Chemistry 105 Course Objectives (T. Zamis, Fall 2005)

Exam 1 Objectives

Chapter 1 Chemistry and Measurement

Essential Terms

matter	conservation of mass	states of matter	physical change	physical property	chemical change
chemical property	substance	element	compound	mixture	heterogeneous mixture
homogeneous mixture	precision	accuracy	scientific notation	exact number	uncertainty
International System (SI)	dimensional analysis	conversion factor	experiment	hypothesis	theory

1) Know the SI base units for length, mass and time. Table 1.1

2) Know the unit prefixes highlighted in blue in Table 1.2.

3) Know the derived units for volume, density, area, and speed. Table 1.3

4) Become proficient in the use of the factor-label method for all calculations.

5) Be able to convert between common English units and metric units (Table 1.4).

6) Be able to convert between degrees Fahrenheit, degrees Celsius and kelvins.

7) Know the importance and proper use of units and significant figures in making and reporting measurements.

8) Know how to determine the correct number of significant figures in numbers and calculations.

9) Be able to use the law of conservation of mass in calculations for chemical reactions.

Practice Problems: 31 33 35 39 41 43 45 47 49 51 55 65 67 69 71 75 77 79 81

Chapter 2 Atoms, Molecules, and Ions

Essential Terms

atomic theory	atom	atomic symbol	nucleus	proton	neutron
electron	atomic number	mass number	nuclide	isotope	atomic weight
periodic table (group, period)	metal	non-metal	metalloid	alkali metals	alkaline earth metals
halogens	noble gases	transition metals	molecule	polymer	biopolymer
monomer	ion	cation	anion	ionic compound	organic compound
inorganic compound	functional group	chemical nomenclature	chemical equation	reactant	product

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1) Know the name, symbol, atomic number, mass number, number of protons, number of neutrons, and number of electrons for the elements 1 - 20, 25 - 30, 35 - 38, 47, 50, 53 - 56, 79, 80, 82, 86. (Given a periodic table.)

2) Know the difference between ionic compounds and molecular compounds and be able to give the systematic name of either kind from the formula, or the formula from the systematic name. (Only for binary compounds of the elements listed in objective 1.)

3) Be able to name any of the normal alkanes, alkenes, halides, alcohols and acids with up to 10 carbons given the formula, or write the formula from the name.

4) Understand molecular formula and structural formula representations of molecules.

5) Know all of the typical monatomic anions and cations given in Table 2.4.

6) Know these polyatomic ions: ammonium, hydroxide, acetate, carbonate, bicarbonate, nitrate, nitrite, phosphate, monohydrogen phosphate, dihydrogen phosphate, sulfate, sulfite, and hypochlorite from Table 2.6.

7) Know how to write the formulas for ionic compounds made up of the cations and anions listed in objectives 5 and 6.

8) Know how to name hydrates and these acids: HCl HF HNO_3 HNO_2 H_2SO_4 H_2SO_3 H_3PO_4 $HC_2H_3O_2$

9) Be able to write down chemical equations from written descriptions and balance simple chemical reaction equations.

Practice Problems: 25 37 39 41 43 45 47bcd 53 55 57 59

Chapter 3 Calculations with Chemical Formulas and Equations

Essential Terms

mole	Avogadro's number	molar mass	percentage composition	mass percentage
empirical formula	molecular formula	balanced chemical equation	stoichiometry	reaction
mole ratio	theoretical yield	percentage yield	limiting reactant	

1) Be able to convert between number of atoms and moles; between mass and moles for a substance.

2) Be able to do mole→mole, mass→mole, and mass→mass calculations for any two substances involved in a chemical reaction.

3) Be able to calculate theoretical yield and percentage yield from masses of one reactant and one product.

4) Be able to determine the limiting reactant and theoretical yield for a chemical reaction given the masses of all reactants.

5) Be able to determine empirical formula from mass percentage composition, and molecular formula if given molecular weight.

Practice Problems: 15 17 19 21 23 25 27 29 33 37 43 45 47 51 53 55 57

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Exam 2 Objectives

Chapter 4 Chemical Reactions

Essential Terms

electrolyte	nonelectrolyte	electrolyte, strong or weak	complete ionic equation	net ionic equation
spectator ion	Bronsted-Lowry acid or base	acid or base, strong or weak	salt	redox reaction
oxidation	reduction	half-reaction	combination reaction	metathesis reaction
decomposition reaction	displacement reaction	combustion reaction	neutralization reaction	titration
oxidation number	concentration	molarity	solvent	solute

1) Be able to write the equations for dissolving ionic compounds in water and be able to write balanced net ionic equations for precipitation reactions given the ionic compound solubility rules in Table 4.1.

