



Credit- Degree applicable
Effective Quarter: Fall 2019

I. Catalog Information

CHEM 1B

General Chemistry

5 Unit(s)

(See general education pages for the requirement this course meets.)

(Not open to students with credit in CHEM 1BH.)

Prerequisite: CHEM 1A or CHEM 1AH with a grade of C or better.

Advisory: EWRT 1A or EWRT 1AH or ESL 5.

Lec Hrs: 36.00

Lab Hrs: 72.00

Out of Class Hrs: 72.00

Total Student Learning Hrs: 180.00

Continuation of an introduction to the principles of chemistry. Investigation of intermolecular forces and their effects on chemical and physical properties. Investigation of reversible reactions from the standpoints of kinetics, thermodynamics, and equilibrium. Investigation and application of gas laws and kinetic molecular theory.

Student Learning Outcome Statements (SLO)

Evaluate the principles of molecular kinetics.

Apply principles of chemical equilibrium to chemical reactions.

Apply the second and third laws of thermodynamics to chemical reactions.

II. Course Objectives

- A. Evaluate how intermolecular forces influence solids, liquids and phase changes
- B. Calculate the rate of a reaction and assess the mechanism of action
- C. Utilize the fundamental principles of equilibrium to probe reaction dynamics.
- D. Differentiate between acids and bases and evaluate their reactivity.
- E. Employ the principles of equilibrium in an expanded discussion of thermodynamics.
- F. Analyze the behavior of gases

III. Essential Student Materials

Safety goggles

IV. Essential College Facilities

Fully equipped chemical laboratory including, at a minimum, the following: consumable

chemicals, chemical balances, glassware, molecular models, melting point apparatus, laptops with data acquisition modules, fume hoods, chemical disposal facilities, lockable student storage areas, periodic tables, and laboratory technician. Lecture room with a periodic table.

V. Expanded Description: Content and Form

A. Evaluate how intermolecular forces influence solids, liquids and phase changes

1. Thermodynamics of phase changes
 - a. Enthalpy of fusion
 - b. Enthalpy of vaporization
 - c. Heating curves
2. Phase diagrams
 - a. Equilibrium nature of phase changes
 1. Temperature and vapor pressure
 2. Pressure and boiling point
 - b. Constructing and reading phase diagrams
 1. Phase boundaries
 2. Triple point
 3. Critical point
 - c. Water and other exceptions to standard phase diagram
3. Types of intermolecular forces
4. Properties of liquids
 - a. Surface tension
 - b. Capillary action
 - c. Viscosity
 - d. Water as an unusual liquid
5. Structure and properties of solids
 - a. Cubic crystal structures
 - b. Types of crystalline solids
 - c. Amorphous solids

B. Calculate the rate of a reaction and assess the mechanism of action

1. Reactions rates
 - a. Instantaneous rates
 - b. Graphical interpretation of rates
2. Rate laws
 - a. Rate constant
 - b. Order of reaction
 - c. Method of initial rates
 - d. Recognition of zero-, first-, and second-order reactions
3. Reaction mechanisms

- a. Elementary steps
 - b. Unimolecular, bimolecular, and termolecular reactions
 - c. Rate-determining step
 - d. Activation energy
 - e. Transition state
 - f. Steric factors
 - g. Arrhenius equation
 - h. Reaction coordinate diagrams
4. Catalysis
- C.** Utilize the fundamental principles of equilibrium to probe reaction dynamics.
1. Definition of equilibrium
 2. Equilibrium constants
 - a. Law of mass action
 - b. Constants involving solutions
 - c. Constants involving gases
 - d. Heterogeneous equilibria
 - e. Reaction quotient
 3. Solving equilibrium problems
 4. Le Chatelier's principle
 - a. Concentration effects
 - b. Pressure effects
 - c. Temperature effects
- D.** Differentiate between acids and bases and evaluate their reactivity.
1. Classification of acid-base reactions
 - a. Arrhenius model
 - b. Bronsted-Lowry model
 - c. Lewis model
 2. Conjugate acid and base pairs
 3. Acids
 - a. Acid dissociation constant
 - b. Strong and weak acids
 - c. Polyprotic acids
 - d. Structure effects on acid strength
 4. Strong and weak bases
 5. Amphoteric compounds
 6. The pH scale
 - a. Autoionization of water
 - b. Definition of the pH scale

- c. Calculate the pH of a solution of a strong acid or base
 - d. Calculate the pH of a solution of a weak acid or base
 - e. Calculate percent dissociation
 - 7. Acid-base properties of salts
 - 8. Acid-base properties of oxides
- E. Employ the principles of equilibrium in an expanded discussion of thermodynamics.
 - 1. Entropy
 - 2. The Second Law of thermodynamics
 - 3. The Third Law of thermodynamics
 - 4. Spontaneity
 - 5. Free energy
 - a. Standard free energy
 - b. Relationship to equilibrium constants
 - 6. Reversible versus irreversible processes
- F. Analyze the behavior of gases
 - 1. Pressure
 - a. Units of measure
 - b. Standard atmosphere
 - 2. Historical development of gas laws
 - a. Boyle's Law
 - b. Charles's Law
 - c. Avagadro's Law
 - 3. Solving Gas Law Problems
 - a. The Ideal Gas Law
 - b. Universal gas constant
 - c. Molar volume, molar mass and gas density
 - d. Standard temperature and pressure
 - e. Gas stoichiometry problems
 - 4. Mixtures of Gases: partial pressures
 - a. Dalton's Law
 - b. Mole Fraction
 - 5. Kinetic Molecular Theory
 - a. Tenets of KMT
 - b. Meaning of temperature
 - c. Root-mean-square speed
 - 6. Effusion and Diffusion
 - 7. Real Gases: The van der Waals Equation

VI. Assignments

A. Reading

1. Required readings from the textbook in preparation for the scheduled lecture. This may include entire chapters or sections from the chapters covering topics included in this outline.
2. Required readings from the laboratory manual as a preparation for the scheduled experiment in order to provide students with familiarity about the specific laboratory protocols and related safety precautions necessary for successful completion of the experiment.

