

OBJECTIVES MATRIX FOR ONLINE STOICHIOMETRY COURSE

KLE_9_11_05

CONTENT AREAS	CONCEPTUAL KNOWLEDGE	PROCEDURAL KNOWLEDGE
THE MOLE	(1) Explain that in chemical reactions atoms and molecules are consumed and produced at the molecular scale (in moles) but that these phenomena are measured at the macroscopic scale (in grams). (2) Identify the mole as a collective numerical quantity that represents an Avogadro's number (6.02×10^{23}) of atoms, ions, molecules, etc.	(1) Convert from the macroscopic world (in grams) to the molecular world (atoms and molecules.) by using the atomic/molecular weight (molar mass) and Avogadro's number. (2) Convert from the molecular world (atoms and molecules) to the macroscopic world (grams) by using Avogadro's number and atomic/molecular weight (molar mass).
THE TOOLS OF STOICHIOMETRY	(1) Describe the quantity that each subscript in a chemical formula represents. (2) Define the atomic/molecular weight (molar mass) as the number of grams per mole of a substance. (3) Explain the relationship between the number of atoms of an element in a molecule and the number of moles of atoms of an element in a mole of a compound. (4) Explain the concentration of a solution in terms of moles, volume, and molarity.	(1) Assemble a sequential combination of dimensional equalities to convert a specified quantity to an equivalent quantity. (2) Use the appropriate number of significant digits when reporting results of calculations involving measured values. (3) Given a periodic table, calculate the molecular weight of a compound. (4) Calculate the number of moles of constituent elements in a given number of moles of a compound. (5) Calculate the masses of the constituent elements in a given mass of a compound. (6) Calculate the percent by mole or by mass of an element in a given compound. (7) Determine the number of moles of solute present in a specified volume of solution of known molarity. (8) Determine the molarity of a solution given the moles of solute dissolved in a specified volume of solvent. (9) Determine the volume of solution with known molarity that is needed to provide a given number of moles of solute. (10) Determine the mass of solute needed to prepare a solution with a specified volume and molarity when given the solute's chemical formula.
MANIPULATING SOLUTIONS	(1) Compare the effects of dilution on the amount of solute present in, and concentration of, a diluted solution. (2) Describe density as mass per unit volume. (3) Evaluate the sensitivity and specificity of density measurements in chemical analysis.	(1) Describe how to make a specified volume of a diluted solution from a concentrated solution of specified molarity. (2) Calculate the final molarity of each solute after specified molarities and volumes of non-reacting solutions are mixed. (3) Calculate the density of a solution in g/mL having measured (or been given) the mass and volume of a specified solution.
QUALITATIVE ANALYSIS OF PURE SUBSTANCES	(1) Explain why elemental analysis is necessary but not sufficient to identify a chemical compound. (2) Describe how chemists use elemental analysis.	(1) Compute the empirical formula of an unknown compound from elemental analysis data. (2) Derive the empirical formula of a compound from its molecular formula.
REACTION STOICHIOMETRY	(1) Using a balanced equation, predict the effects of a chemical reaction on the amounts of each substance in a reaction mixture. Explain how titration is used to quantify the amount of solute in a solution.	(1) Given the formulas for reactants and products, write a balanced chemical equation. (2) Calculate the mass of any reactant or product consumed or produced in a chemical reaction when given the mass of one of the other reactants or products. (3) Deduce the percent yield of a specified product of a chemical reaction given the mass of a reactant and the mass obtained of the specified product. (4) Determine the limiting reactant when masses of two or more reactants are given for a chemical reaction. (5) Calculate the mass of product formed from the mass of the limiting reactant. (6) Deduce the mass of any reactant left over after a reaction goes to completion when given the initial masses of the reactants. (7) Deduce the mass fraction of each substance in a binary mixture when given the chemical formulas of the substances, the initial mass of the mixture, and the mass of a common product formed from the complete reaction of the mixture with a common reactant. (8) Given a chemical reaction of the solute and the colors of the reactants and products, design a titration experiment to determine the amount of solute in a solution. (9) Calculate the concentration, mass, or number of moles of a solute in an unknown solution from titration data.