INTRODUCTORY CHEMISTRY Spring, 2012

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You are expected to know and understand this syllabus. If you do not understand anything, please **ASK**.

COURSE MATERIALS: A CALCULATOR that has log, ln, 10^x (antilog), and e^x functions.

TEXT: *Chemistry: Principles & Rxns*, 7th ed.,Masterton,Hurley & Neth, Brookes/Cole, 2012, ISBN 978-1111427108

LAB MANUAL: *Experiments in General Chemistry* 9/e, T.G.Greco, L.H.Rickard, G.S.Weiss, Prentice Hall, 2007.

LABORATORY NOTEBOOK: **Must** be bound (no ring binders) approximate size 7 × 9.5", quadrille ruled. **Carefully follow the instructions** for the laboratory notebook on pages 12 through 16 of the laboratory manual.

LABORATORY SAFETY GOGGLES: **You must wear goggles** whenever you are in laboratory, even if just visiting.

COMBINATION PADLOCK for your laboratory drawer, if your laboratory instructor so directs.

ASSIGNED PROBLEMS: Success in chemistry has a "secret." When you work problems you understand the material. Then you have to study to reinforce that understanding. You will receive more than 10% of your course grade for solutions to problems assigned the previous class day. At the beginning of each lecture day, problems are due. Your handed-in problem solutions (not simply answers) will be checked over and be available to pick up the next class day. (Please remove ragged edges.) Each problem set is worth five points, based on whether you attempted each problem; a restatement is NOT an attempt. Late problem solutions are not accepted because solutions are distributed.

Tests: Six fifty-point thirty-minute tests will be given about every fifth class period, as indicated (by 𝕋) on the calendar. Each test consists of material covered since the last test, although material since the beginning of Chemistry 111 may be included. Sample questions from past years' tests will be distributed, with solutions. The final examination is a comprehensive, American Chemical Society standardized examination; it covers all of the material of both CH111 and CH112. The tests and the final will assume that you have mastered the material in each chapter in the text.

Tests are *not* curved. Curved grades state how well you did compared to your classmates and, in effect, let the class choose what material is important. Curved grades do not state how well you know the material that chemists have decided is important. General chemistry is a prerequisite for many other courses, and chemists (including the faculty at Millersville) have given much thought to what it must include. Thus, there are definite goals that you must reach by the end of the course. Do not expect the problems on exams to be as easy as the lecture examples. A lecture example is probably the first time that you have seen a given type of problem. A complex example would confuse. But, by the time of the examination, you have practiced solving that type of problem and should be easily able to solve harder ones.

Quizzes: CHEMICAL EQUATIONS & CHEMISTRY 111 REVIEW: Chemistry 112 is almost exclusively the study of chemical equations. Included in the recitation quizzes will be questions that supply you with reactant names and ask for a balanced chemical equation. A sample set is included with this syllabus. Also included is a listing of the Introductory Chemistry I material that you need to have mastered. Throughout the semester, that material will be included in quizzes, sometimes as multiple-choice questions, to help you review, and prepare you for the format of the final..

Laboratory Practice and Policy: MAKE SURE THAT YOU HAVE READ THE LABORATORY SAFETY RULES ON PAGES 1 AND 2 OF THE LAB MANUAL BEFORE COMING TO LAB. You will be given a copy of these rules to sign and return to your lab instructor. Bring your laboratory notebook and safety goggles. You are not permitted in laboratory without safety goggles; be sure to bring them. You are expected to finish the scheduled experiment during the laboratory period. If you need more time (and you won't if you are prepared for lab), you must obtain written permission from your lab instructor to work at another time. The instructor present in lab when you work must sign and date your laboratory notebook. Even with written permission, you can only work during the hours of 9:00 a.m. to 4:00 p.m. Also, working alone is ABSOLUTELY FORBIDDEN for everyone. Someone must be present who can go for help if you have an accident.