B. Writing

1. Homework assignments based on classroom discussion/lecture may include answering questions from end-of-chapter exercises or other sources as deemed appropriate by the instructor.
2. Periodic quizzes and mid-term examinations based on material discussed in lectures and/or reading assignments

C. Laboratory assignments

1. Pre-lab exercise: The pre-lab assignment for the scheduled laboratory experiment to be completed prior to beginning of each new experiment. This assignment may be identical to that provided in the laboratory manual or substituted with other appropriate assignments determined by the instructor.
2. Report: Data obtained in laboratory exercises are to be entered in the assigned laboratory manual or a laboratory notebook. Necessary calculations required to obtain the final results from the experiment must be completed in the manual or the notebook as to be determined by the instructor. Detailed lab reports incorporating results and discussions from the experiment will be required.

VII. Methods of Instruction

Lecture and visual aids
Discussion of assigned reading
Discussion and problem solving performed in class
Quiz and examination review performed in class
Homework and extended projects
Collaborative learning and small group exercises
Laboratory experience which involve students in formal exercises of data collection and analysis
Laboratory discussion sessions and quizzes that evaluate the proceedings weekly laboratory exercises

VIII. Methods of Evaluating Objectives

- A. Homework assignments based on end-of-chapter problems from the primary text will be evaluated for completion to test comprehension of lectures.
- B. Periodic quizzes will be used to test the comprehension of topics covered during the lecture and will be evaluated for accuracy of responses.
- C. A minimum of two mid-term examinations will be used to evaluate the ability of students to a) solve problems, b) outline various concepts covered in the lecture, and c) demonstrate an understanding of reading assignments. These will be evaluated for accuracy to assess student progress in achieving various learning outcomes.
- D. A comprehensive final examination in any chosen format (multiple choice questions or free response) will be based on all the course material covered during the entire quarter and evaluated for accuracy of responses.
- E. Pre-lab assignments will be evaluated for completeness and level of preparedness required for safe and timely execution of laboratory protocols and experiments.
- F. Report sheets and/or laboratory reports will be evaluated for successful completion of

laboratory experiments as well as accuracy of data analysis and interpretation.

- G. A comprehensive laboratory examination or periodic quizzes will be used to evaluate the student understanding of the various concepts discussed in the different experiments performed during the course. Concepts evaluated will include: a) general laboratory protocol b) comprehension of data analysis and interpretation and c) critical thinking as it pertains to the scientific method.

IX. Texts and Supporting References

A. Examples of Primary Texts and References

1. Silberberg and Amateis. Chemistry: The Molecular Nature of Matter and Change, 8th edition. McGraw-Hill, 2018. ISBN 978-1-259-63175-7.
2. De Anza Chemistry Department General Chemistry Laboratory Manual (<https://www.deanza.edu/chemistry/Chem1B.html>)

B. Examples of Supporting Texts and References

1. Silberberg, Martin. Student Solutions Manual: Chemistry: The Molecular Nature of Matter and Change, 8th edition. McGraw-Hill, 2018. ISBN 978-1259916250

X. Lab Topics

A. Laboratory methodology

1. Maintaining a laboratory notebook
2. Writing laboratory reports

B. Chemical safety

1. Materials safety data sheets (MSDS)
2. Chemical disposal
 - a. Separation of waste streams
 - b. Proper disposal methods
 - c. Environmental hazards of improper waste disposal
3. Laboratory environment
 - a. Maintaining laboratory cleanliness
 - b. Chemical labeling
 - c. Segregation of chemicals by hazard
 - d. Secondary containment
4. Personal safety
 - a. Safety goggles
 - b. Limiting chemical exposure
 - c. Safety shower
 - d. Eyewash stations
 - e. Proper use of fire extinguishers
5. Emergency situations
 - a. Fires
 - b. Earthquakes
 - c. Evacuation procedures

C. Acid-Base Titration

1. pH Meters
 - a. Calibration of pH meters
 - b. Use of pH meters
2. Analysis of a weak acid
3. Selection of an indicator

D. Experimental determination of a rate law

1. Measurement and calculation of reaction rate
2. Determination of activation energy
3. Observation of the effect of a catalyst

E. Spectroscopy

1. General theory of spectroscopy
 - a. Absorbance versus transmittance
 - b. Origin of electromagnetic absorption
2. Beer's law
3. Operation of a spectrophotometer
4. Spectroscopic determination of an equilibrium constant
5. Spectroscopic determination of the acid strength of an indicator

F. Gas Laws**G. Synthesis and analysis of a transition metal complex**