CH111: Study Guide Including Assigned Homework and Reading – 2015

1 How to succeed in this course

Come to class. Be engaged. The UO recommends students engage in 120 hrs of activities (10-11 hrs/wk) for this 4 credit course. Table 1 shows a recommended student engagement inventory.

Do not fall behind on the assigned reading and homework problems. The assigned reading and homework for a given topic (see below) should ideally be completed before we move to the next topic in lecture. Sometimes scheduling will prohibit this, but it is a good goal to strive for. The material in this class is cumulative, and if you fall behind, it is difficult to catch up.

Working problems is the best way to learn chemistry. Since many quiz and exam problems will follow from the homework, it is also an excellent way to assure success on these assessments. You must *critically* evaluate your performance using the answer keys provided. If you have trouble with a problem, work similar ones. The problems in the book are well organized so that closely related problems can generally be found. *Students that do well on tests are generally able to solve the homework problems in random order (so there is not context to guide problem solving) and without referring to the text, notes, or asking for assistance in any way (mimicking the test environment).*

Come to office hours. Office hours provide a great venue for working problems in smaller groups or to get help on specific topics. You can also schedule an individual appointment.

Learn the language of chemistry In the sidebar next to the summary at the end of each chapter, there is a list of key words that you should be able to define.

Table 1: Weekly student engagement inventory

Activity	Hours	Comments
On-line lectures	0.5	Part of Flipped Fridays
Course attendance	4	Including assessment (quizzes and exams)
Assigned reading	2	Every sentence of a science textbook must be carefully considered for full comprehension (don't forget the examples)
Working problems	4	Key to success!

2 Assigned Reading, Homework and Learning Objectives

The overall objectives of this course are for students to be able to: (1) describe matter and transformations of matter at an atomic level, (2) use representations and models to describe, understand and predict chemical phenomena, and (3) solve quantitative problems. Specific learning objectives for the course are listed on the following pages along with the assigned reading and homework. It is essential that you keep up with reading and assigned homework. Chemistry is a cumulative subject. It is very hard to catch up if you fall too far behind. A couple of notes on the list:

- Problems marked with a * have a related companion problem (also with answer in the back of the book). Depending on chapter, these companion problems are either immediately before or after the assigned problem.
- Each learning objective lists problems associated with it and some appear more than once.

Unit: I. Chemistry's Building Blocks

1. The Atom and the Elements

Reading: Sections 3.1-3.3 (7 pages)

Homework: 3.36, 3.37, 3.44, 3.45, 3.47*, 3.49*, 3.50, 3.55*

Objectives: 1.1. State modern atomic theory (3.36).

1.2. Describe the composition of an atom in terms of subatomic particles (3.44, 3.45).

1.3. Describe how atoms of one element are different or the same as atoms of another element (3.37, 3.47*).

1.4. Describe how atoms of isotopes of a given element differ (3.50).

1.5. Create and use element symbols ${}^{A}_{Z}\mathrm{X}$ to determine/represent the number of electrons, protons, and neutrons in an atom (3.49*, 3.55*).

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2. Physical Quantities and Significant Figures

Reading: Sections 2.1-2.6 and 2.9-2.12 (18 pages)

Homework: 2.3, 2.34, 2.43*, 2.44, 2.45, 2.47*, 2.49*, 2.50, 2.51, 2.54, 2.65*, 2.73*, 2.75*

Objectives: 2.1. Use scientific notation (2.44, 2.45).

2.2. Explain the difference between a physical quantity and a number (2.34).

2.3. Be able to convert between the Farenheit (°F), Celcius (°C) and Kelvin (K) temperature scales if given the formula relating Celcius and Farenheit (2.65*).

2.4. Calculate density and use it to interrelate mass and volume (2.73*, 2.75*).

2.5. Know select SI system prefixes, use them in representing very large or small physical quantities, and interconvert between them (2.3, 2.43*, 2.54).

2.6. Express the precision of a measurement using significant figures and determine which figures in a physical quantity are significant (2.47*, 2.49*).