2) Know the strong acids (HCl, HNO_3, H_2SO_4) and bases (NaOH, KOH, $Ba(OH)_2$, $Ca(OH)_2$) in water and be able to write down the equations for their reactions with water. Know the following weak acids (phosphoric, organic carboxylic acids) and be able to write down the equations for their reactions with water. Know the following weak bases (ammonia, organic amines) and be able to write down the equations for their reactions with water.

3) Be able to write balanced equations for neutralization reactions of acids and bases.

4) For balanced redox reaction equations; be able to assign oxidation numbers (Table 4.5), identify what is oxidized and what is reduced, and determine the moles of electrons transferred.

5) Be able to calculate molarity of a solution from grams or moles of solute and volume of solution; be able to calculate the grams of a substance needed to make a certain volume of solution of a given molarity.

6) Be able to calculate molarities of solutes from dilution or mixing of solutions.

7) Be able to calculate the volume of solution required for a reaction, given the balanced equation and the reactant and product molarities.

8) Be able to calculate the concentration of an analyte from gravimetric data.

9) Be able to calculate the molarity of an analyte from titration data.

Practice Problems: 15 17 19 21 25 31 33 39 41 43 47 49 53 67 71

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Chapter 6 Thermochemistry

Essential Terms

energy	joule	calorie	thermochemical equation
system	surroundings	heat	exothermic
endothermic	specific heat capacity	calorimeter	enthalpy
vaporization	fusion	sublimation	standard state
standard enthalpy of formation (ΔH^o_f)		Hess's Law	

1) Be able to combine reactions and their standard enthalpies to find an overall reaction and its standard enthalpy.

2) Be able to use ΔH^o_f's for products and reactants in a reaction to calculate the ΔH^o for the overall reaction.

3) Be able to calculate the heat output of a reaction from ΔT and the heat capacity of a calorimeter; be able to calculate the enthalpy of a reaction from heat output and amount of a substance reacted.

4) Be able to use the specific heat capacity of a substance, and an amount of substance, to calculate either temperature change or heat gain or loss.

5) Be able to determine the amount of heat gained or lost for a substance undergoing a phase change given the standard enthalpy of phase change and the amount of substance.

6) Be able to solve heat transfer problems where heat is transferred between two substances and find either the amount of substance, specific heat capacity, amount of heat, or temperature change.

Practice Problems: 27 31 33 35 37 39 41 43 45 47 55 57 59 61 63 65

Chemistry 105 Course Objectives (T. Zamis, Fall 2005)
Exam 3 Objectives

Chapter 7 Quantum Theory of the Atom

Essential Terms

electromagnetic radiation	continuous spectrum	wave	speed of light	frequency
hertz	wavelength	photons	line spectrum	quantum mechanics
energy levels	electronic transitions	absorption	emission	spectrophotometer
atomic orbitals	ground state	excited state	shell	subshell
subshell spacial orientation	valence electrons			

1) Be able to interconvert between wavelength and frequency of radiation, $c=\nu\lambda$; calculate photon energy for radiation frequency or wavelength, $E = h\nu = hc/\lambda$.

2) Know the wavelength ranges for visible light, ultraviolet radiation, infrared radiation, and microwave radiation. Know the ordering of colored light in the visible spectrum and complementary colors. Know what kinds of molecular processes interact with UV, visible, IR and microwave radiation.

3) Be able to calculate energy level difference (ΔE) for electronic transitions given the frequency or wavelength of radiation absorbed or emitted, $\Delta E_{electron} = E_{radiation} = h\nu = hc/\lambda$.

4) Know the meanings of the three quantum numbers that identify an atomic orbital, and also the spin magnetic quantum number. Know the allowed values for these for an electron in an atom.

5) Know the shapes of the boundary surfaces for s, p, and d atomic orbitals. Know the shell and subshell quantum numbers for these.

