CHEM 1220 Lecture Notes
OpenStax Chemistry 2e

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COURSE ADMINISTRATIVE DETAILS

- My office hours

- Intro to my research

- Introductory Quiz

- Grading details

  · Exams - 40, Final - 20, Online Homework - 15, Book Homework - 15, Quizzes - 10
  · Online homework
  · Frequent quizzes

- Importance of reading and learning on your own

- Learning resources

  · My Office Hours
  · Tutoring services - https://www.suu.edu/academicsuccess/tutoring/

- Show how to access Canvas

  · Calendar, Grades, Modules, etc.
  · Quizzes
  · Textbook

- Introduction to chemistry

  · Ruby fluorescence
  · Levomethamphetamine
  · Rubber band elasticity
  · Structure of the periodic table
  · Salt on ice and purifying hydrogen peroxide

CHAPTER 0

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1210 REVIEW

There is a whole semester of material from 1210, and these are only the topics which are *most* important for success in 1220

- Composition of atoms and ions (protons, neutrons and electrons)

- Chemical formulas and names

  - Formulas and molar masses
  - Polyatomic ion names
  - Naming ionic compounds
  - Naming binary molecular compounds
  - Naming acids

- Balancing molecular equations

- Solubility rules

- Fundamentals of acid/base chemistry

- Measurements vs. chemistry

  - Converting from measurements to moles and back
  - Stoichiometry and predicting amounts
  - Limiting reactants

- Enthalpy of reaction and heat equations

- Lewis structures

CHEM 1210 Review Quiz

CHAPTER 10
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LIQUIDS AND SOLIDS

10.1   Intermolecular Forces

○ Many physical properties of solids, liquids, and gases can be explained by the strength of attractive forces between particles (Figure 10.5)

○ Phase changes happen due to the interplay between kinetic energy and intermolecular forces (Figure 10.2)

○ Pressure can also play a role in phase changes, as discussed later

○ These *intermolecular forces* come in different varieties

- Dispersion Forces Non-polar molecules, impacted by polarizability, molecular weight, and surface area
    * Dominant in non-polar molecules
    * Created by induced dipoles (Figure 10.6)
    * Impacted by polarizability (Table 10.1)
    * Impacted by molecular weight (hydrocarbons from methane to wax)
    * Impacted by molecule shape (Figure 10.7 compares the boiling points of pentane isomers)
- Dipole-Dipole Forces
    * Dominant in polar molecules
    * Results from attraction between permanent dipoles (Figure 10.9)
- Hydrogen Bonding
    * Dominant only in molecules capable of hydrogen bonding
    * Must contain a hydrogen-donor atom (H attached to N, O, or F)
    * Must contain a hydrogen-acceptor atom (lone pair of electrons attached to N, O, or F)
    * Hydrogen bonds are more than just particularly strong dipole-dipole forces. They have strong directionality according to VSEPR
    * Figures 10.10, 10.14, and other figures on the Internet show water, DNA, and proteins all organized by hydrogen bonds
    * Figures 10.11 and 10.12 illustrate how much hydrogen bonds exceed dipole-dipole forces in strength

10.2   Properties of Liquids

○ Viscosity is a fluid's resistance to flow

- We intuitively know that both water and honey flow...but at very different rates
- Viscosity is proportional to the strength of intermolecular forces (high IF = high viscosity)
- As temperature increases, kinetic energy is able to overcome intermolecular forces and viscosity decreases
- Table 10.2 gives the viscosities of some common substances (note the unusual units!)

○ Surface tension is a force which minimizes a fluid's surface area

- Cohesive vs. adhesive forces
- Bulk molecules have lower energy than surface molecules due to being *surrounded* by cohesive forces (Figure 10.16)
- Figure 10.17 illustrates a waterbug supporting itself on water surface tension
- Surface tension is often in conflict with gravity and other forces, making most liquids rounded but not perfect spheres
- Surface tension is proportional to intermolecular forces (Table 10.3)
- Surface tension can be strongly affected by addition of certain solutes, called surfactants

○ Capillary action is a force between a fluid and narrow channels or capillaries of solid materials

- Due to adhesive forces with the solid, liquids will be drawn up (or, less often, pushed down) a capillary
- Figure 10.19 shows how paper towels are made to maximize capillary action, so they soak up water-based spills
- The top of the liquid (called the meniscus) will curve differently depending on the reletive strength of cohesive and adhesive forces (Figure 10.18)
- Figure 10.20 shows capillary action in a variety of situations, including capillary repulsion
- Remember that when measuring volumes, convention is to read the *bottom* of the meniscus regardless of how it curves
- Don't worry about the formula given here

