

Miami Dade College
CHM 1045 First Semester General Chemistry

Course Description: CHM 1045 is the first semester of a two-semester general chemistry course for science, premedical science and engineering majors. CHM 1045 topics include: stoichiometry, atomic structure, completing and balancing chemical reactions, nomenclature, bonding, acid-base theories, solutions, and gas laws, and beginning thermodynamics.

3 Credits Each

Prerequisites for CHM 1045: CHM 1025 or grade of “C” or better in high school chemistry.

Corequisites for CHM 1045: CHM 1045L; MAC 1105

Course Competencies:

Competency 1: The student will demonstrate knowledge of the basic units, calculations, conversions, and measurements that are at the very foundation of chemistry by:

- a. Demonstrating how very large or very small numbers are expressed in scientific or exponential notation.
- b. Converting ordinary numbers into scientific or exponential notation.
- c. Adding, subtracting, multiplying, and dividing numbers in scientific or exponential notation.
- d. Applying the concept of significant figures and rounding off.
- e. Categorizing units as either, units of length, mass, volume, or temperature.
- f. Demonstrating how to use measurements for length, mass, volume, and temperature
- g. Applying dimensional analysis to solve unit conversion problems.
- h. Showing an ability to use the metric system of measurements by solving metric conversion and English-to-metric conversion problems.
- i. Converting among the three common temperature scales.
- j. Performing density calculations.

Competency 2: The student will demonstrate knowledge of matter’s classification, properties, and changes by:

- a. Classifying matter as either a pure substance or mixture.
- b. Classifying pure substances as either elements or compounds.
- c. Classifying a mixture as either homogeneous or heterogeneous.
- d. Distinguishing between physical and chemical properties and changes of matter.

- e. Characterizing the three common states of matter, how the interconversion among states can occur, and the terminology employed during interconversion.
- f. Applying the Law of Conservation of Matter.

Competency 3: The student will demonstrate knowledge of the basic building blocks of matter by:

- a. Identifying the three major subatomic particles (electrons, protons, and neutrons) of the atom and describing their general arrangement within the atom.
- b. Defining isotopes and determining how the properties and structure of isotopes of a single atom differ.
- c. Relating an element's isotopic abundance and mass to its average atomic mass.
- d. Identifying the number of protons, neutrons, electrons, mass number, and atomic number that an atom has given its isotope symbol.
- e. Supplying the early experimental evidence that lead to the discovery of subatomic particle. [OPTIONAL]
- f. Learning the name and symbol of common elements, as well as describing their nature.
- g. Illustrating how an ion is formed from its parent atom, and learning the name and formula of common ions.
- h. Showing how atoms or ions combine to form compounds.
- i. Identifying the basic repeating unit of elements (atom, molecule, or formula unit), ions (ion or formula unit), and compounds (molecule or formula unit).

Competency 4: The student will demonstrate an ability to understand several of the intricacies of the periodic table by:

- a. Showing how to obtain an element's average atomic mass and atomic number from the periodic table.
- b. Using the structure of the periodic table to classify elements (e.g., metal, non-metal, metalloid, noble gas, representative element, transition element, inner transition element, alkali metal, alkaline earth metal, and/or halogen).
- c. Using the periodic table to identify common patterns such as atomic radii, ionic radii, ionization energy, electron affinity, and electronegativity within groups of elements.
- d. Pointing out the relationship that exists between an element's number of valence electrons and its group number.
- e. Pointing out the relationship that exists between an element's group number and the ion that it commonly forms.
- f. Identifying the s, p, d and f blocks in the periodic table.

- Competency 5: The student will demonstrate knowledge of electronic structure by:
- Demonstrating the relationship that exists between the wavelength, frequency, and energy of electromagnetic radiation.
 - Demonstrating an ability to understand electronic transitions by working problems involving the Rydberg equation for hydrogen-like species. [OPTIONAL]
 - Comparing and contrasting the particle and wave description of light.
 - Relating important advances made in atomic theory to electronic emission and absorption spectra.
 - Giving some of the very basic tenants involved in the quantum mechanical picture of the atom.
 - Generating a viable set of four quantum numbers associated with an electron.
 - Illustrating how electrons fill their principal energy levels and sublevels.
 - Giving the maximum number of electrons that can be accommodated in the various principal energy levels, sublevels, and orbitals.
 - Generating the spectroscopic electronic configuration of elements and ions.
 - Relating the number of paired or unpaired electrons in a species to their diamagnetism or paramagnetism.
 - Recognizing the shape of s and p atomic orbitals. [OPTIONAL: Recognizing the shape of d orbitals].
 - Applying Pauli's Exclusion Principle and Hund's Rule of Maximum Multiplicity to construct electronic orbital diagrams.
 - Giving the number of valence electrons in an atom.
 - Relating electronic configurations to the position of elements in the periodic table.

- Competency 6: The student will demonstrate knowledge of chemical bonding by:
- Predicting the type of bond that a compound will form.
 - Relating the nature of the type of bond elements will form to the electronegativity differences of the elements involved in bonding.
 - Comparing and contrasting ionic and covalent bonding.
 - Writing the Lewis electron dot structure of elements, ions, ionic compounds, and covalent compounds.
 - Recognizing exceptions to the octet rule.
 - Recognizing when resonance structures are possible, how the concept of resonance helps to explain experimental bond lengths, and how to write resonance structures.
 - Calculating the formal charge for atoms involved in a covalent bond.

