Competencies for CHEM 1110: summary

KEY:		
text (Tro)	**delivery method**	**evaluation method**
x.y where	l = lecture	T = lecture test
x = chapter	n = notes	Lx = lab number x (labs are also delivery methods)[1]
y = section	v = video tape or internet streaming video available	F = final exam
1,2,3,4,5	TBR* General Education learning outcomes 1-5 - see below	CI = critical item question and lecture test

item	**Performance/Task:** The student will:	text sections	delivery method	eval. method	TBR*
General					
1	Know the definitions and characteristics of "science" and "chemistry."	1.1	l/n/v	T	3
2	Be able to describe the scientific method and the distinctions between "hypothesis", "theories" and "laws"	1.2	l/n/v	T	2, 3
3	Know the definitions of and distinctions between of the following:"substance" , "homogeneous mixture", "heterogeneous mixture", "element", "compound", “solid”, “liquid”, “gas”	1.3	l/n/v	T	3, 4
4	Be able to distinguish between the three major phases of matter, solids, liquids and gases by their specific properties	1.5	l/n/v	T	3,4
5	Be able the distinguish between a physical and a chemical change and the types and roles of energies.	1.5	l	T	3,4
Units					
6	Know the SI base units and unit symbols for mass, length, temperature, amount, time and charge and the unit prefixes M, k, c, m, μ, and n. Know what is meant by a “derived unit”	1.6	l/n/v	T/L2	3
7	Know the equation which defines density and be able to use it in calculations.	1.6	l/n/v	CI/L3	1,2,3
Significant Figures					
8	Know what is meant by significant figures, least significant figure and be able to express a written number with the correct number of digits..	1.7	l/n/v	T/L2	3
9	Know how to determine the correct number of significant figures when adding, subtracting, multiplying and dividing quantities.	1.7	l/n/v	T/L2	1,3

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Unit Conversions					
10	Be able to interconvert between temperatures in degrees celcius, degrees fahrenheit and kelvins	1.6	l/n/v	T	2, 3
11	Be able to apply the principles of quantity calculus, i.e. unit factor, to multiplicative interconversion of units.	1.8	l/n/v	T/L2	3
Introduction to Atomic and Molecular Structure					
12	Be able to describe the modern atomic theory and the law pertaining to it	2.1-2.4			
13	Know the characteristics of charge and mass of protons, neutrons and electrons.	2.5	l/n/v	T	3
14	Know the composition and general construction of atoms and how in general atoms are related to elements, isotopes and compounds.	2.5	l/n/v	T/L4	3,4,5
15	Be able to write and interpret the nuclear symbol conventions, eg. ^{2}H,	2.5	l/n/v	T	3
16	Be able to tell what an ion is and what the charges of simple mono-atomic ions are.	2.6			
Avogadro's Number, N_A, Molar Mass, M, and Moles, n					
17	Be able to obtaining the molar masses,M, from the periodic chart.	2.7, 2.8	l/n/v	CI/L4	3
18	Be able to distinguish between ionic and covalent compounds and be able to write their chemical symbolism	3.2-3.4	l/n/v	T	1,3,4,5
Naming and Oxidation Numbers					
19	Be able to name simple common ionic and covalent compounds .	3.5	l/n/v	T/L	1, 3
20	Know the rules for determining oxidation numbers (including the polyions) and be able to apply them.	3.5, 4.9	l/n/v	T/L	2,3,4
21	Know the rules for naming compounds (including the polyions) by the IUPAC convention and be able to apply them.	3.5, 3.6	l/n/v	T/L	3
Compound Stoichiometry					
22	Be able to calculate the molar mass of a compound	3.7	l/n/v/	CI/L2	2, 3
23	Know what is meant in chemistry by % and be able to calculate or interconvert between % of element in a compound and its stoichiometric formula.	3.7, 3.8	l/n/v	T/L2	1, 3
Reaction Stoichiometry					
24	Know what is meant by a chemical reaction and the symbolism used to describe a reaction	3.10, 4.2	l/n/v	CI/L4	1,3,4,5
25	Be able to do reaction stoichiometry problems if given a reaction.	4.2	l/n/v	T/L5	1,4,5
26	Be able to do a limiting reactant stoichiometry problem.	4.3	l/n/v	T/L5	1,4,5
27	Know the definition of percent yield.	4.3	l/n/v	T/L5	1,4,5