PreLab Quizzes: On the day each experiment is scheduled to start, your laboratory instructor will give a prelaboratory quiz. Each quiz is worth five points, is closed book, and will last five minutes. The purpose of the quiz is to ensure that you have carefully read and understand the experimental procedure. Your laboratory instructor may require you to outline the procedure for each experiment in ink in your laboratory notebook. Having so prepared, you will be able to collect data efficiently and will not have to repeat an experiment. Also, you will not be a hazard to yourself or others around you.

Format of Laboratory Reports and Laboratory Notebook: All lab reports *must* be in ink, written on the pages from your laboratory manual. Pages should be assembled in numerical order and stapled together. These must be **neat** final drafts. Write the first draft (in ink) in your laboratory notebook. If your instructor loses your lab report, s/he will ask for your notebook. The instructions for lab reports and lab notebooks are on pages 10 through 16 of the lab manual. READ these instructions before coming to lab for the first time and follow them carefully.

Absences: **YOU ARE RESPONSIBLE** for obtaining the notes for any class you miss, whether your absence is excused or not. You must arrange to make up any missed work. Absences may be excused for university-sponsored events, jury duty, military duty, religious holidays, death or critical illness in immediate family, or personal illness. Support each request for excuse with a written statement of the absence's reason, signed by the responsible person (coach, faculty member, judge, commander, physician), on letterhead including that person's phone number. Except for death or illness, requests for excuse must be presented before the date of the anticipated absence; other requests are INVALID after a week of your return to class. An excuse for personal illness is granted only if a health professional states you were too ill to come to class; MU Health Services rarely issues such statements. Do not expect to miss more than four class days for any reason and still pass the course. You makeup "excused" points based on your % score on the final.

Plagiarism: You have plagiarized when you submit someone else's work as your own, including copying lab reports or problem assignments without giving credit. The penalty ranges from zero for the assignment plagarized to a course grade of "F." That penalty becomes part of your official record. We may refer both the copier and the one copied from for appropriate action, since we cannot tell which one copied. However, we encourage working together on some assignments. To protect yourself from the charge of plagiarism, simply write, either: "I received help from Joe Smith on this part," or "I helped Sue Jones on this part."

Course Policies: If you have an objection to any aspect of the course, please communicate it (anonymously or otherwise) to the instructor. Because of "academic freedom," neither department chair nor dean can do as much to help.

Cancelled Classes: "The cancellation of classes by the University does not alter the mutual responsibility of faculty and students to fulfill the requirements of the curriculum." [Faculty Senate 29 Oct 2001] In the event that classes are cancelled, we shall agree as a class on means to make sure that the content of the course is not compromised.

Course Grading: To pass the course, you must perform all experiments, turn in all lab reports, and earn a lab grade of 60% [138 points] or more. (Lecture total = 670 points, lab total = 230 points)

Assigned problems	100 points	
Recitation quizzes (10 points each)	120 points	A = 90% [810 points]
Six tests [50 points each]	300 points	B = 80% [720 points]
Final exam—Covers all of CH111 and CH112	150 points	C = 70% [630 points]
Six lab reports (Expts. 14, 15, 16, 19, 25, 28)	90 points	D = 60% [540 points]
Eight prelab quizzes (five expts & three qual expts)	40 points	(minus) is _0%, _1%, _2%
Three qualitative analysis unknowns	<u>100 points</u>	(plus) is _7%, _8%, _9%
TOTAL	900 points	

