PURDUE UNIVERSITY

CHEMISTRY 11200

STUDY GUIDE and SAMPLE EXAMINATION

This Study Guide describes topics to be mastered prior to attempting the examination to establish credit in Purdue's Chemistry 11200. The material can be studied from many of the textbooks on the market. A list of several of these is given below.

SUBJECT MATTER: A Brief Outline
The subject matter of any General Chemistry course is varied. Chemistry 11200 deals with gases and their properties, solids and their properties, solutions, reaction rates and chemical equilibrium, oxidation reduction reactions, nuclear chemistry, organic chemistry with an emphasis on nomenclature and functional groups, and biochemistry.

The course is taken primarily by students in the College of Agriculture and the College of Health and Human Sciences and is designed to meet their needs. It is also taken by smaller numbers of students in the College of Liberal Arts and the College of Technology. A knowledge of high-school chemistry is presumed and the course goes far beyond the high school level.

A weekly three-hour laboratory is an integral part of the course and includes measurement techniques, the use of the analytical balance, titration techniques and experiments with various elements and compounds.

The topics presented in the outline should be studied prior to attempting the sample examination included with this study guide. These topics are broken down under several headings according to those found in the texts currently in use at Purdue. In preparing for the examination it is important to work many problems. However, the problems should not only be used to test your recall of relations like PV = nRT or M = moles/Liter, but also should be used to measure your understanding of the concepts and principles involved.

At the end of this Study Guide you will find a sample examination over this material. Allow one hour for the exam. Naturally, it does not cover every point. No examination extending over a reasonable time period can do that.

SPECIAL NOTE:
Words of advice concerning the taking of the actual examination for credit are warranted. No one does well on an examination when he or she is excessively fatigued. Therefore, you are urged to provide yourself an adequate rest period before taking the actual examination. If your trip to the campus necessitates travel into the late hours of the night or an extremely early departure from your home, you may be well advised to allow for a one night's rest in the Lafayette area before taking the examination. Many students who are unsuccessful with the examination tell us that failing to take the above precautions contributed strongly to this result. Most such students find that their first year was somewhat less rewarding than it might have been because of the time spent retracing materials studied in high school. Please consult your advanced credit schedule for the actual time and place of the examination. It is usually given both morning and afternoon.

(Revised June, 2013)

Local Book Stores:

University Book Store, 360 State Street, W. Lafayette, IN 47906.

Village Book Cellar, 308 W. State Street, W. Lafayette, IN 47906.

Follett's Purdue Book Store, Purdue Service Center, W. Lafayette, IN 47906.

Texts:

Introduction to Chemistry, 2nd ed (2010) by Bauer/Birk/Marks; McGraw-Hill.

General Chemistry, the Essential Concept by Chang; McGraw-Hill.

Introductory Chemistry by Tro; Pearson/Prentice-Hall.

STUDY GUIDE FOR CHEMISTRY 11200

1. Properties of gases

Given any three of the following pieces of information, you should be able to calculate the fourth, assuming that the gas is ideal.

(a) the number of moles of gas, or the weight of the gas
(b) the pressure of the gas
(c) the volume of the gas
(d) the temperature of the gas

Given the volume of a gas at one temperature and pressure, you should be able to find the volume it would occupy at another temperature and pressure.

You should be able to determine the density of a gas from the pressure and temperature. You should be able to determine the molecular weight of a gas from its density.

From the chemical equation for a reaction involving a gas, given the mass, moles or volume of a gaseous reactant, you should be able to find the mass, moles or volume of any other product or a different reactant.

You should be able to describe the conditions under which a real gas such as H_2 or CO_2 will deviate from ideal gas behavior.

You should be able to identify the assumption(s) of the kinetic theory of gases.
Given the total pressure of a gas mixture, and the partial pressure of all components except one, you should be able to find the partial pressure of the remaining component using Dalton's law.

If you know the mole fraction of each gas in a mixture, and the total pressure, you should be able to find the partial pressure of each component.

2. Properties of liquids and solids

You should be able to use a microscopic or atomic/molecular scale model to describe the changes which occur when a solid becomes a liquid, or when a liquid becomes a gas. You should be able to explain the differences in the arrangements of the atoms or molecules, what happens to the average speed of the particles, what changes occur in the distance between particles, and the temperature changes that must occur.

You should be able to describe the differences between solids, liquids and gases in terms of macroscopic properties such as density, compressibility, surface tension, viscosity and vapor pressure.

You should be able to describe the effect that varying any of the following will have on the vapor pressure of a liquid.

(a) volume of the liquid
(b) surface area of the liquid
(c) volume of gas over the liquid
(d) temperature

You should be able to describe heating and cooling curves and connect it to temperature changes and a molecular scale model to describe changes.

