UWGB Chemistry 211 Syllabus

Howards Grove High School  
Instructor: Tom Heier

Materials:

Textbook:

Zumдаhl, Steven and Susan Zumдаhl. Chemistry, 10th ed. Belmont CA: Cengage Learning, 2019. (This is an additional reference book, not the main instructional book)

Lab Materials:


Course Details:

This course is designed to be the equivalent of the general chemistry course usually taken during the first year of college. This course includes writing and balancing equations, naming and writing formulas, percent composition, empirical and molecular formulas, Stoichiometry, Enthalpy, the Gases and gas laws, the periodic table and periodicity, atomic theory, and colligative properties if time. Over the course of the 90 days, approximately 10 “hands-on” mostly inquiry based laboratory investigations are performed. The selected labs are described in the course syllabus. For each lab, the student is required to write a formal lab report which includes the following: title, purpose, visual flowchart, data tables, analysis of data, calculations, error analysis questions, and a conclusion. In their conclusion, the student describes how the purpose of the lab was achieved in terms of procedure and calculations.

Homework:

At the beginning of each chapter (unit), the student receives a document listing the overview of the unit, the student performance objectives, and a list of assignments. The assignments are required problems from the textbook, practice worksheets, lab experiments, and practice review multiple choice and free response questions. The homework is assigned one day and discussed the next. Their homework notebooks are collected and checked for clarity, organization, and completion during that period of time when they are taking their unit exam.

Additionally, reaction sets are distributed every two weeks to remind, enhance, and develop the students writing of chemical formulas. Students are expected to write complete net
ionic reactions, balance the reactions, identify the type of reaction, and answer specific questions concerning the reactions.

Assessments:

1) Evaluation of laboratory reports using a rubric to emphasize the major points in a lab.
2) Friday quizzes – a quiz given each week on the learning objectives and reaction cards.
3) Unit Tests given approximately every 2 weeks which include multiple choice questions, free response questions, and error analysis questions from any labs.

I. Chemical Fundamentals
   A. Measurements and units
   B. Uncertainties in measurement & significant figures
   C. Dimensional analysis
   D. Elements, compounds, and mixtures
   E. Chemical and physical properties of substances
   F. The atomic theory: A chronological survey
   G. Electrons, protons, and neutrons: evidence for and properties of
   H. Masses of atoms
   I. The mole
   J. Moles in solution: molarity
   K. Lab Work

Lab: The % of copper in a post 1983 penny. The purpose of this lab is to acquaint the student with the lab, its equipment and the format of the lab report along with an interesting redox reaction. The students calculate the % composition of copper and the % error in their results. (guided inquiry)

Assessment: 1 Test, 1 lab, 1 quiz

II. Bonding (10 days)
   A. The bond spectrum and the nature of each
      1. Covalent bond
2. Polar covalent bond
3. Ionic bond

B. Electronegativities and bond type

C. Bond representations for covalent molecules
1. Lewis dot structures
   a. octet molecules
   b. non-octet molecules
2. Resonance
3. Molecular shapes: VSEPR rules
   a. octet
   b. non-octet
4. Molecular polarities
5. Hybridization
6. Multiple bonds: sigma and pi bonding

D. Molecular Orbital Approach
1. Nature of and need for the molecular orbital
2. Bond orders
3. Bond stability
4. Explaining diamagnetic/paramagnetic effects
5. Versus valence bond approach

Lab:

The geometrical structure of molecules: prediction and building of simple molecular structures using models (guided inquiry). The design is to use pipecleaners and Styrofoam balls to build the geometric and molecular structures of various polar and nonpolar
compounds. Students use their model to verify lewis structures, hybridization, orbitals used, polarity, and 3-D shapes.

**Assessment: 1 Test, 1quiz, 1 model building lab.**

Lippincott structures (3D shape)  Lab on model building
Bonding minilab wkst (every other)

II. **Atomic Structure and Periodicity (12 days)**

A. **Electronic Structure of the Atom**
   1. Nature of light
   2. Atomic Spectra
   3. Quantum Theory
   4. Bohr’s model of the hydrogen atom
   5. PED’s
   6. Quantum Mechanical model of the atom
      a. orbitals
      b. quantum numbers
      c. electron configuration

B. **Periodicity**
   1. Historical background
   2. Electron configurations and the Periodic Table
   3. Periodic properties: what are they and why are they
      a. atomic radius
      b. ionic radius
      c. ionization energy
d. electron affinity

Labs:

