

Exam 1 Objectives**Chapter 11 Liquids, Solids and Materials****Key Terms**

intermolecular forces	London forces	dipolar forces	hydrogen bonding	polar molecule	nonpolar molecule
viscosity	surface tension	capillary action	meniscus	phase diagram	volatility
vapor pressure	boiling point	relative humidity	melting point	fusion	freezing
vaporization	condensation	sublimation	deposition	critical point	triple point
molecular solid	metallic solid	ionic solid	network solid	crystalline solid	amorphous solid
unit cell	simple cubic	body-centered cubic	face-centered cubic	hexagonal close packed	cubic close packed

- 1) Given the structural formula of a substance, be able to identify the kinds of intermolecular forces that would be significant. Identify hydrogen bond donors and acceptors.
- 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 given ΔH° 's. Be able to perform calculations using the Clausius-Clapeyron equation.
- 5) Be able to classify solids according to type of attraction and properties, and give examples. (Table 11.5)
- 6) Be able to describe and identify simple cubic, body-centered cubic and face-centered cubic crystal structures. Be able to describe and identify cubic close-packed and hexagonal close-packed crystal structures.
- 7) Be able to do unit cell calculations involving the unit-cell dimension, number of atoms contained in a unit cell, Avogadro's number, atomic molar mass, atomic radii, crystal structure type and density.

Practice Problems: 18 20 29 31 48 50 56 59 91 95 100 102 104 106

Chapter 12 Fuels, Organic Chemicals and Polymers**Key Terms**

hydrocarbons	saturated hydrocarbon	unsaturated hydrocarbon	cyclic hydrocarbon	aromatic hydrocarbon	alkanes
alkenes	geometric isomer	cis, trans	alkynes	functional group	oxidation (reduction)
gasoline	kerosene	fuel oil	lubricating oil	monomer	polymer
free radical	addition reaction	condensation reaction	hydrolysis reaction	polyester	polyamide
amino acid	polypeptide (protein)	monosaccharide	polysaccharide	fatty acid	biochemical fat (oil)

Chemistry 116 Course Objectives (T. Zamis Spring Semester 2008)

- 1) Given the structural formula of an organic molecule, be able to give its systematic name. [Any alkane and alkene; branched; cyclic; and benzene derivative; with up to 10 C parent compound, and containing any of the following functional groups: halogen atoms, alcohol, aldehyde, ketone, carboxylic acid, ester, amine, amide.]
- 2) Be able to draw the structural formula of any simple organic molecule listed above from the systematic name.
- 3) Understand the following types of organic reactions: oxidation/reduction, addition, and condensation.
- 4) Know the components of the various petroleum distillation fractions.
- 5) Given the monomer structural formula(s) and type of polymerization (addition, condensation), be able to draw the polymer structure through three repeating units. Given the polymer structure, be able to identify the monomer molecule(s).
- 6) Know the monomer types, and important functional groups in proteins, carbohydrates and fats and bonds (linkages) in proteins and fats.

Practice Problems: (35 37 43 45 names and structures) 59 61

Chapter 15 The Chemistry of Solutes and Solutions

Key Terms

solvent	solute	miscible	solubility	saturated solution	hydration
lattice energy	heat of solution	hydrophilic	hydrophobic	adhesion	cohesion
colligative property	mass fraction	weight percent	molarity	molality	mole fraction

- 1) Given the solubility of an ionic compound, calculate the solution ion concentrations. Know how to determine the value of i_{solute} (van't Hoff factor) for ionic solids.
- 2) Given a choice of two solvents for a given substance, be able to predict which one would be the better solvent based on intermolecular forces. Be able to predict relative solubilities of organic compounds in water based on IMF's.
- 3) Be able to use Henry's Law to calculate gas solubilities.
- 4) Be able to do the conversion between any of the following concentration units: molarity, molality, mole fraction, mass fraction, weight percent (ppm, ppb).
- 5) Be able to use Raoult's Law to calculate vapor pressures.
- 6) Given the appropriate constants and temperature, be able to perform calculations for: boiling point elevation, freezing point depression and osmotic pressure of a solution.

Practice Problems: 32 38 46 50 52 58 60 68 70 86 112

Exam 2 Objectives**Chapter 13 Chemical Kinetics: Rates of Reactions****Key Terms**

reaction rate	rate constant	rate law	half-life	Arrhenius equation	activation energy
catalyst	elementary reaction	reaction intermediate	reaction mechanism		

- 1) Be able to express the reaction rate in terms of any substance in a balanced chemical equation.
- 2) Be able to calculate any one of the following given the others and the rate law: average reaction rate, rate constant, reactant concentrations.
- 3) Know how to do calculations using the integrated rate law for first order and second order reactions.
- 4) Know how to interpret a reaction potential energy diagram. Be able to sketch a reaction potential energy diagram given $\Delta H_{\text{reaction}}$ and E_a . Know how a catalyst affects a reaction potential energy diagram.
- 5) Know how to do calculations using the Arrhenius equation.
- 6) Know what is meant by a reaction mechanism. Given the elementary reactions of a reaction mechanism, be able to identify reactants, products, intermediates and catalysts. Be able to write down the equation for the balanced overall reaction.

