are in dynamic equilibrium
    - **Dynamic equilibrium** is the condition where two opposing processes occur at the same time and rate
    - Stronger IMFs → Lower Vapor Pressure at a certain temperature
    - **Normal boiling point**: b.p. of a liquid at 1atm (760 torr)

Phase Change and Phase Diagram

- **Melting** – solid to liquid
- **Freezing** – liquid to solid
- **Vaporization** – liquid to gas
- **Condensation** – gas to liquid
- **Sublimation** – solid to gas
- **Deposition** – gas to solid
- **Endothermic** (absorb energy) – melting, vaporization, sublimation
- **Exothermic** (release energy) – freezing, condensation, deposition

- **Phase diagram** summarizes the conditions at which a substance exists as a solid, liquid, or gas
    - The curves represent boundaries of phase change
    - **Triple Point**: the temperature and pressure where three phases coexist in equilibrium
    - **Critical Point**: beyond this point, liquid and gas are indistinguishable



Structure of Solids

- **Crystalline Solid** possesses rigid and long-range order
    - Atoms, molecules, or ions occupy specific positions
- **Amorphous Solid** does not possess a well-defined arrangement and long-range molecular order
- **Unit Cells** are basic repeating structural units of a crystalline solid
- Ionic Crystals
    - Cations and anions as lattice points
    - Held together by electrostatic attraction
    - Hard, brittle, high m.p.
    - Poor conductor of heat and electricity
- Covalent Crystals
    - Atoms as lattice points
    - Held together by covalent bonds
    - Hard, high m.p.
    - Poor conductor of electricity (except graphite)
    - Diamond v.s. Graphite
        - Diamond
            - Hard due to rigid covalent bonds
            - Poor conductor of heat and electricity
        - Graphite
            - Soft and slippery due to layered structure with LDF
            - Good conductor of heat and electricity due to delocalized electrons
- Molecular Crystals
    - Molecules as lattice points

    - Held together by IMF
    - Soft, low m.p.
    - Poor conductor of heat and electricity
- Metallic Crystals
    - Metal atoms as lattice points
    - Held together by metallic bonds
    - Can be soft/hard, with low/high m.p.
    - Good conductors of heat and electricity

Stoichiometry

Stoichiometry

- Derived from στοιχεῖον (element) and μέτρον (measure)
- Area of study that examines the quantities of substances consumed and produced in chemical reactions
- Built on understanding of atomic mass, chemical formulas, and the Law of Conservation of Mass

Chemical Equations

- Reactant(s) → Product(s)
    - **Reactants**: starting substances, left of the arrow
    - +: read as “reacts with”
    - →: read as "produces” or “yields”
    - **Products:** substances produced, right of arrow
    - **Coefficients**: numbers in front of formulas, relative numbers of molecules
        - Should use simplest whole-number ratio for coefficients
    - (g) for gas, (l) for liquid, (s) for solid, (aq) for aqueous solution, Δ above the arrow for a heated reaction
- Equations have to be balanced, meaning that they need an equal number of atoms of each element on each side

Simple Patterns

- **(Direct) Combinations Reactions/Syntheses** is when 2+ substances react to form 1 product
    - A + B → C
- **Decomposition Reaction/Analyses** is when 1 substance breaks down into 2+ substances
    - C → A + B

- **Combustion Reactions** are rapid reactions that produce a flame, most involve O_2 as a reactant
    - $X + O_2 \rightarrow CO_2 + H_2O$

Chemical Reactions of 1A Elements (Alkali Metals)

- Reaction with water
    - Metal fizzes and floats and disappears
    - The test tube becomes warm
    - Indicator (pH tester) turns pink
        - Formation of an alkali (XOH)
    - Reactivity of alkali metals increase down the group
    - Word equation: sodium + water → sodium hydroxide + hydrogen
    - Chemical equation: $2Na + 2H_2O \rightarrow 2NaOH + H_2$
- Reaction with Chlorine
    - Burst into flame, burns bright, forms chloride
    - Word equation: sodium + chlorine → sodium chloride
    - Chemical equation: $2Na + Cl_2 \rightarrow 2NaCl$
- Reaction with Oxygen
    - Burst into flame, burns fiercely to form oxides
    - Word equation: sodium + oxygen → sodium oxide
    - Chemical equation: $4Na + O_2 \rightarrow 2Na_2O$