2.7. Determine significant figures in adding, subtracting, multiplying or dividing physical quantities (2.50, 2.51).

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3. Calculations and Conversions

Reading: Sections 2.7-2.8 (5 pages)

Homework: 2.12, 2.13, 2.52, 2.53, 2.57*, 2.59, 3.41*

Objectives: 3.1. Write conversion factors from equivalences (2.12).

3.2. Use conversion factors to convert a physical quantity from unit to another including multistep conversions and units raised to powers (2.13, 2.52, 2.53, 2.57*, 2.59, 3.41*).

3.3. Cancel units like factors (same as last item).

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4. Matter and Chemical Compounds

Reading: Sections 1.2-1.6 (9 pages)

Homework: 1.6,1.9, 1.19*, 1.20, 1.23*, 1.25*, 1.27*, 1.29*, 1.41*, 1.45, 1.55

Objectives: 4.1. Define matter and explain its composition in terms of atoms.

4.2. Define a bond.

4.3. Define a chemical compound.

4.4. Explain the difference between the way atoms are connected in a molecule versus an extended solid.

4.5. Define solid, liquid, and gas, including the arrangement and movement of atoms or molecules in each, and the terms melting and boiling points (1.20, 1.23*).

4.6. Use chemical formulas to express the atomic composition of chemical compounds (1.9, 1.41, 1.45).

4.7. Understand how chemical equations represent chemical reactions including identifying reactants and products (1.29*).

4.8. Classify changes or properties as physical or chemical (1.6, 1.19*, 1.55).

4.9. Classify matter as mixtures, pure substances, compounds, or elements and describe how the atoms and/or molecules are arranged or bonded in each (1.25*, 1.27*).

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5. Periodic Table

Reading: Sections 3.3-3.5 (6 pages)

Homework: 3.32, 3.59*, 3.63*, 3.67*, 3.69*, 3.70, 3.71, 3.96, 3.103

Objectives: 5.1. Define a group or period of the periodic table.

5.2. Describe how the properties of the elements are reflected in the organization of the periodic table (3.32, 3.69*).

5.3. Identify on the periodic table main group elements, transition metals, metals, nonmetals, metalloids, alkali metals, halogens, and noble gases (3.63*, 3.67*, 3.70, 3.71, 3.96).

5.4. Differentiate a metal from a nonmetal based on its properties (3.32).

5.5. Describe the difference between atomic mass and atomic weight.

5.6. Calculate the atomic weight of an element from its isotope distribution (3.59*, 3.103).

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6. Electronic Structure of the Atom.

Reading: Sections 3.6-3.7 (7 pages)

Homework: 3.20, 3.22, 3.30, 3.72, 3.73, 3.74, 3.75, 3.76, 3.77, 3.79*, 3.83

Objectives: 6.1. Define an orbital and how many electrons it holds (3.72).

6.2. Describe the organization of orbitals into shells and subshells including the numbers and types of orbitals in each (3.75, 3.76, 3.77).

6.3. Describe the shapes of the s-, p- and d-orbitals and how their size changes with shell number (3.30) .

6.4. Determine the number of electrons each shell and subshell can hold (3.74, 3.77, 3.79*).

6.5. Write orbital filling diagrams and the electron configuration of an atoms (3.20, 3.22, 3.83).

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7. Electron Configuration and The Periodic Table

Reading: Sections 3.8-3.9 (5 pages)

Homework: 3.33, 3.80, 3.85*, 3.87, 3.88, 3.89, 3.108,

Extra homework question: Identify the block (s, p, or d) of the periodic that the following elements belong to: Mg, Ti, Ar, Pd, P

Objectives: 7.1. Explain how the electronic structure of the atom determines the shape of the periodic table (i.e. use your knowledge of electron configuration to draw the organization of "boxes" in the periodic table) (3.33).

7.2. Use knowledge of atomic structure to explain periodic trends in atomic radii.

7.3. Identify s-block, p-block, and d-block element and explain what about their electron configuration leads to this assignment.