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28	Be able to do calculations which involve percent yield.	4.3	l/n/v	T/L5	1,4,5
Solutions, Solution Reactions and Solution Stoichiometry					
29	Know the definition of molarity and be able to interconvert from grams or moles of solute and liters of solvent to molarity	4.4	l/n/v	CI/L6 /L11	1,2,3,4 ,5
30	Be able to calculate concentrations in a solution dilution problem	4.4	l/n/v	CI/L6 /L11	1,2,3,4 ,5
31	Be able to describe the properties of solutions, both electrolytic and non-electrolytic	4.5	l/n/v	T	3
32	Be able to recognize and write a precipitation reaction	4.6	l/n/v	T	3,4,5
33	Know what spectator ions are and how to identify them	4.7	l/n/v	T	3,5
34	Be able to recognize an "overall reaction" and be able to describe its usefulness for measurement purposes.	4.7	l/n/v	T	3,4,5
35	Be able to write and recognize net ionic reactions and be able to describe its usefulness for chemical reactions.	4.7	l/n/v	T	2,5
36	Be able to describe and recognize an acid or base by the Arrhenius definition	4.8	l/n/v	T/L	1,3,4,5
37	Be able to write and recognize the Arrhenius acid-base reaction	4.8	l/n/v	T/L	1,3,4,5
38	Know the definition of and be able to recognize a redox reaction.	4.9	l/n/v	T	3,4,5
39	Be able to describe the Bronsted-Lowery acid-base reaction and identify the conjugate pairs	in chap. 15	l/n/v	T/L	1,2,3,4 ,5
40	Be able to do calculations involved with titrations. (Instructor: Show how it is just another stoichiometry problem)	16.14	l/n/v	CI/L11 /L12	1,2,3,4 ,5
The Perfect Gas Law					
41	Know the definition of pressure and the appropriate units	5.2	l/n/v	T	3
42	Be able to use the subset of gas laws: Boyle's, Charles', Amontons', Gay-Lussac's, Avogadro's**,** combined gas law. and the Dumas method.	5.3, 5.4	l/n/v	L13/ L14/CI	1,2,3,4 ,5
43	Be able to perform the Dumas method.	L14	l/n/v/L	L14	1,2,3,4 ,5
44	Be able to use the ideal gas law to solve problems	5.5	l/n/v	13/ L14/T	1,2,3,4 ,5
45	Know the definition of STP and the significance/use of the value 22.4 L/mol at STP.	5.5	l/n/v	T/L13	3,4
Dalton's Law					
46	Know the definition of mole fraction and be able to calculate it and interconvert it to other units. This should come later.	5.6	l/n/v	T	3,4,5
47	Be able to use Dalton's Law in problem solving.	5.6	l/n/v	T/L13 /L14	1,3,4,5
48	Be able to work with vapor pressure together with Dalton's Law.	5.6	l/n/v	T/L13	1,3,4,5