1. **Study of line spectra and PED’s**
2. **Synthesis of a periodic table (guided inquiry)**

Assessment: 1 test, 1 quiz, 2 labs

IV. **Liquids and Solids (8 days)**

A. General bonding information

1. intermolecular vs. intramolecular bonding
2. why $PV = nRT$ doesn’t work for liquids and solids
3. why puddles of water, acetone, and mercury look different

B. Properties of liquids: vapor pressure, boiling point, and critical point

C. Changes in State

1. cooling and warming curves
2. phase diagrams

D. Intramolecular Forces in gases, liquids and solids of molecular compounds:

1. London -dispersion forces, dipole-dipole forces, and hydrogen bonds

E. Other solids and their bonding:

2. network covalent substances
3. ionic compounds
4. metals

Lab:

1. **Freezing and melting behavior of a pure substance**

Assessment: 1 test, 1 quiz, 1 lab

V. **Colligative Properties of Solutions (8 days)** **if time, I will cover these topics**
A. Solution Terminology
B. Concentration Units
C. Solubility as a function of temperature and pressure
D. Colligative Properties: vapor pressure lowering, freezing point depression, boiling point elevation, and osmotic pressure

Lab:

Molar mass determination by freezing point depression

Assess: 1 test, 1 lab

VI. Organic Chemistry (2 days) **covered throughout term or given an extra day
A. Nomenclature
B. Functional Groups
C. Structural Isomers

Qualitative Analysis (1 day)

VII. Stoichiometry (14 days)
A. Formula Stoichiometry
   1. Percent composition
   2. Simplest formula
   3. Molecular formula
   4. Names and formulas of compounds
B. Equation Stoichiometry
   1. Writing a balanced equation
   2. Mass relationships in an equation
   3. Limiting reactant and theoretical yield
C. Solution Stoichiometry
   1. An overview of precipitation, acid-base, and redox reactions
   2. Precipitation
a. Solubility rules
b. Writing precipitation equations

3. Acid-Base Reactions
a.. Behavioral and Arrhenius acid-base definitions
b.. Strong vs. weak acids and bases
c.. Writing A/B neutralization equations

4. Oxidation-Reduction Reactions
a. Terms
b. Oxidation numbers
c. Balancing redox reactions by the writing of ½ reactions.

5. Stoichiometry for reactions in solution (volumetric analysis)

Labs:
1. Determination of the empirical formula of copper iodide
2. Volumetric analysis of an unknown monochloride
3. Acid-base titration: standardization of a base and solving for the % of acid in vinegar. (guided inquiry)
4. Redox titration: Determination of Fe in an unknown iron sample.

Assessment: 1 test, 2 quizzes, 4 labs

VIII. Gases (12 days)
A. Ideal Gases
   1. Gas laws
   2. Ideal Gas Equation
   3. Combined Gas Equation
   4. Dalton’s Law of Partial Pressures
B. Kinetic Theory of Gases
1. Explaining the gas laws
2. Temp and motion of gas molecules
3. Effusion and diffusion: Graham’s Law

C. Deviations from ideal behavior
1. Conditions leading to deviations
2. Meaning of the Van der Waal’s equation

Labs:
1. **Determination of R, the universal gas constant.**
2. **Molar mass of a volatile liquid (Dumas Method)**

Assessment: 1 Test, 2 quizzes, 2 labs

IX. Energy Relationships (8 days)

A. The meaning of heat and heat terminology

B. Measuring Heat Flow: Calorimetry
   1. Coffee Cup Calorimetry
   2. Bomb Calorimetry

C. Enthalpy
   1. Thermochemical equations
   2. Determination of enthalpy
      a. Calorimetry
      b. Hess’ Law
      c. Additivity of Heats of Formation

D. First Law of Thermodynamics

Labs:

**Calorimetry: Determination of atomic mass of a metal through its specific heat, Heat of Solution of an ionic compound and Heat of Neutralization.**
Assessment: 1 test, 1 quiz, 1 lab

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Lab Materials:
Vondebrink, Sally Ann, *Laboratory Experiments for Advanced Placement Chemistry.*


**Course Details:**

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**Assessments:**

4) Evaluation of laboratory reports using a rubric to emphasize the major points in a lab.
5) Friday quizzes – a quiz given each week on the learning objectives and reaction cards.
6) Unit Tests given approximately every 2 weeks which include multiple choice questions, free response questions, and error analysis questions from any labs.