7.4. Determine the valence electron configuration of an element (3.80, 3.85*, 3.87, 3.89).

7.5. Draw dot structures of the main group elements (3.85, 3.88).

Unit: II. Holding it Together: Chemical Compounds

8. Ion Formation and Ionic Bonds

Reading: Sections 4.1-4.6 (10 pages)

Homework: 4.8, 4.31, 4.32, 4.40, 4.42, 4.44, 4.45, 4.47*, 4.48, 4.50, 4.64, 4.78

Objectives: 8.1. Describe the difference between an ionic and covalent bond.

8.2. Define ion, cation, and anion.

8.3. Write chemical equations for the formation of ions from neutral atoms and determine the ions charge from the number of electrons added or removed (4.40, 4.42, 4.47*).

8.4. Explain why combining a metal with a nonmetal forms an ionic compound.

8.5. Identify groups of the periodic table that form anions or cations and elements that form more than one type of cation (4.31).

8.6. Write the electron configuration of an ion (4.50).

8.7. Explain the octet rule (4.44, 4.45).

8.8. For main group elements that form ions, predict their charge using the octet rule (4.8, 4.32, 4.42, 4.48).

8.9. Recognize polyatomic ions (you will be given Table 4.3 on assessments) (4.64).

8.10. Name and write the chemical formula of the ions that acids and bases form in water (4.78).

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9. Ionic Compounds

Reading: Sections 4.7-4.11 (10 pages)

Homework: 4.36, 4.43, 4.60, 4.64, 4.71*, 4.73*, 4.77, 4.96, 4.98, 5.38

Objectives: 9.1. List some distinguishing properties of ionic compounds (4.43, 5.49 on later assignment).

9.2. Explain why the combination of a metal with a nonmetal forms an ionic compound.

9.3. Recognize an ionic compound from its chemical formula (5.38).

9.4. For main group elements that form ions, predict the chemical formula for ionic compounds formed from the reaction of a metal with a nonmetal (4.36, 4.98).

9.5. Write the chemical formula for ionic compounds formed from a particular cation and anion, including polyatomic ions (4.71*, 4.77, 4.96).

9.6. Name ions and ionic compounds (4.60, 4.73*).

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10. Molecules and Covalent Compounds

Reading: Sections 5.1-5.5 (10 pages)

Homework: 5.1, 5.2, 5.4, 5.27, 5.37, 5.40,5.41, 5.49, 5.50, 5.51

Objectives:

10.1. Describe a covalent compound including the types of elements that form them (5.37).

10.2. Describe the difference between covalent and ionic compounds and the difference between a molecule and an extended solid (5.27, 5.49).

10.3. Describe and predict covalent bond formation in molecules using the octet rule and electron dot structures (5.2, 5.4, 5.40, 5.41).

10.4. Explain why certain elements exist as diatomics and use the octet rule to predict whether they have a single, double or triple bond (5.1).

10.5. Define a lone pair.

10.6. Determine the number of valence electrons in molecules and polyatomic ions (5.50).

10.7. Identify correct Lewis structures (5.51).

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11. Drawing Lewis Structures

Reading: 5.5-5.6 (5 pages)

Problems: 5.48, 5.54, 5.59*, 5.61*, 5.65*, 5.67*

Objectives:

11.1. Use dot structures to predict the number of bonds nonmetal elements from the first and second row and the halogens will form (common bonding rules), and use this in drawing structural formula and Lewis structures (5.61).

11.2. Draw Lewis structures of molecules (5.59*, 5.65*).

11.3. Draw Lewis structures of polyatomic ions (5.67*).

11.4. Given one of chemical formula, structural formula, condensed structure, or Lewis structure, write the others (5.48, 5.54)

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12. Shapes of Molecules (VSEPR) and Naming

Reading: 5.7 and 5.9 (6 pages)

Problems: 5.69, 5.70, 5.71, 5.72, 5.73, 5.87*, 5.89*

Objectives:

12.1. Use VSEPR to predict the molecular geometry about a central atom (5.69, 5.70, 5.72, 5.73*).

12.2. Draw common molecular geometries (5.71).

12.3. Name binary molecular compounds (5.87*, 5.89*).

Unit: III. Transformations: Chemical Reactions

13. Chemical Equations

Reading: 6.1-6.3 (9 pages)

Problems: 6.2, 6.28, 6.29, 6.37, 6.38, 6.42

Objectives:

13.1. Use the principle of conservation of mass to explain why chemical equations must be balanced (6.28)

13.2. Explain the difference between the coefficients of chemical equations and the subscripts in chemical formulae (6.29, 6.37)

13.3. Write balanced chemical equations that show chemical transformations and include phase labels (6.2, 6.38, 6.42)

13.4. Use the coefficients of chemical equations to determine the ratios in which chemical compounds or elements combine.