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Combining the Perfect Gas Law with Stoichiometry Problems					
49	Be able to use the ideal gas equation in combination with reaction stoichiometry	5.7	l/n/v	T/L13 /CI	1,2,3,4 ,5
Kinetic Molecular Theory					
50	Be able to describe the situation where there are independent particles as a gas and derive the expression for the molecular kinetic energy.	5.8	l/n/v	T/L9	5
51	Be able to calculate the root mean square velocity of a molecule.	5.9	l/n/v	T	5
Graham's Law					
52	Be able to derive Graham's law from kinetic molecular theory.	5.9	l/n/v	T	2
53	Be able to use Graham's law for various practical examples.	5.9	l/n/v	T/L10	1,3,4,5
van der Waal's Equation					
54	Be able to perform calculations using the van der Waal's equation and know the significance of the van der Waal's constants.	5.10	l/n/v	T	2,3,4,5
NEW Nature of Electromagnetic Waves					
55	Be capable of describing the wave nature of light and make calculations base on frequency and wave length	7.2			
56	Be capable of describing diffraction and interference effects	7.2			
57	Be capable of describing some effects of the particle nature of light and the relationship to the photon energy	7.2			
Theory of Atomic Structure					
58	Be able to describe the dual nature of matter, giving some examples of this dual nature	7.4	l/n/v	T	3,4,5
59	Know the implications of and be able to perform calculations base upon the deBroglie relationship and the Heisenberg uncertainty principle.	7.4			
60	Know what is meant by "Quantum" and be able to describe the fundamental differences between classical and quantum physics	7.5	l/n/v	T	2,3,4,5
61	Be able to describe how emission and adsorption spectra arise and do calculations for simple spectra (change in n for H atom)	7.5			
62	Be able describe and to give reasons for quantum numbers	7.5	l/n/v	T	3,4,5
63	Know what is meant by energy levels and the meaning of the four quantum numbers for an electron in an atom	7.6	l/n/v	T/L7	1,3,4,5
64	Know the selection rules for the quantum numbers of electrons in an atom.	7.6	l/n/v	T/L7	3,4,5
65	Know how to designate the quantum numbers by the letter designation, i. e. the electron configurations.	8.3	l/n/v	T/L7	4,5
66	Be able to use the aufbau principle based on the hydrogen atom to give the electron configuration for any atom in its ground state..	8.3	l/n/v	T/L7	1,3,4,5

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67	Know the order of the high stability configurations and Hund's rule.	8.3	l/n/v	T/L7	1,3,4,5
68	Be able to correlate the electron configuration with the position of elements on the periodic table	8.4, 8.5	l/n/v		
Periodic Trends					
69	Know the periodic trends, the exceptions to the trends, and the logic behind both for inozation energy, electron affinity, atomic and ionic radius.	8.6, 8.7	l/n/v	T	3,4,5
70	Be able to describe the peroxides and superoxides in terms of oxidation number and ions formed	table 3.5	l/n/v	T	3,4,5
Bond Structure					
71	Know the definition of valence electrons and how to tell how many there are for a particular atom.	9.3	l/n/v	T/L7	3,4
72	Know the definition of ionic compound formation and be able to describe what an ionic compound is.	9.4	l/n/v	T	3,4
73	Be able to write combination reactions of non-metals (including H) with metals to give principal oxidation number.		l/n/v	T	2,3,4,5
74	Be able to use the Lewis dot structures of ionic and covalent molecules and ions using valence electrons.	9.4, 9.5	l/n/v	T/L8	1,3,4,5
75	Be able to apply the rules for Lewis dot formulas. (These are given in the lab manual.)	9.4, 9.5	l/n/v	T/L8	1,3,4,5
76	Know the definition of covalent compounds and how each is formed.	9.4, 9.5	l/n/v	T/L8	1,3,5
77	Be able to explain the reason for the formation of ionic or covalent compounds based on the tendency to obtain highly stable electron configuations	9.4, 9.5	l/n/v	T	3,4,5
78	Know the definition of lone or unshare electron pair and how to show this in the Lewis dot structure	9.5	l/n/v	T/L8	3,4,5
79	Know the definition of electronegativity and its periodic trend.	9.6	l/n/v	T	3,4,5
80	Be able to predict whether a compound is ionic or covalent based upon electronegativity and periodic table position.	9.6	l/n/v	T/L8	1,3,4,5
81	Be able to describe the bonding involved in a covalent compound including the possibility of double and triple bonding.	9.7	l/n/v	T	3,5
82	Be able to distinguish between hydrogen compounds with H having an oxidation number -1 and those with +1.	**?.?**	l/n/v	T	3,4,5
83	Be able to recognize the presence of resonance and symbolize it.	9.8	l/n/v	T	3,4,5
84	Be able to determine ΔH from Bond Energies.	9.8			
85	Be able make calculations bases on bond lengths.	9.8			
Molecular Geometry					