Chemistry 112 — 7 Dec 11 version — Spring 2012 Tentative Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
JAN	23 **10** Solutions	24	25 **10** Solutions	26	27 **11** Reaction Rate
		14.	Molecular Mass Deter'n by Depression of the Freezing Point		
JAN fEB	30 **11** Reaction Rate	31	1 **11** Reaction Rate	2	3 **11** Reaction Rate
		15.	A Kinetic Study of an Iodine Clock Reaction (start)		
fEB	6 **12** Gaseous Chemical Equil	7	8 **12** GaseousChemicalEquil 𝕋	9	10 **12** GaseousChemEquil
		15.	Kinetic Study (end) ***16.***	Det'n of an Equilib. Constant (start)	
fEB	13 **12** GaseousChemEquil	14	15 **13** Acids and Bases	16	17 **13** Acids and Bases
		16.	Determination of an Equilibrium Constant (end)		
fEB	20 **13** Acids and Bases	21	22 **13** Acids and Bases	23	24 **14** EquilAcid/Base
		19.	Determination of the Ionization Constant of a Weak Acid		𝕋
fEB	27 **14** EquilAcid/Base	28	29 **14** EquilAcid/Base	1	2 **14** EquilAcid/Base
		33-35.	Qual Unknown I: Soluble, Chloride, and H_2S Groups		
MAR	5 **15** ComplexIon&Pptn	6	7 **15** ComplexIon&Pptn	8	9 **15** ComplexIon&Pptn
		33-35.	Qual Unknown I: Soluble, Chloride, and H_2S Groups		𝕋
MAR	12 M I D – S E M E S T E R			B R E A K	
MAR	19 **15** ComplexIon&Pptn	20	21 **16** ReactionSpontaneity	22	23 **16** ReactionSpontaneity
		33-35. Qual I (finish)	***36-37.*** Qual Unknown II: $(NH_4)_2S$ and Carbonate Groups		
MAR	26 **16** ReactionSpontaneity	27	28 **16** ReactionSpontaneity	29	30 **17** Electrochemistry 𝕋
		36-37.	Qual Unknown II: $(NH_4)_2S$ and Carbonate Groups		
APR	2 **17** Electrochemistry	3	4 **17** Electrochemistry	5	6 **17** Electrochemistry
		25.	Investigation of Voltaic Cells—The Nernst Equation		
APR	9 **19** Complex Ions	10	11 **19** Complex Ions	12	13 **19** Complex Ions 𝕋
		36-37.	Qual Unknown II: $(NH_4)_2S$ and Carbonate Groups		
APR	16 **20** Metal Chemistry	17	18 **20** Metal Chemistry	19	20 **20** Metal Chemistry
		38.	Qual Unknown III: Anions and Soluble Solids		
APR	23 **21** Nonmetal Chemistry	24	25 **21** Nonmetal Chemistry	26	27 **21** Nonmetal Chemistry
		28.	A Penny's Worth of Chemistry		
APR MAY	30 **18** Nuclear Reactions 𝕋	1	2 **18** Nuclear Reactions	3	4 **18** Nuclear Reactions
		38.	Qual Unknown III: Anions and Soluble Solids		
MAY	7	8	9	10	11
		F8:00	**FINAL TUESDAY 8 MAY**	**8:00 TO 10:00 A.M.**	

Things to Know

Assume that you always will have a periodic table (with atomic weights) and a calculator.

Chemical Nomenclature:
"Name" should be taken to mean: Give the correct name if the formula is given as well as give the correct formula if the name is given.

1. Name binary covalent compounds with numerical prefixes.
2. Name binary ionic compounds. This includes memorizing the names and formulas of the ions given below.
3. Name common acids and name common strong acids and bases.
4. Name compounds that contain polyatomic ions in the table below.
5. Determine the oxidation states of an element in a substance.
6. Name oxoacids and compounds that contain oxoanions, including using oxidation states to determine names.

Chemical Stoichiometry:

1. Determine the mole weight (formula weight or molar mass) of a compound, given its chemical formula.
2. Determine the percent composition of a compound, given its formula.
3. Determine the empirical formula of a compound, given its percent composition, or the masses of compounds produced from a given mass of the unknown compound.
4. Determine the quantity of product made or reactant needed for a chemical reaction.
5. Solve limiting reagent (reactant) problems.
6. Use percent yield, actual yield, and theoretical yield in calculations.
7. Calculate solution concentrations with several concentration units: molarity, molality, mole fraction, percent.

