CHEM 30A: SURVEY OF INORGANIC & ORGANIC CHEMISTRY

Foothill College Course Outline of Record

Heading	Value
Units:	5
Hours:	4 lecture, 3 laboratory per week (84 total per quarter)
Prerequisite:	Elementary Algebra or equivalent.
Advisory:	UC will grant transfer credit for a maximum of one course from the following: CHEM 25, 30A or 30B.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Area III: Natural Sciences
Transferable:	CSU/UC
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- Students will be able to represent chemical changes correctly through balanced chemical equations with proper formulas for elements and compounds.
- Students will be able to classify matter correctly.
- Students will be able to use common laboratory equipment correctly and report measurements to the correct significant figures with proper units. Equipment includes Bunsen burners, beakers, graduated cylinders, thermometers, top loading balances, rulers and burets.

Description

An introductory course covering basic principles of chemistry more descriptive than quantitative in emphasis. Topics include atomic structure, the periodic table, the three states of matter, energy, chemical bonding in ionic and molecular compounds, nomenclature, measurement and the metric system, chemical reactions and equations, solutions, acids, bases, salts and electrolyte systems. Primarily intended for students entering the allied health field, including: nursing, veterinary technology, dental assistant, dental hygiene, biotechnology, primary care associate, radiation therapy technology, radiologic technology, respiratory therapy, and pharmaceutical technology.

Course Objectives

The student will be able to:
A. Examine and classify matter and the chemical changes it undergoes, and name common elements from the periodic table.
B. Use dimensional analysis for problem solving, and show answers with correct units and with the correct significant figures.
C. Explain the difference between a solid, liquid and a gas.
D. Understand atomic theory, atomic structure and isotopes.
E. Use the periodic table to determine electron configuration and assign oxidation numbers.
F. Name ionic and molecular compounds, and name basic organic compounds (hydrocarbons only).
G. Write balanced equations to show basic chemical reactions.
H. Use the concept of the mole and Avogadro's number in stoichiometry.
I. Understand the behavior of an ideal gas and use the ideal gas equation.
J. Draw Lewis structures, determine if a molecule is polar or nonpolar, and analyze for intermolecular forces of attraction.
K. Know how to prepare a solution and understand the effects of temperature, pressure, and concentration on the rate of dissolution.
L. Understand osmotic pressure.
M. Understand solution conductivity.
N. Understand Le Chatlier's Principle to determine affects on a system at equilibrium.
O. Define acids, bases and salts and know what components of a solution will make a buffer.
P. Write a nuclear reaction showing alpha, beta and gamma decay.
Q. Know the difference between an organic and inorganic compound, and be able to name them correctly.
R. Understand the significance of a functional group in an organic molecule, and be able to recognize a functional group within a molecule.
S. Gain an understanding of the scientific method.

Course Content

A. Matter (Lec, Lab)
1. Classifying matter correctly
2. Chemical and physical properties
3. Chemical and physical change
B. Measurements and Calculations (Lec, Lab)
1. Accuracy in measurements
2. SI units and the metric system
3. Temperature and the Kelvin scale
4. Significant figures
5. Density
6. Dimensional analysis
C. States of Matter (Lec, Lab)
1. Solid
2. Liquid
3. Gas
D. Atoms (Lec)
1. What is an atom?
2. Subatomic particles: protons, neutrons and electrons
3. Isotopes
E. Periodic Table (Lec)
1. Interpreting the periodic table: atomic number, average atomic mass number, element symbols
F. Naming Compounds (Lec, Lab)
1. What is an ionic compound?
2. Writing chemical formulas of binary ionic compounds
3. Polyatomic ions
4. Writing chemical formulas for ionic compounds containing polyatomic ions
5. Molecular compounds and acids
6. What is a molecular compound?
7. Writing chemical formulas for molecular compounds
8. What is an acid?
9. Writing formulas for common acids that you will use in the lab
G. Chemical Reactions (Lec, Lab)
1. Writing a chemical equation
2. Balancing a chemical equation
3. Classifying the 5 basic reaction types
4. Predicting products for double displacement (ppt and acid-base neutralization) reactions
5. Oxidation and reduction