Practice Problems: 13 19 21 23 30 41 52 54(calc or graph) 65 80 106 114

Chapter 14 Chemical Equilibrium**Key Terms**

reactant favored, product favored	dynamic equilibrium	homogeneous equilibrium	heterogeneous equilibrium
standard state	equilibrium constant	reaction quotient	Le Chatelier's principle

- 1) Be able to write the equilibrium constant equation or the reaction quotient for any balanced chemical equation based on the standard state definitions for solids, liquids, gases and solutions.
- 2) Be able to calculate the equilibrium constant or reaction quotient given all concentrations. Be able to use equilibrium constants to calculate equilibrium concentrations.
- 3) Be able to predict the direction of a reaction from comparing Q and K.
- 4) Given the equilibrium constant and initial composition, be able to use an ICE table to calculate the equilibrium composition. Know how to employ the extent-of-reaction variable. Know how to solve a quadratic equation.

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- 5) Be able to predict the effect of adding/removing reagents, pressure, temperature, or adding a catalyst on a reaction equilibrium. Be able to perform calculations with the van't Hoff equation for the effect of temperature on the equilibrium constant.

Practice Problems: (13 15 written as in lecture) 42 56 58 77 94

Chapter 18 Thermodynamics: Directionality of Chemical Reactions

Key Terms

system	surroundings	heat	work	internal energy
enthalpy	entropy	Gibbs free energy	spontaneous process	standard state

- 1) Understand the first law of thermodynamics and be able to perform calculations involving heat, work and internal energy for changes of ideal gas systems. Be able to calculate ΔH from ΔE for chemical reactions.
- 2) Understand the second law of thermodynamics and be able to predict which of two systems has greater entropy given their compositions and conditions. Be able to calculate the entropy change for phase transitions, simple heat transfer and changes of an ideal gas system.
- 3) Be able to calculate standard enthalpy changes, standard entropy changes and standard free energy changes for any balanced chemical equation from tables of standard values. Use enthalpy and entropy of a phase change to estimate the temperature of the change.
- 4) Be able to calculate an equilibrium constant from the standard reaction free energy and vice versa.
- 5) Be able to calculate a reaction free energy from the standard free energy and the composition of the reaction mixture.

Practice Problems: Ch 6 - 23 25 94 96 116; Ch 18 - 21 25 31 35 39 54 71

Exam 3 Objectives**Chapter 16 Acids and Bases****Key Terms**

Arrhenius acid-base concept	Brønsted-Lowry concept	conjugate acid/base	Lewis concept
pH	pOH	pK	K_a , K_b

- 1) Know the difference between strong acids (bases) and weak acids (bases).
- 2) Be able to write down the K_a or K_b expression for any aqueous acid/base or their conjugates. Know how to calculate K_a or K_b from the other for any conjugate pair. Know how to convert between K and pK.
- 3) Be able to use K_a or K_b values to predict relative strengths of two acids or two bases.
- 4) Be able to calculate the pH of a solution of a strong acid or a strong base.
- 5) Know how to calculate pH and pOH for any solution where either $[H_3O^+]$ or $[OH^-]$ is given and vice versa.
- 6) Be able to write down the balanced chemical equation for the acid-base reaction of a weak acid or base, or an aqueous salt solution.
- 7) Know how to predict whether a salt solution is acidic, basic, or neutral.
- 8) Be able to calculate the pH of a solution of an acid or base from the initial concentration and K_a or K_b . Know how to use the solution to the quadratic equation.
- 9) Be able to calculate K_a or K_b for a weak acid/base from the initial molarity of the solution and the equilibrium pH of the solution.

Practice Problems: 12 14 16 24 26abc 28 32 34 36 42 56 58 60 62 72 74 102

Chapter 17 Additional Aqueous Equilibria**Key Terms**

buffer	indicator	titration	equivalence point
solubility product constant		complex ion formation constant	
molar solubility	common-ion effect	complex ion	ligand

- 1) Be able to calculate the pH of a buffer solution given the molarities of the two conjugates and K_a .
- 2) Be able to calculate the molarities of the two conjugates in a buffer solution given the desired buffer molarity and desired pH.

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- 3) Be able to calculate the mL titrant needed to reach the equivalence point, and the pH at the start, half-way, and at the equivalence point of any titration where the titrant is a strong electrolyte. Molarities of analyte and titrant are given.
- 4) Be able to calculate the analyte molarity and determine the pK_a from an acid-base titration curve where the analyte is a weak acid or base, and the titrant is a strong acid or base.
- 5) Be able to determine a solubility constant from molar solubility and vice versa.
- 6) Be able to calculate molar solubility in a solution with an added common-ion.
- 7) Predict whether a precipitate will form given the concentrations of ions in a solution and K_{sp} .
- 8) Be able to do equilibrium calculations with complex-ion formation.