Writing Chemical Equations:

1. Balance equations by inspection.
2. Write, and balance, net ionic equations.
3. Balance oxidation-reduction equations with the ion-electron method.
4. Predict whether an insoluble compound is produced by a chemical reaction.
5. Determine if gas forms in a chemical reaction. Recognize and predict the products of acid-base reactions.

Molecular Structure:

1. Write the ground-state electron configuration of an element in spectroscopic or abbreviated spectroscopic notation, as an orbital diagram, as an abbreviated orbital diagram, as an energy level diagram, or by specifying the values of the four quantum numbers of the last electron added.
2. Write the ground-state electron configuration for a specified monatomic ion.
3. Know how the properties of atomic and ionic size, ionization potential, electron affinity, and electronegativity vary for the representative elements, based on their periodic table positions.
4. Draw Lewis structures for atoms and monatomic ions.
5. Draw Lewis structures for simple covalent compounds and simple polyatomic ions. Compute formal charges and use them to evaluate Lewis structures.
6. Predict the shapes of molecules and ions, with VSEPR theory, given Lewis structures.
7. Use valence bond theory to predict the hybridization on each atom in a molecule or ion, and describe the bonding in such species in terms of the orbitals that overlap.

H^+	hydrogen	Mn^{2+}	manganese(II)	Cr^{2+}	chromium(II),chromous	H^-	hydride	$C_2O_4^{2-}$	oxalate
Li^+	lithium	Ni^{2+}	nickel(II)	Cr^{3+}	chromium(III), chromic	F^-	fluoride	FO^-	hypofluorite
Na^+	sodium	As^{3+}	arsenic(III)	Co^{2+}	cobalt(II), cobaltous	Cl^-	chloride	ClO^-	hypochlorite
K^+	potassium	Fe^{2+}	iron(II), ferrous	Co^{3+}	cobalt(III), cobaltic	Br^-	bromide	ClO_2^-	chlorite
Rb^+	rubidium	Fe^{3+}	iron(III), ferric	Cu^+	copper(I), cuprous	I^-	iodide	ClO_3^-	chlorate
Cs^+	cesium	Au^+	gold(I), aurous	Cu^{2+}	copper(II), cupric	N^{3-}	nitride	ClO_4^-	perchlorate
Mg^{2+}	magnesium	Au^{3+}	gold(III), auric	Hg_2^{2+}	mercury(I), mercurous	O^{2-}	oxide	OH^-	hydroxide
Ca^{2+}	calcium	Au^{3+}	gold(III), auric	Hg^{2+}	mercury(II), mercuric	S^{2-}	sulfide	O_2^{2-}	peroxide
Sr^{2+}	strontium	Sn^{2+}	tin(II),stannous	Pb^{2+}	lead(II), plumbous	Se^{2-}	selenide	O_2^-	superoxide
Ba^{2+}	barium	Sn^{4+}	tin(IV), stannic	Pb^{4+}	lead(IV), plumbic	CN^-	cyanide	$S_2O_3^{2-}$	thiosulfate
Al^{3+}	aluminum	Tl^+	thallium(I),thallous	Tl^{3+}	thallium(III), thallic	CNO^-	cyanate	SCN^-	thiocyanate
Zn^{2+}	zinc	CO_3^{2-}	carbonate	HCO_3^-	hydrogen carbonate	SO_4^{2-}	sulfate	HSO_4^-	hydrogen sulfate
Cd^{2+}	cadmium	PO_4^{3-}	phosphate	HPO_4^{2-}	hydrogen phosphate	SO_3^{2-}	sulfite	HSO_3^-	hydrogen sulfite
Ag^+	silver	$C_2H_3O_2^-$	acetate	$H_2PO_4^-$	dihydrogen phosphate	NO_2^-	nitrite	CrO_4^{2-}	chromate
NH_4^+	ammonium	MnO_4^-	permanganate	HS^-	hydrogen sulfide	NO_3^-	nitrate	$Cr_2O_7^{2-}$	dichromate
		MnO_4^{2-}	manganate	BrO^-	hypobromite	BrO_3^-	bromate	BrO_4^-	perbromate
				IO^-	hypoiodite	IO_3^-	iodate	IO_4^-	periodate