H. The mole (Lec, Lab)
1. Avogadro's number
2. Stoichiometry
I. Gases (Lec, Lab)
1. Solids, liquids and gases; the kinetic molecular theory
2. Gas laws
3. STP and the molar volume of a gas
J. Liquids and Solids (Lec)
1. Molecular shape (VSEPR Theory)
2. Electronegativity and polarity
3. Intermolecular forces of attraction
K. Solutions (Lec, Lab)
1. Affect of temperature, pressure and concentration on solubility
2. Solubility of ionic compounds
3. Solubility of covalent compounds
4. Molarity
5. Percent concentrations
L. Osmosis and Osmotic Pressure (Lec)
1. Molarity versus osmolarity
2. Hypotonic, hypertonic and isotonic
M. Conductivity (Lec, Lab)
1. Strong, weak and non-electrolytes
N. Reaction Rates (Lec)
1. Equilibrium
2. Le Chatlier's Principle
O. Acids and Bases (Lec, Lab)
1. Acids: the Arrhenius Concept
2. Strong and weak acids
3. Some common bases
4. Neutralization reactions
5. Concentrations of acids and bases
6. Acid-base titrations
7. The pH scale
8. Buffers: control of pH
P. Nuclear Chemistry (Lec)
1. Alpha, beta and gamma decay
2. Applications in nuclear medicine: diagnostic imaging and radiation therapy
Q. Hydrocarbons (Lec, Lab)
1. Introduction to the field of organic chemistry
2. Alkanes, alkenes and alkynes
3. Basic nomenclature of straight chained and branched alkanes
4. Isomers
R. Functional Groups (Lec)
1. What is a functional group?
2. Recognizing functional groups in a compound
3. Naming functional groups
S. The Scientific Method (Lec, Lab)
1. Experience conducting experiments and collecting data
2. Experience analyzing data to answer questions and draw conclusions
3. Understanding of the terms hypothesis, experiment and theory

Lab Content

A. Density of Solids and Liquids
1. Introduction to the use of common laboratory equipment, including the graduated cylinders, top loading balances, beakers, and rulers
2. Make measurements and report them to the correct number of significant figures
3. Use collected data to calculate volume and density
4. Experience working collaboratively with another chemistry student
5. Ability to keep accurate experimental records and record data correctly
6. Use of reference manuals to look up physical data
7. Calculation of percent error
B. Inorganic Nomenclature
1. Practice naming and writing formulas for elements, ions, ionic compounds, molecular compounds and acids
C. Separation of a Sand/Salt Mixture
1. Introduction to common lab techniques, including extraction, gravity filtration and evaporation
2. Use of common laboratory equipment, including Bunsen burners, beakers, funnels and top loading balances
3. Experience working collaboratively with another chemistry student
4. Ability to keep accurate experimental records and record data correctly
5. Calculation of percent recovery
6. Analysis of sources of loss in an experimental procedure
D. Chemical Reactions
1. Practice writing balanced chemical reactions based on observations in the lab
2. Use of common laboratory equipment, including test tubes, beakers and graduated cylinders
3. Ability to keep accurate experimental records and record data correctly
4. Experience working collaboratively with another chemistry student
5. Practice classifying reactions into five basic reaction types
6. Practice predicting products of simple chemical reactions
7. Observations of physical and chemical change
E. Percent Yield of Sodium Carbonate
1. Calculating theoretical, experimental and percent yield based on real lab data
2. Use of common laboratory equipment, including crucibles and top loading balances
3. Ability to keep accurate experimental records and record data correctly
4. Experience working collaboratively with another chemistry student
5. Analysis of sources of error in a procedure
F. Synthesis of Alum
1. Introduction to a use for used aluminum cans in recycling
2. Use of common laboratory equipment, including top loading balances, graduated cylinders, beakers and funnels
3. Experience working collaboratively with another chemistry student
4. Ability to keep accurate experimental records and record data correctly
5. Reinforcement of lab techniques learned in past lab sessions
6. Reinforcement writing formulas and chemical equations
7. Calculation of theoretical yield, experimental yield and percent yield
8. Analysis of sources of loss in an experimental procedure
G. Gas Forming Reaction
1. Calculation of required amounts of reactants needed to produce a desired amount of gaseous product
2. Use of the ideal gas equation and stoichiometric calculations
3. Use of common laboratory equipment, including top loading balances, thermometers, barometers and graduated cylinders
4. Experience keeping accurate experimental records
5. Experience working collaboratively with another chemistry student
6. Use of solution concentration in stoichiometric calculations
H. Titrating to Determine Citric Acid Content in Juice Samples
1. Use of common laboratory equipment, including beakers, graduated cylinders, funnels and burets
2. Introduction to a new lab technique, titration
3. Stoichiometric calculations to determine the unknown concentration of citric acid in juice samples using molarity and % m/v
4. Experience keeping accurate experimental records
5. Experience working collaboratively with another chemistry student
I. Organic Nomenclature and Modeling
1. Use of molecular models to understand molecular geometry of organic molecules