I. Kinetics (15 days)

A. Recognition that reactions have different rates through demonstrations.
B. Definition of Rate

C. Measuring Rate
   1. Average Rate
   2. Instantaneous Rate

D. Collision Theory

E. Rate and concentration: rate law, rate constant, order of reaction

F. Time and concentration: integrated rate law, order of reaction, half lives

G. Temperature and Rate
   1. Activation energy
   2. Maxwell-Boltzmann KE distribution curve
   3. Arrhenius Equation

H. Potential Energy diagrams

I. Catalyst and Rate

J. Mechanisms

Labs:
   1. Kinetics of water flow through a buret
   2. Kinetics of the reaction of crystal violet with sodium hydroxide through spectrophotometric data.

Assessment: 1 Test, 2 quizzes, 2 multiday labs

II. Gaseous Equilibrium (10 days)

A. Meaning of equilibrium

B. The Equilibrium Constant
   1. Expression for, evaluation of, and using to find equilibrium concentrations
   2. Kp and Kc

C. LeChatelier’s Principle [CR6]
Labs:

1. **Determination of an equilibrium constant for**
   \[ \text{Fe}^{3+} + \text{SCN}^- = \text{FeSCN}^{2+} \] through spectrophotometric studies.

2. **LeChatelier’s Principle: Predicting (and checking) equilibrium changes through LeChatelier.**

Assessment: 1 Test, 1 Quiz, 2 multiday labs

III. **Acid-Base Equilibria (19 days)**

A. **Acid-Base Models: Arrhenius, Bronsted-Lowry and Lewis**

B. **Weak vs. strong acids and bases**

C. **Hydrolysis reactions and acidic and basic salts**

D. **Kw**

E. **pH of strong acids and bases**

F. **Ka and Kb**
   1. pH of weak acids and bases
   2. pH of polyprotic acids
   3. pH of salts

G. **Buffers**
   1. Choosing the buffer
   2. Preparing the buffer to a specific pH
   3. Calculating the change of pH in a buffer reaction

H. **Acid-Base Titration**

Labs:

1. **Hydrolysis: observing, finding patterns and predicting.**

2. **Titration of strong acid and strong base using a pH meter**

3. **Titration of weak acid and strong base to find MW, pKa, Ka of the**
weak acid

4. Preparation and use of a buffer solution.

Assessment: 2 Tests, 2 quizzes, 4 labs

IV. Solubility Equilibrium (9 days)

A. The dissolving reaction

B. The solubility product: writing the expression, evaluation of the constant, and use of to find equilibrium concentrations of ions or solubility of the solid.

1. The common ion effect

Labs:

The solubility product of Ca(OH)$_2$

Assessment: 1 Test, 1 quiz, 1 lab

V. Reaction Spontaneity (8 days)

A. Definition and examples of spontaneous processes

B. Entropy

1. Define

2. Calculate through the summation of absolute entropies.

C. Enthalpy

1. Review of definitions

2. Calculate through the summation of Heats of Formation

D. Free Energy

1. Calculation by

   a. Gibbs Free Energy

   b. Summation of Free Energies of Formation

2. Related to spontaneity of reaction

E. Temperature and Free Energy
F. Free Energy and Equilibrium Constant

Assessment: 1 test, 1 quiz

VI. Electrochemistry (15 days)

A. Review of terminology.
B. The Voltaic cell
C. Standard electrode potentials
D. Cell voltage, free energy and the equilibrium constant
E. Nernst Equation
F. Electrolytic cell
   1. prediction of electrolysis reactions
   2. use information of time, amps, Faradays, ½ reactions and molar mass to find grams of product or vice versa.

Labs:
   1. The determination of E0, ΔH, ΔS, ΔG, and Keq of Zn/Cu2+ reaction

Assessment: 1 Test, 2 quizzes, 2 labs

VII. Nuclear Chemistry (1 day)

A. Nuclear emissions and their particles. [CR 2b]
B. “Balancing” nuclear equations. [CR 2b, 3]
C. Half Lives [CR 2b]

VIII. Other Lab Work. Qual I scheme is done before the AP test but the other two after the test.

A. Qualitative Analysis of Group I Ions
   1. Developing a scheme for qualitative analysis [CR 2b, 7, 8]
   2. Qualitative analysis of group I ions (guided inquiry) [CR 2b, 7, 8]
B. Synthesis and analysis of a complex iron salt [CR 2b, 7, 8]

C. The ten tube mystery: solving the identity of ten solutions by their visible properties and reactions with each other. (guided inquiry) [CR 2b, 7, 8]

Assessment: 3 labs