WORKING PROBLEMS: Working problems is one of the most important aspects of your study of chemistry. Over the years, students who diligently work problems inevitably succeed in chemistry. Likewise, those who rarely work problems rarely pass the course. Because of these facts, problems will be assigned during each lecture; solutions will be distributed the next lecture period.

Do not simply work for the right answer to a problem. Given enough time, *anyone* can combine the numbers in a problem and get the right answer. You are trying to learn how to solve all problems of that type, with one specific problem as an example. Realize as you work that no one cares if you get the answer in the back of the book. You want to be able to solve that type of problem. On examinations, a correct set-up for a problem typically is worth full credit even with a wrong answer. The answer by itself is worth nothing.

What if you have no idea how to solve a problem? First, try to rewrite the problem. You may be uncertain because the problem is stated in unfamiliar terms. Second, break the problem into pieces and solve the parts you can. Third, look to the examples and your lecture notes to find out how to solve the other parts. Fourth, ask other students or your instructor for help. Following this technique will help you become a good problem solver. It is important that you do as much yourself as you can, for *you* are the one who must learn to solve problems. (But be sure to get help quickly if you are stuck.) After you have solved one problem of a given type with help, do another one by yourself. There are many problems in the textbook, and even more in the *Study Guide*. Practice, practice, practice.

So, we start. The problems for the beginning of the semester will be drawn from these problems.

Chapter 10: 1, 5, 7, 13, 15, 17, 21, 23, 25, 29, 33, 35, 37, 39, 43, 45, 49, 53, 57, 59

Possible test question An unknown compound is 10.0% H and 90.0% C. When 5.612 g of this compound is dissolved in 133.6 g cyclohexane (C_6H_{12}, d = 0.7781 g/mL, M_W = 84.16 g/mol, K_f = 20.0°C/molal, t_f = 6.5°C) the resulting solution freezes at –2.5°C. What is the molecular formula of the unknown compound?

ΔT_f = 6.5 – (–2.5) = 9.0°C = $K_f\,m$ = (20.0°C/molal) × molality   molality = 9.0°C ÷ 20.0°C/molal = 0.45 molal

solvent mass = 133.6 mL × 0.7781 g/mL × (1 kg/1000 g) = 0.1040 kg

solute amount = 0.1040 kg × (0.45 mol solute/kg solvent) = 0.0468 mol solute

$M_{W_{solute}}$ = 5.612 g/0.0468 mol = 120. g/mol

10.0 g H × (1 mol H/1.008 g H) = 9.92 mol H ÷ 7.49 → 1.32 mol H × 3 → 3.97 ≈ 4 mol H

90.0 g C × (1 mol C/12.01 g C) = 7.49 mol C ÷ 7.49 → 1.00 mol C × 3 → 3.00 mol C

$C_3H_4$is the empirical formula; the empirical weight = (3 × 12.01 g C) + (4 × 1.008 g H) = 40.1 g/mol

This is almost exactly $^1/_3$ $M_{W_{solute}}$. Thus the molecular formula is three times the empirical formula: C_9H_{12}.

Possible questions from **Chapter 11:** 3, 7, 11, 13, 15, 17, 21, 25, 27, 29, 31, 35, 39, 43, 47, 51, 53, 57, 59, 65, 67, 73, 75, 79

Possible kinetics test questions Circle the letter corresponding to the best answer of each of the following.