2. Use of common laboratory equipment
3. Practice naming and drawing organic molecules
4. Experience working collaboratively with another chemistry student

Special Facilities and/or Equipment

A. Calculator.
B. Safety goggles.
C. Mastering Chemistry access code for online learning/homework.
D. Introductory laboratory and laboratory equipment.
E. When taught via Foothill Global Access, on-going access to computer with email software and hardware; email address. Student will be required to access both CANVAS and Mastering Chemistry.

Method(s) of Evaluation

A. Two midterm exams
B. Homework (from book chapters and Mastering Chemistry)
C. Labs
D. Cumulative final exam
E. Evaluation based on lab performance

Method(s) of Instruction

A. Lecture
B. Laboratory
C. Online learning/homework

Representative Text(s) and Other Materials

McMurry, J., M. Castellation, and D. Ballantine. Fundamentals of General, Organic, and Biological Chemistry. 8th ed. Pearson Prentice Hall, 2016.

Norick, A. Chemistry 30A Lab Manual for Foothill College. 3rd ed. 2012.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

A. Examine and classify matter and the chemical changes it undergoes, and name common elements from the periodic table.

1. Which of the following is a chemical change and which is a physical change?

a. steam condensing

b. milk souring

c. ignition of matches

d. breaking a dinner plate

e. exploding nitroglycerin

2. Classify each as an element, compound or mixture:

a. aluminum

b. air

c. table salt (sodium chloride)

d. water

e. salt water

3. How many atoms of what elements are represented by the following formulas?

a. propane (LP gas) C3H8

b. aspirin C9H8O4

c. isopropyl alcohol C3H8O

B. Use dimensional analysis for problem solving, and show answers with correct units and with the correct significant figures.

1. Use a meter stick to measure the height of the bench top in cm. Report your answer to the tenth (0.1) of a cm. Convert your measurement to express the bench height in the following units:

a. m

b. km

c. mm

C. Explain the difference between a solid, liquid and a gas.

D. Explain atomic theory, atomic structure, isotopes and electron structure.

1. Write the symbol to represent the isotope of carbon that has 7 neutrons. Include the mass number and the atomic number.

2. How many protons, neutrons and electrons are in the isotope symbolized as 16O.

E. Use the periodic table to determine electron configuration, assign oxidation numbers and compare elements based on periodic trends (electronegativity, electron affinity, atomic radius, etc.).

1. Write the electron configuration for a neutral fluorine atom.

2. Write the electron configuration for a fluoride ion.

3. Write the correct symbol to represent the following ions:

a. sulfide ion

b. calcium ion

c. sodium ion

d. fluoride ion

F. Name ionic and molecular compounds, and name basic organic compounds (hydrocarbons only).

1. Write the formulas for the following ions:

a. hydroxide ion

b. acetate ion

c. nitrate ion

2. Convert the following formulas into names:

a. CaS

b. NH4Cl

c. SO_3

d. H_2SO_4 (aq)

e. HCl (aq)

3. Convert the following names into formulas:

a. copper (II) chloride

b. sodium sulfate

c. carbon dioxide

d. dinitrogen tetroxide

e. phosphoric acid

G. Write balanced equations to show basic chemical reactions.

1. Convert the following into balanced chemical reactions:

a. sulfuric acid and aqueous sodium hydroxide react to form aqueous sodium sulfate and water.

b. methane gas reacts with oxygen gas to form carbon dioxide gas and water vapor.