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86	Know the rules for creating hybrid orbials and be able to apply them to determine electron geometry	10.2, 10.7	l/n/v	T/L8	1,3,4,5
87	From the molecular structure, be able to determine if a molecule is polar and, if so, what the orientation of the dipole is	11.4	l/n/v	T/L8	1,3,4,5
88	From the hybrid orbitals and the lone electron pairs, be able to predict the electronic and molecular geometry	10.3,-10.7	l/n/v	T/L8	1,3,4,5
89	Know the definition of sigma and pi bonds and the physical appearance and how these might affect geometry (including hindered rotation)	10.7	l/n/v	T/L8	1,3,4,5
Intermolecular Forces and the Condensed Phases					
90	Be able to describe and rank the various inter-particle forces. (London, dipole/ionc-dipole/ionic, dipole-induced dipole, "hydrogen bond", **ion-dipole**)	11.3	l/n/v	T	3,4,5
91	Be able to describe and explain the relative boiling points and melting points from the inter-particle forces	11.5, 11.9	l/n/v	T	1,2,3,4,5
Liquid Phase					
92	Be able to do calculations based on the Clausius-Clapeyron equation and the associated van't Hoff plot	11.5	l/n/v	T	1,2,3,4,5
93	Be able to do calculations to obtain the total enthapy using heat capacities and heats of phase changes	11.5	l/n/v	T	1,3,4,5
Phase Diagrams					
94	Know meaning and location of the regions, boundaries and points in a phase diagram (including the supercritical fluid.)	11.8	l/n/v	T	3,4
95	Be able to describe the equalibria involved for each phase boundary and point.	11.8	l/n/v	T	1,3,4,5
Solid State					
96	Be able to describe some simple crystal structures for solids and do calculations based on these structures.	11.10	l/n/v	T	3,4,5
97	Be able to identify types of solids and describe the inter-particle forces for each type. (ionic, metallic, covalent, molecular)	11.11	l/n/v	T	3,4
98	Be able to describe a system that is in dynamic equilibrium.	11.5	l/n/v	T	3,4,5
Electrolytic Solutions					
99	Know the general characteristic of electrolytic and non-electrolytic solutions and the molecular dynamics involved	12.2	l/n/v	T	3,4,5
100	Be able to describe qualitatively what entropy is and its importance for solutions and solubility				
101	Given enthapies of solution, be able to describe the temperature effects involved in solubility.	12.3, 12.4	l/n/v	T	1,3,4,5
102	Be able to do calculations based upon Henry's law	12.4	l/n/v	T/L	1,3,4,5

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103	Be able to calculate mole fraction and molality *del. "based upon particle concentrations."*	12.5	l/n/v	T,L15	1
104	Know the definitions of and be able to interconvert between molarity, percent concentration, molality and mole fraction.	12.5	l/n/v	T/L1	1,2
Colligative Properties and Mole Fraction					
105	Know the definition of colligative properties and the dependence upon mole fraction of solvent.	12.6	l/n/v	T,L15	1,3,4
106	Be able use Raoult's law in calculations.	12.6	l/n/v	T	1,2,3,4,5
107	Be able calculate freezing point depression and boilint point elevation.	12.6	l/n/v	T,L15	1,2,3,4,5
108	Be able calculate osmotic pressure.	12.6	l/n/v	T	1.3,4,5
109	Know how to modify the colligative property calculations with the total concentration for electrolytic solutions, i.e. van't Hoff factor.	12.7	l/n/v	T	1,3,4,5

TBR General Education Outcomes for Natural Sciences Learning Outcomes

Item	Students will demonstrate the ability to...
1	Conduct an experiment, collect and analyze data, and interpret results in a laboratory setting.
2	Analyze, evaluate and test a scientific hypothesis.
3	Use basic scientific language and processes, and be able to distinguish between scientific and non-scientific explanations.
4	Identify unifying principles and repeatable patterns in nature, the values of natural diversity, and apply them to problems or issues of a scientific nature.
5	Analyze and discuss the impact of scientific discovery on human thought and behavior.

[1]For more details about the CHEM 1110 Laboratories see:
http:/www.genchem.net/competencies/lab1comp.html