1. The initial rate (R_i) of the reaction 2 A + 2 B ⟶ C + D for several different conditions follows.
   [A] = 0.210 M, [B] = 0.115 M, $R_i = 6.30 \times 10^{-6}$ M/s; [A] = 0.210 M, [B] = 0.230 M, $R_i = 1.25 \times 10^{-5}$ M/s;
   [A] = 0.420 M, [B] = 0.115 M, $R_i = 2.51 \times 10^{-5}$ M/s; [A] = 0.420 M, [B] = 0.230 M, $R_i = 5.13 \times 10^{-5}$ M/s.
   This reaction is **(a)** 2nd order in both [A] & [B]; **(b)** 2nd order in [A] & 1st in [B]; **(c)** 1st order in [A] & 2nd in [B]; **(d)** 1st order in both [A] & [B]; **(e)** none of these. **(b)** is correct, since R_i doubles when [B] doubles (first order) and R_i quadruples when [A] doubles (second order)
2. The reaction 2 NO(g) + 2 H_2(g) ⟶ N_2(g) + 2 H_2O(g) is 2nd order in $P\{NO(g)\}$ and 1st order in $P\{H_2(g)\}$. When $P\{NO(g)\}$ = 359 mmHg and $P\{H_2(g)\}$ = 400 mmHg, the rate of the reaction is measured as 0.750 mmHg/s. Give the units of the specific rate constant, k, in the rate equation for this reaction? **(a)** sec^{-1}; **(b)** $mmHg^{-1}\ sec^{-1}$; **(c)** $mmHg^{-2}\ sec^{-1}$; **(d)** $mmHg^{-3}\ sec^{-1}$; **(e)** mmHg/sec. **(c)** is correct, since rate = $k\,P\{NO\}^2P\{H_2\}$ OR in terms of units, [mmHg/sec] = k[units] $[mmHg]^2$ [mmHg] = k[units] $[mmHg]^3$ k[units] = [mmHg/sec]÷$[mmHg]^3$ = $mmHg^{-2}\ sec^{-1}$
3. In the reaction 2 A + 2 B ⟶ C + 3 D, $\Delta[A]/\Delta t$ is found to be -4.6×10^{-4} M/s. What is the rate of this reaction? **(a)** -4.6×10^{-4} M/s; **(b)** 9.2×10^{-4} M/s; **(c)** 6.9×10^{-4} M/s; **(d)** 2.3×10^{-4} M/s; **(e)** none of these. Answer **(d)** is correct, since rate = $-\Delta[A]/2\Delta t = -(-4.6 \times 10^{-4}$ M/s)/2
4. In the reaction A ⟶ products, the initial [A] = 0.1108 M. And 44 s later, [A] = 0.1076 M. What is the initial rate of this reaction? **(a)** 0.00251 M/s; **(b)** 0.147 M/s; **(c)** 1.21×10^{-6} M/s; **(d)** 7.27×10^{-5} M/s; **(e)** none of these. Rate = $-\Delta[A]/\Delta t$ = –(0.1076 M – 0.1108 M)/44 s = 7.3×10^{-5} M/s, answer **(d)**
5. Substance A decomposes by a *1st-order* reaction. Initially [A] = 2.00 M; after 159 min, [A] = 0.250 M. For this reaction, what is the value of k? **(a)** 0.169 min^{-1}; **(b)** 0.0245 min^{-1}; **(c)** 85.1 min^{-1}; **(d)** 0.0117 min^{-1}; **(e)** none of these. As the concentration decreases, it halves from 2.00 M to 1.00 M, it halves again from 1.00 M to 0.50 M, and it halves a third time from 0.50 M to 0.25 M. Thus, three half lives have elapsed in 159 min, or 3 $t_{1/2}$ = 159 min. $t_{1/2}$ = 159 min/3 = 53.0 min. Since $k = 0.693/t_{1/2}$ = 0.692/53.0 min = 0.0131 min^{-1}, **(e)** is the correct answer.