Practice Problems: 16 18 20 28 30 38 40 42 44ab 46abd 52 56 58 60 62

Final Exam Objectives

Study all questions from Exams 1, 2 and 3. Approximately 3/4 of Final Exam will be these questions, with calculation numbers and multiple choice answers changed.

Chapter 19 Electrochemistry and Its Applications**Key Terms**

oxidation	reduction	half-reaction	electrochemical cell	anode
cathode	galvanic cell	electrolytic cell	cell potential	Nernst equation

- 1) Know how to balance redox equations (general, acid solution, base solution).
- 2) Know the shorthand notation (cell formulation) for redox cells.
- 3) Know how to convert between cell potential (E, voltage) and Gibbs free energy (ΔG , kJ/mole).
- 4) Be able to calculate a standard cell potential for a reaction from a table of standard half-reaction potentials.
- 5) Be able to calculate an equilibrium constant from the standard cell potential and vice versa.
- 6) Understand how to calculate a cell potential from the standard cell potential and the composition of the reaction mixture. (Nernst Equation)
- 7) Be able to calculate the amount of product formed from electrolysis given the cathode reaction, current and time lapse.

Practice Problems: 10 14 30 32 36 38 44 46 60 62 64

Electrochemistry Equations

$$E^{\circ}_{\text{cell}} = E^{\circ}_{\text{oxidation}} + E^{\circ}_{\text{reduction}}$$

$$(nF E^{\circ}/RT)$$

$$E^{\circ} = (RT/nF) \ln K_{\text{eq}} \quad \text{or} \quad K_{\text{eq}} = e^{\wedge}$$

$$R = 8.314 \times 10^{-3} \text{ kJ/mol}\cdot\text{K}$$

$$F = 96.49 \text{ kJ/V}\cdot\text{mole}$$

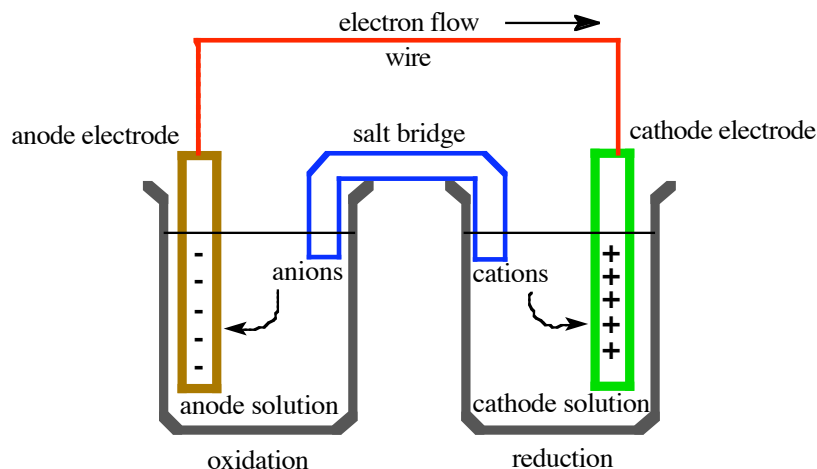
$$E = E^{\circ} - (RT/nF) \ln Q$$

$$1 \text{ mole of electrons} = 9.649 \times 10^4 \text{ C}$$

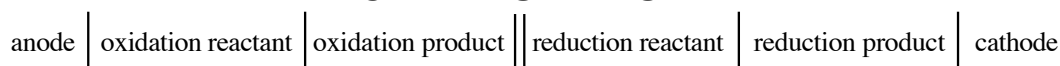
C = a coulomb of charge

$$1 \text{ ampere (A) of current} = 1 \text{ C /second}$$

SIMPLE GALVANIC CELLS



CELL NOTATION



Balancing Oxidation-Reduction Equations

- 1) Assign ON's; Decide what is oxidized, what is reduced
- 2) Write these substances as reactants and products in half-reactions
- 3) Balance all atoms in equations except O and H
- 4) Balance O using H_2O ; Balance H using H^+
- 5) Balance charge using e^-
- 6) Multiply half-reactions by numbers such that e^- are the same, add half-reactions
- (7) If reaction is in basic solution, add same number of OH^- to both sides of equation (number of OH^- to add equals number of H^+ in equation); make H^+ and OH^- on same side of equation into H_2O and cancel extra H_2O

Memory Helpers:

OIL RIG oxidation is losing electrons, reduction is gaining electrons

Oxidation and anode begin with vowels – oxidation occurs at the anode

Reduction and cathode begin with consonants – reduction occurs at the cathode