- h. Using the Valence Shell Electron-Pair Repulsion Theory to determine molecular geometry and bond angles.
- i. Predicting the relationship between molecular geometry and molecular polarity.
- j. Using Valence Bond Theory to analyze the hybrid orbitals used in bonding and to describe double and triple bonds.
- k. Using Molecular Orbital Theory to describe the type of bonding involved in homonuclear and heteronuclear diatomic molecules or ions and how this theory is used to predict bond order, bond stability, paramagnetism, and diamagnetism. [OPTIONAL]

Competency 7: The student will demonstrate knowledge of compositional stoichiometry by:

- a. Pointing out what atoms are present in a compound and in what ratio.
- b. Calculating the molar mass of a substance from the sum of its atomic masses.
- c. Demonstrating the ability to convert among moles, mass, and number of atoms in a given sample.
- d. Showing how to find the mass percent of an element in a given compound.
- e. Determining the empirical formula of a compound from elemental masses, mass percentages, or combustion analysis data.
- f. Determining the molecular formula of a compound given its empirical formula and molar mass.

Competency 8: The student will demonstrate knowledge of chemical reactions in relation to reaction stoichiometry by:

- a. Balancing chemical reactions.
- b. Solving stoichiometry problems.
- c. Determining which is the limiting reactant.
- d. Using the limiting reagent concept in calculations with chemical equations.
- e. Comparing the amount of substance actually formed in the reaction (actual yield) with the predicted amount (theoretical yield) to determine the percent yield of a chemical reaction.
- f. Showing how the concept of equivalence can be used to solve acid-base and reduction-oxidation stoichiometry problems. [OPTIONAL]

Competency 9: The student will demonstrate knowledge of several aspects of solutions by:

- a. Distinguishing between a solute and solvent in a solution.
- b. Distinguishing between the different types of solutions: saturated, unsaturated, and supersaturated.
- c. Writing the concentration of a solution in terms of mass percent and showing how to calculate it.

- d. Writing the concentration of a solution in terms of molarity and showing how to calculate it.
- e. Writing the concentration of a solution in terms of normality and showing how to calculate it. [OPTIONAL]
- f. Demonstrating the ability to work with Normality concentration units.
- g. Solving problems involving solution stoichiometry.
- h. Calculating the concentration of a solution made by dilution of a stock solution.

Competency 10: The student will demonstrate knowledge of writing chemical formulas and the chemical nomenclature of inorganic compounds by:

- a. Determining the oxidation number of elements in a chemical formula.
- b. Writing formulas of ionic compounds given their respective ions.
- c. Distinguishing between the types of binary compounds and ternary compounds as a means to pointing out what rules to apply in their nomenclature.
- d. Generating the name of binary compounds of a metal and a non-metal or writing their formula when their name is given.
- e. Generating the name of binary compounds containing only non-metals or writing their formula when their name is given.
- f. Generating the name of binary acids or pseudo binary acids or writing their formula when their name is given.
- g. Generating the name of common polyatomic ions or writing their formula when their name is given.
- h. Generating the name of salts and acid salts containing common polyatomic ions or writing their formula when their name is given.
- i. Generating the name of bases or writing their formula when their name is given.
- j. Generating the name of oxy acids or writing their formula when their name is given.

Competency 11: The student will demonstrate knowledge of several aspects involved in chemical reactions by:

- a. Categorizing chemical reactions such as ionization, dissociation, combustion, single replacement, redox, and double replacement reactions.
- b. Showing how the solubility rules and electromotive series are used to predict whether or not a chemical reaction will occur.
- c. Interpreting the solubility rules as a means to determining the physical state of substances involved in aqueous chemical reactions and as a means to determining the type of electrolyte a substance is.

- d. Completing and balancing the above mentioned chemical reactions.
- e. Writing chemical equations of substances in aqueous solution in molecular, ionic, and net ionic form.
- f. Determining whether a species involved in a redox reaction is being reduced or oxidized.
- g. Categorizing reagents involved in redox reactions as reducing or oxidizing agents.

Competency 12: The student will demonstrate knowledge of gases and their properties by:

- a. Comparing and contrasting the properties of gases to those of liquids and solids.
- b. Determining the qualitative and quantitative relationship among pressure, volume, temperature, and amount of gas (Boyle's Law, Charles' Law, Avogadro's Law, and Combined Gas Laws).
- c. Using the Ideal Gas Equation in solving gas law problems.
- d. Calculating gas densities and standard molar volumes.
- e. Determining molar masses and formula of gaseous substances from measured properties of gases.
- f. Describing how mixtures of gases behave and how Dalton's Law is used to solve problems involving a mixture of gases.
- g. Using the kinetic-molecular theory of gases and showing and how this theory is consistent with the observed gas laws.
- h. Describing molecular motion, diffusion, and effusion of gases.
- i. Identifying the factors responsible for making gases behave either more or less ideally.
- j. Performing calculations involving gas stoichiometry.

Competency 13: The student will demonstrate knowledge of the properties of aqueous solutions of acids and bases by:

- a. Comparing and contrasting the various acid-base theories (Arrhenius, Brønsted-Lowry, and Lewis).
- b. Giving various properties of acids and bases.
- c. Categorizing substances as Arrhenius, Brønsted-Lowry, and/or Lewis acids/bases.
- d. Understanding the relationship between acid and base conjugate pairs by being able to correctly identify acid-base conjugate pairs in an acid-base reaction.
- e. Predicting strengths of acids and bases.

- f. Predicting when an acid or a base is leveled by a solvent and by recognizing pairs of acids or bases which can be differentiated by a solvent. [OPTIONAL]

Competency 14: The student will demonstrate knowledge of thermodynamics by:

- a. Distinguishing among state functions, system, surroundings, and universe.
- b. Calculating the change in enthalpy for a physical process or chemical reaction from tabulated standard molar heat of formation data.
- c. Using Hess' Law to calculate the change in enthalpy for a reaction.
- d. Carrying out calculations relating temperature change to heat absorbed or liberated.