H. Use the concept of the mole and Avogadro's number in stoichiometry.

1. In the atmosphere, nitrogen dioxide gas reacts with water to form nitrogen monoxide gas and nitric acid. Both products contribute to formation of acid rain. Use this information to complete a-e below:

a. write a balanced equation for this reaction, including the states of each substance.

b. find the mole ratio between the two reactants.

c. find the molar mass of nitrogen dioxide, and express your answer to the hundredth decimal place.

d. find the molar mass of water, and express your answer to the hundredth decimal place.

e. calculate the number of grams of water needed to react with 1.00 g of nitrogen dioxide gas.

I. Understand the behavior of an ideal gas and use the ideal gas equation.

1. A sample of gas has a mass of 0.44 g. This sample of gas occupied a volume of 128.0 mL at 0.998 atm and 379 K. What is the molar mass of this gas?

J. Draw Lewis structures, determine if a molecule is polar or nonpolar, and analyze for intermolecular forces of attraction.

1. Draw the Lewis structure for nitrogen trifluoride below, and use this to answer a-d below:

a. given that the electronegativity of fluorine is 4.0 and nitrogen is 3.0, show any partial positive and partial negative charge buildup that exists in the molecule drawn above.

b. what is the molecular geometry of a nitrogen trifluoride molecule?

c. is nitrogen trifluoride a polar or nonpolar molecule?

d. what type of intermolecular force of attraction exists between two nitrogen trifluoride molecules?

K. Know how to prepare a solution and understand the effects of temperature, pressure, and concentration on the rate of dissolution.

1. How many grams of NaCl are needed to prepare 90.0 mL of a 0.40 M solution?

2. Write out the steps that you would take to prepare 90.0 mL of a 0.40 M NaCl solution in the lab.

3. What volume of a 1.2 M NaCl solution is needed to prepare 30.0 mL of a 0.40 M solution?

L. Understand osmotic pressure.

1. Which of the following solutions will have the highest osmotic pressure?

a. 1 M NaCl

b. 2 M KCl

c. 1 M K_2SO_4

d. 1 M K_3PO_4

M. Understand solution conductivity.

1. When equal volumes of 0.1 M BaOH and H_2SO_4 are mixed the light should have gone out. Did the light go out? Explain why it did or did not go out upon mixing these solutions.

N. Understand Le Chatlier's Principle to determine affects on a system at equilibrium.

1. The reaction H_2 (g) + I_2 (g) --> 2 HI (g) is exergonic. Will the concentration of HI increase, decrease, or remain unchanged when:

a. I_2 is added

b. H_2 is removed

c. a catalyst is added

d. the temperature is increased

e. the volume is decreased

O. Define acids, bases and salts and know what components of a solution will make a buffer.

1. List the ions and/or molecules present in a solution of H_3PO_4 and NaH_2PO_4.

2. For the above solution, identify the acid and conjugate base pair.

P. Write a nuclear reaction showing alpha, beta and gamma decay.

Q. Know the difference between an organic and inorganic compound, and be able to name them correctly.

R. Understand the significance of a functional group in an organic molecule, and be able to recognize a functional group within a molecule.

1. Which of the following functional groups does not contain a carbonyl?

a. amide

b. ester

c. ether

d. carboxylic acid

S. Students will gain an understanding of the scientific method.

1. Calculate the theoretical yield of barium sulfate that could form from your starting mass of barium chloride (the limiting reactant).

2. Using your experimental yield and the calculated theoretical yield, determine the percent yield for this reaction.

3. Your percent yield will always be less than 100%. Explain why.

4. Write a procedure that could be used to measure the density of a salt solution. Be detailed. Assume that a student brand new to chemistry will be following your steps.

Discipline(s)

Chemistry