Practice Problems: 23 29 35 47 49

Chapter 8 Electron Configurations and Periodicity

Essential Terms

electron configuration	orbital diagram	Pauli Exclusion Principle
Aufbau Principle	Hund's Rule	paramagnetic
diamagnetic	valence electrons	

For the "A" groups' elements only:

1) Be able to write the electron configurations for any element or monatomic ion of those listed in the objectives from Chapter 1. Be able to write the four quantum numbers for any electron in a given atomic orbital.
2) Know the number of valence electrons for any element of those listed in the objectives from Chapter 1.

3) For the "A" groups' elements, be able to choose between two atoms as to which has the larger atomic radius.

Practice Problems: 31 39 41 49

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Chapter 9 Ionic and Covalent Bonding

Essential Terms

ionic bond	covalent bond	Lewis symbol	Lewis structure
octet rule	valence electrons	shared electrons	lone pairs
single bond	double bond	triple bond	resonance
formal charge	electronegativity		

For the "A" groups' elements only:

1) Know how to write the chemical formula of a binary ionic compound and write its Lewis structure.

2) Be able to draw the Lewis structure of a covalent molecule or polyatomic ion containing any of these elements: H, C, N, O, F, P, S, Cl, Se, Br, or I. This includes the structures of the polyatomic ions listed in Chapter 2 objective #6, and the simple organic molecules listed containing up to three carbon atoms.

3) Be able to write resonance structures for a molecule.

4) Be able to calculate formal charges on atoms in a Lewis structure.

5) Know how to use a table of electronegativities to predict relative ionic or covalent character of a bond.

6) For the "A" groups' elements, be able to choose between two atoms as to which has the larger ionic radius or electronegativity.

Practice Problems: 21 23 25 29 31 33 35 39 43 47 57

Chemistry 105 Course Objectives (T. Zamis, Fall 2005)
Exam Final Objectives

Chapter 10 *Molecular Geometry and Chemical Bonding Theory*

Essential Terms

bond angle	VSEPR model	polar covalent bond	dipole
partial positive charge	partial negative charge	polar molecule	nonpolar molecule
structural isomers	geometrical isomers	cis isomer	trans isomer
stereoisomers	chiral carbon	enantiomers	D and L notation
valence bond model	hybrid orbitals	σ-bond (sigma-bond)	π-bond (pi-bond)

1) Use the VSEPR model to predict electron region geometries and molecular geometries for "central atoms" with up to 4 electron regions, and at least 2 bonding regions, in molecules. Know the bond angles for these geometries: linear, trigonal planar, and tetrahedral. Know the effect of lone pairs on bond angles for these geometries: angular and trigonal pyramidal.

2) Be able to draw structural formulas that depict a molecule's correct three-dimensional geometry showing proper angles and using lines and solid and dashed wedges for bonds.

3) Understand and be able to provide examples of structural, geometrical and stereo-isomers.

4) Be able to predict the polarity of bonds and label partial charges from electronegativities. Be able to identify polar and nonpolar molecules.

5) Understand the valence bond model explanation of covalent bonds.

6) Know the shapes and spatial arrangements of sp, sp^2 and sp^3 hybrid orbitals.

7) Be able to identify hybrid orbitals and σ-bonds and π-bonds in a molecule.

Practice Problems: 17 19 39 41

Chapter 5 (5.1–5.5) *The Gaseous State*

Essential Terms

pressure	pascal (Pa)	torr	atmosphere
STP	gas constant	ideal gas	ideal gas law
partial pressure	mole fraction		

1) Be able to interconvert pressure units.

2) Be able to use the ideal gas law to calculate P, V, T or n for a given set of conditions or after a change of conditions.

3) Be able to calculate the partial pressures of gases in a mixture.

Practice Problems: 19 21 25 27 29 33 35 37 43 47

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Chapter 11 States of Matter

Essential Terms

solid	liquid	gas	melting	freezing
vaporization	condensation	sublimation	deposition	vapor pressure
boiling point	melting point	triple point	critical point	hydrophilic
van der Waals forces	London forces	dipolar forces	hydrogen bonding	hydrophobic

1) Given the structural formula of a substance, be able to identify the kinds of intermolecular forces that would be significant.

2) Given a pair of substances, be able to predict relative boiling points and vapor pressures based on the strengths of intermolecular forces.

3) Be able to interpret vapor pressure versus temperature graphs and one component phase diagrams.

4) Understand whether phase transition enthalpies are positive or negative (endothermic or exothermic), and be able to calculate heat gained or lost for these processes.

Practice Problems: 21 23 25 33 34 43