Quiz 10.1 - Intermolecular Forces and Liquid Properties

Homework 10.1

○ 10.11: Predicting trends in boiling points

○ 10.21: Identifying intermolecular forces

○ 10.25: Affect of temperature on viscosity

10.3   Phase Transitions

○ Vaporization and condensation are the transitions between liquid and gas phases

· The enthalpy of vaporization (ΔH_{vap}) is the energy required to transition from liquid to gas phase

· Enthalpy of condensation is the opposite $\Delta H_{con} = -\Delta H_{vap}$

· In a closed volume, these processes will reach a *dynamic equilibrium*

· The partial pressure of the liquid at this equilibrium state is called its *vapor pressure* (Figure 10.22)

· Higher intermolecular forces lead to lower vapor pressures

· Higher temperatures increase the vapor pressure due to increased kinetic energy (Figure 10.23)

○ Boiling points

· Figure 10.24 shows vapor pressure curves and the normal boiling points of several liquids

· Boiling points generally depend on the pressure (pressure cookers, boiling water to freezing, etc.)

· The Clausius-Clapeyron equation defines these curves (Note the rearrangments I've made)

$$P = Ae^{-\Delta H vap/RT} \qquad \ln P = -\frac{\Delta H_{vap}}{RT} + \ln A \qquad \ln\left(\frac{P_2}{P_1}\right) = -\frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

○ Fusion (melting), freezing, sublimation, and deposition all have their enthalpies and transition temperatures

○ These enthalpies are state functions, such that $\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$ (Figure 10.28)

○ Heating and Cooling curves

· When heat is added to a system, it will either cause a phase change, or a change in temperature

· For phase changes, $q = n\Delta H_{change}$

· For temperature changes, $q = mc\Delta T$, where c is the specific heat for that substance and phase

· Sometimes ΔH_{change} is given as a -per gram value, and sometimes c is given as a -per mole value, but usually not :(

· Figure 10.29 shows a typical heating curve (Work example 10.10 in the text)

Quiz 10.2 - Heating Curves

Homework 10.2

○ 10.31: Temperature during a phase transition

○ 10.39: Definition of normal boiling point

○ 10.51: Heating curve problem

10.4   Phase Diagrams

- The stable phase at different temperatures and pressures is best illustrated with a phase diagram (Figures 10.30, 10.31)

- We can tell at a glance what transitions might occur as we increase or decrease either the temperature or pressure

- Note that at some pressures, sublimation may occur instead of fusion

- The triple point is a unique point where liquid, solid, and gas can all exist at equilibrium (contrast with a glass of icy water on a humid day)

- The critical point is where the distinction between liquid and solid phases disappears

- Figure 10.34 shows the phase diagram of CO_2

- Supercritical fluids exhibit some interesting properties, and are often great solvents (Nile Blue Youtube video)

- Critical points vary widely depending on the intermolecular forces, and other factors (Table in text)

Quiz 10.3 - Phase Diagrams

10.5   The Solid State of Matter

10.6   Lattice Structures in Crystalline Solids

CHAPTER 11

SOLUTIONS AND COLLOIDS

CHAPTER 12

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KINETICS

CHAPTER 13
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FUNDAMENTAL EQUILIBRIUM CONCEPTS

13.1   Chemical Equilibria

13.2   Equilibrium Constants

13.3   Shifting Equilibria: Le Châtelier's Principle

13.4   Equilibrium Calculations

CHAPTER 14

ACID-BASE EQUILIBRIA

CHAPTER 15

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EQUILIBRIA OF OTHER REACTION CLASSES

CHAPTER 16

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THERMODYNAMICS

CHAPTER 17

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ELECTROCHEMISTRY

17.1   **Review of Redox Chemistry**

17.2   **Galvanic Cells**

17.3   **Electrode and Cell Potentials**

17.4   **Potential, Fee Energy, and Equilibrium**

17.5   **Batteries and Fuel Cells**

17.6   **Corrosion**

17.7   **Electrolysis**

CHAPTER 21

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NUCLEAR CHEMISTRY

21.1   **Nuclear Structure and Stability**

21.2   **Nuclear Equations**

21.3   **Radioactive Decay**

21.4   **Transmutation and Nuclear Energy**

21.5   **Uses of Radioisotopes**

21.6   **Biological Effects of Radiation**

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