

## **Indiana State University**

### **CHEM 106 Section 001**

#### **General Chemistry II**

##### **Catalog Course Description**

Continuation of 105 with chemical kinetics, elementary thermodynamics, aqueous equilibria, electrochemistry, and physical properties of solids, liquids, and solutions.

##### **Faculty Information**

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Office Hours: MWRF 1:00-2:00 pm and by appointment

##### **Course Learning Objectives**

Distinguish between intermolecular and intramolecular forces. Describe how intermolecular forces influence liquid state properties, including heat of vaporization, boiling point, vapor pressure, and viscosity. Calculate heat of vaporization and normal boiling point from vapor pressure data in van't Hoff plot form. Sketch the heating curve for a substance, indicating the solid, liquid, and gas regions, and indicating the regions of fusion and vaporization. Classify crystalline solids as ionic, atomic, or molecular. Identify the three cubic unit cells, (i) simple cubic, (ii) body-centered cubic, and (iii) face-centered cubic. Relate unit cells to edge lengths and densities for atomic solids. Predict whether a given mixture will yield a solution based on molecular properties. Describe the effects of temperature and pressure on solubility. Describe solution composition using (i) molarity, (ii) molality, (iii) mole fraction, and (iv) mass percent. Calculate boiling-point elevation and freezing-point depression for a solution of known composition. Describe how boiling-point elevation, freezing-point depression, and osmotic pressure are influenced by dissociating solutes. Calculate reaction rates from concentration vs time data. Describe factors (reactant concentrations, temperature, catalysts) that influence reaction rates. Apply the method of initial rates to experimental data to determine the rate law for chemical reactions. Manipulate concentration data and construct plots based on integrated rate laws to determine reaction order and rate constants. Use the Arrhenius equation to calculate activation energy from rate constants at differing temperatures. Develop the rate law for the net reaction of a reaction mechanism given the relative rates of the mechanism steps, including for steps involving fast equilibria. Identify the role of catalysts in reaction mechanisms. Explain dynamic equilibrium and the relationship between the rates of forward and reverse reaction. Calculate equilibrium constants for reactions that result from the reversal, scaling, and addition of chemical equations. Explain how an equilibrium will shift in response to changes in reactant/product concentrations, temperature, and volume of the reaction vessel. Calculate equilibrium concentrations or pressures given initial conditions for a chemical reaction. Define Brønsted-Lowry acid and base. Calculate  $H^+$ / $OH^-$  concentrations

from pH/pOH, and vice versa. Calculate the pH of strong/weak acid/base solutions. Calculate  $K_b$  from  $K_a$  of the conjugate acid. Calculate the pH of a weak acid solution that contains a common ion. Calculate quantities of weak acid/conjugate base needed to prepare a buffer solution of a desired pH. Calculate the pH at any point during a weak acid/strong base titration. Predict whether precipitation occurs upon mixing aqueous solutions of ionic compounds. Distinguish between spontaneous and nonspontaneous processes. Predict the sign of entropy change for chemical and physical processes. Calculate entropy changes of chemical and physical processes from standard molar entropies. Relate free energy change to equilibrium constants. Identify the oxidizing and reducing agents of a redox reaction. Write and interpret cell notation for electrochemical cells. Calculate standard cell potentials from standard electrode (reduction) potentials. Use the Nernst equation to determine cell potentials under nonstandard conditions.

This course also meets the Foundational Studies Quantitative Literacy Learning Objectives.

#### Required Textbooks and Materials

(1) Flowers et al., Chemistry (2e). (Openstax). (2) Scientific calculator.

#### Graded Elements of the Course

Aktiv Assignments, Workshops, Quizzes, Exams.