You should be able to describe intramolecular forces (bonding and bonding types), as well as intermolecular forces such as van der Waals, hydrogen bonding, dispersion forces, and dipole forces.

Be familiar with the definitions of vaporization, condensation, boiling point, heat of vaporization, heat of fusion.

Know the different types of solids amorphous and crystalline (ionic, molecular, covalent network, and metallic).

3. Solutions

Know the following terms and how they apply to solutions: homogeneous, heterogeneous, solute, solvent, miscible, immiscible, soluble, insoluble, concentrated, dilute, saturated, unsaturated, hydration and solvation.

You should be able to describe the processes that must occur in order for a substance to dissolve in a solvent at the molecular level. You should be able to decide whether the energy associated with that process favors dissolution.

You should know factors which effect solubility including the solubility of gases.

Know how to express solution concentration as molarity, percent by volume, percent by mass, ppm ppb, and molality.

You should know how to prepare a specified volume of a solution of known concentration, e.g., 200 mL of 0.100 M NaCl. You should be able to calculate the number of moles or the mass of solute dissolved in a given volume of solution of known concentration, e.g., how many grams of NaCl are present in 50.0 mL of a 1.50 M solution? You should be able to use a solution of known concentration to prepare a solution of a lower concentration by dilution, e.g., prepare 100 mL of 0.22 M HCl starting with a solution that is 2.50 M HCl.

Be able to identify and describe the colligative properties: osmotic pressure, vapor pressure lowering, boiling point elevation, freezing point depression.

Given the boiling point of a pure solvent, its molal boiling point elevation constant, and the molality of the solution, you should be able to calculate the boiling point of the solution. Conversely, you should be able to find the molality of a solution from the boiling point of that solution. You should be able to find the molecular weight of a solute from the molality of the solution, the boiling point of the solution, the boiling point of the pure solvent, and the molal boiling point elevation constant.

You should be able to calculate the freezing point of a solution from the freezing point of the pure solvent, its molal freezing point depression constant, and the molality of the solution. You should be able to find the molecular weight of a solute from the molality of the solution, the freezing point of the solution, the freezing point of the pure solvent, and the molal freezing point depression constant.

4. Reaction rates and chemical equilibrium

Know the conditions that can affect the rate of a chemical reaction. You should be able to describe reaction rates using collision frequency, orientation, activation energy, and potential energy reaction pathways.

Know how to use a reaction progress diagram to identify the activation energy and whether a reaction is exothermic or endothermic.

You should be able to define chemical equilibrium. Given a chemical reaction you should be able to write the equilibrium constant. Given data, you should be able to calculate the equilibrium constant.

Use Le Chatelier's Principle to predict how changes in concentration, temperature, and pressure affect equilibrium.

5. Acids and bases

You should be able to use the Arrhenius theory and the Bronsted Lowry definition to describe acids and bases.

Know what a hydronium ion is.

Be able to identify monoprotic, diprotic, and triprotic acids. Be able to give definitions and examples of strong and weak acids.

You should know how to write a neutralization reaction between an acid and a base.

You should thoroughly understand the pH scale and how to calculate pH and pOH.

Be able to define a buffer, how it responds to the addition of acids or bases, its importance in regulating pH.

You should be able to carry out acid-base titration calculations.

6. Oxidation and Reduction

You should be able to calculate or assign oxidation numbers for atoms, molecules, and ions.

Know the definition of oxidation and reduction, and oxidizing and reducing agents.

You should be able to balance (and identify) oxidation and reduction reactions. From that balanced chemical equation you should be able to identify the species which are oxidized and reduced, as well as the oxidizing and reducing agents.

Be able to describe electrolytic and voltaic cells.

7. Nuclear Chemistry

Know the symbols for alpha, beta, and gamma particles. Be able to use those symbols to predict the products of a nuclear decay.

Define half-life and perform half-life calculations.

Define and describe fission and fusion reactions.

8. Organic Chemistry

Know how to use IUPAC names and structures so that you can name alkanes, alkenes, and alkynes.

Know how to identify cyclic hydrocarbons, those which are saturated and unsaturated.

You should be able to name and identify alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, and amides.

9. Biochemistry

Know the basic structural components of carbohydrates, lipids, fatty acids, amino acids, proteins, nucleic acids, DNA, RNA, monosaccharides, disaccharides, and polysaccharides.

You should be able to identify and describe a peptide bond.

You should be able to identify and describe primary, secondary, tertiary, and quaternary protein structure.

You should be able to describe transcription and translation.

_____ 1. The air in a jar of home-canned beans is heated to the boiling point of water, 100.0°C, and the jar is sealed at that temperature. Assume the pressure is 1.0 atm when the jar is sealed. What will be the air pressure in the jar when it is cooled to room temperature, 20.0°C?

(a) 0.20 atm
(b) 5.00 atm
(c) 0.79 atm
(d) 1.27 atm
(e) none of these

_____ 2. Determine the volume that 1.0 mole of laughing gas, N_2O, occupies at 15.0 atm and 275°C.

(a) 1.5 L
(b) 2.0 L
(c) 3.0 L
(d) 5.9 L
(e) 7.5 L

_____ 3. In the kinetic theory, which of the following is <u>not</u> a property of an <u>ideal</u> gas?

(a) Gases consist of tiny particles in random motion.
(b) Collisions between gas molecules are perfectly elastic.
(c) There are attractive intermolecular forces.
(d) The average molecular kinetic energy is proportional to the Kelvin temperature.
(e) The volume occupied by gas molecules is negligible.

_____ 4. Which of the following phase changes is endothermic ($\Delta H = +$)?

(a) freezing of water
(b) liquefaction of air
(c) condensation of butane gas to liquid
(d) solidification of magnesium metal from its molten state
(e) sublimation of solid dry ice to CO_2 gas

_____ 5. In which of the following compounds will there be hydrogen bonding?

(a) CH_4
(b) H_2O
(c) H_2
(d) HI
(e) BH_3

_____ 6. Water dissolves many ionic salts because:

(a) H_2O is a linear molecule.

(b) H_2O is a very small molecule.

(c) H_2O has a large vapor pressure.

(d) H_2O is a polar molecule.

(e) H_2O is a very volatile liquid.

_____ 7. A particular solid crystal has a structure consisting of cations at the lattice positions bound together by a sea of mobile electrons. This solid can be:

(a) copper.
(b) aluminum chloride.
(c) solid CO_2.
(d) ice.
(e) diamond.

_____ 8. 144 g of ethanol, C_2H_5OH, and 96.0 g of water are mixed giving 269.4 mL of a solution with density of 0.891 g/mL. The water is considered to be the solvent. What is the molarity (M) of ethanol in this solution?

(a) 11.6
(b) 3.13
(c) 1.50
(d) 8.4
(e) none of these

_____ 9. What is the molality (m) of ethanol for the solution described in question 8?

(a) 3.13
(b) 1.50
(c) 11.6
(d) 32.6
(e) none of these

_____ 10. As a chemical reaction proceeds, the reaction rate generally decreases. The main reason for this is:

(a) the temperature decreases as reaction proceeds.
(b) the catalyst is used up.
(c) the unreacted molecules have insufficient energy.
(d) the concentrations of the reactants are decreasing.
(e) the energy of activation increases steadily.

_____ 11. In a chemical reaction between a solid substance and a gas, the speed of reaction is proportional to:

(a) the surface area between solid and gas phases.
(b) the volume of gas plus the volume of solid.
(c) the solubility of the gas in the solid.
(d) the electronegativities of the reactants.
(e) the intermolecular attractions between gas and solid molecules.

_____ 12. The equilibrium constant, K_{eq}, for the following reaction at a certain temperature is found to be 62.0. When the equilibrium concentrations of $H_2(g)$ and $I_2(g)$ are 0.200 M and 0.250 M respectively at this temperature, what is the equilibrium concentration of HI(g)?

$$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g)$$

(a) 1.76 M
(b) 0.440 M
(c) 3.10 M
(d) 1.24 M
(e) none of these

_____ 13. Consider the following five reactions at equilibrium. For one of these equilibrium systems, increasing the pressure (by decreasing the volume of the container) will not disturb the equilibrium and will result in no changes in reactant concentrations. Which one?

(a) $H_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$
(b) $2\ CO(g) + O_2(g) \rightleftharpoons 2\ CO_2(g)$
(c) $2\ NO_2(g) \rightleftharpoons N_2O_4(g)$
(d) $2\ NO(g) + O_2(g) \rightleftharpoons 2\ NO_2(g)$
(e) $H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g)$

_____ 14. Which of the following statements is false?

(a) More than one hydrogen isotope exists.
(b) Intense short range forces act between nucleons.
(c) β-decay is often accompanied by γ-ray emission.
(d) Most neutron-rich radioisotopes decay by neutron emission.
(e) Different isotopes of a single element are chemically similar.

_____ 15. $^{239}_{94}Pu$ decays by α-particle emission to form the product X. The identity of X is:

(a) $^{235}_{93}Np$

(b) $^{235}_{92}U$

(c) $^{243}_{96}Cm$

(d) $^{237}_{90}Th$

(e) $^{237}_{91}Pa$

_____ 16. In pure water at 25°C:

(a) $[H_3O^+] = [OH^-]$

(b) $[H_3O^+] = 1.0 \times 10^{-7}$

(c) $[H_3O^+] \times [OH^-] = 1.0 \times 10^{-14}$ moles^2/liters^2

(d) pH = pOH

(e) all of the above

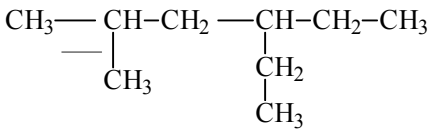
_____ 17. What is the pH of a solution with $[H^+] = 0.0417$ M?

(a) 1.830
(b) 3.177
(c) 1.380
(d) 8.132
(e) 8.315

_____ 18. How many constitutional isomers are there with the formula C_5H_{12}?

(a) 1
(b) 2
(c) 3
(d) 4
(e) 5

_____ 19. What is the proper IUPAC name of the following compound?



(a) 4-ethyl-2-methylhexane
(b) 3-ethyl-5-methylhexane
(c) 2-methyl-4-ethylhexane
(d) 4-ethyl-2-methylnonane
(e) none of the above

_____ 20. The oxidation of a secondary alcohol can produce a(n):

(a) aldehyde.
(b) ketone.
(c) carboxylic acid.
(d) primary alcohol.
(e) tertiary alcohol.

_____ 21. An unsaturated fat:

(a) is always a synthetic product.
(b) can be safely digested in unlimited quantities.
(c) is not considered a lipid.
(d) will react with Br_2.
(e) all of the above.

_____ 22. Which functional groups are commonly found in disaccharides?

(a) hydroxyl.
(b) amines.
(c) amides.
(d) alkynes.
(e) all of these.

_____ 23. Enzymes are polymers made of what type of monomer?

(a) fatty acids.
(b) proteins.
(c) nucleotides.
(d) hexoses.
(e) amino acids.

_____ 24. Enzymes:

(a) catalyze biochemical reactions.
(b) do not change the equilibrium state of a reaction.
(c) are oligosaccharides.
(d) (a) and (b)
(e) (a) and (c)

_____ 25. The acetic acid/acetate buffer solution maintains a pH near:

(a) −4.76
(b) 0
(c) 4.76
(d) 9.25
(e) −7.20

The following reactions illustrate the process of corrosion (to be used to answer questions 26-27):

I. $2\ Fe + O_2 + 2\ H_2O \rightarrow 2\ Fe(OH)_2$

II. $4\ Fe(OH)_2 + O_2 + 2\ H_2O \rightarrow 4\ Fe(OH)_3$

III. $2\ Fe(OH)_3 \rightarrow Fe_2O_3 \cdot H_2O + H_2O$

_____ 26. Which reactions are oxidation/reduction reactions?

(a) I, II, III
(b) I, II
(c) I, III
(d) II, III
(e) I

_____ 27. Which reactions are dehydration reactions?

(a) I, II, III
(b) I, II
(c) I, III
(d) II, III
(e) III

_____ 28. What are the three major components of the nucleotide?

(a) zwitterion, amide, R-group
(b) base, sugar, phosphate
(c) guanine, adenine, cytoseine
(d) DNA, RNA, base
(e) blood, sweat, tears

_____ 29. An amide is synthesized from:

(a) an alcohol and an alkane.
(b) a phosphate and an amine.
(c) a carboxylic acid and an amine.
(d) an amine and an alkane.
(e) a sugar and a carboxylic acid.

_____ 30. Benzene is aromatic because:

(a) it smells good.
(b) it is carcinogenic.
(c) it has delocalized π electrons.
(d) it has 4 π electrons.
(e) none of the above.

_____ 31. Benzene is most soluble in:

(a) hexane
(b) water
(c) H_3PO_4
(d) CaO
(e) NaOH

_____ 32. Cis/trans isomers have which of the following:

i. different connectivities
ii. the same geometry
iii. different physical properties

(a) i
(b) ii
(c) iii
(d) i, iii
(e) ii, iii

Answers to the 11200 Sample Exam

1.	C	18.	C
2.	C	19.	A
3.	C	20.	B
4.	E	21.	D
5.	B	22.	A
6.	D	23.	E
7.	A	24.	D
8.	A	25.	C
9.	D	26.	B
10.	D	27.	E
11.	A	28.	B
12.	A	29.	C
13.	E	30.	C
14.	D	31.	A
15.	B	32.	E
16.	E		
17.	C		

*****Additional help (problem solving by topic) is available here:**

http://www.chem.purdue.edu/gchelp/

This is a site with multiple questions on many different topics!