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14. The Mole and Mass/Number Relationships

Reading: 6.4-6.5 (4 pages)

Problems: 6.12, 6.45, 6.47*, 6.49, 6.50, 6.54, 6.55, 6.57, 6.58, 6.60, 6.63, 6.100

Objectives:

14.1. Define a mole (6.45, 6.47*).

14.2. Know why Avogadro's number is 6.022×10^{23} (3.41* (from earlier assignment)).

14.3. Calculate the molar mass of elements or compounds and interconvert between moles, mass and the number of molecules, atoms, or formula units (6.49, 6.50, 6.54, 6.55, 6.57, 6.58, 6.60, 6.100)

14.4. Use the coefficients of a chemical equation to calculate the moles of a reactant or product needed to produce or consume a certain number of moles of a different reactant or product (6.12, 6.63)

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15. Mass Number Relations and Chemical Reactions (Stoichiometry)

Reading: 6.6-6.7 (5 pages)

Problems: 6.14, 6.15, 6.64, 6.66, 6.67, 6.68, 6.69

Objectives:

15.1. Calculate the the amount (in moles, numbers, or mass) of a reactant or product needed to produce or consume a certain amount (in moles, numbers or mass) of a different reactant or product (6.14, 6.15, 6.64, 6.66, 6.67, 6.68, 6.69)

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16. Spontaneity and Reactions

Reading: 7.1-7.4 (10 pages)

Problems: 7.1, 7.6, 7.18, 7.19, 7.26, 7.29*, 7.31*, 7.33, 7.34, 7.37, 7.38, 7.40

Objectives:

16.1. Define a spontaneous process.

16.2. Define entropy and predict whether a chemical reaction proceeds with an increase or decrease in entropy or equivalently a positive or negative ΔS (7.18, 7.19, 7.31*, 7.38).

16.3. Define enthalpy change ΔH and identify a reaction as exothermic or endothermic, or equivalently with $\Delta H < 0$ or $\Delta H > 0$, based on whether heat is released or absorbed (7.1, 7.26, 7.29*, 7.38).

16.4. Use the ΔH of a chemical reaction to calculate the amount of heat released or absorbed in reacting a given amount (mass or moles) of a chemical compound (7.26, 7.29*).

16.5. Describe how ΔH and ΔS contribute to the spontaneity of a chemical reaction (7.18, 7.19, 7.34, 7.37, 7.38).

16.6. Calculate and use the free energy change ΔG to predict whether a reaction will be spontaneous or not, including as a function of temperature (7.6, 7.33, 7.40).

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17. Rates of Chemical Reactions

Reading: 7.5-7.6 (4 pages)

Problems: 7.8, 7.9, 7.10, 7.44, 7.46, 7.47, 7.48, 7.50, 7.51

Objectives:

17.1. Define activation energy E_{act}.

17.2. Describe the difference between spontaneity and the rate of a chemical reaction (7.50, 7.51).

17.3. Sketch and interpret reaction energy diagrams including how they are affected by ΔG and E_{act} (7.8, 7.9, 7.44)

17.4. Describe how temperature, activation energy, and contact between reactants (e.g. concentration) affect the rate of a chemical reaction and explain in terms of an atomic-level picture of a chemical reaction (7.10, 7.46, 7.47).

17.5. Describe how a catalyst affects the rate of a chemical reaction and explain in terms of reaction energy diagrams and an atomic-level picture of a chemical reaction (7.10, 7.48)

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18. Chemical Equilibrium

Reading: 7.7-7.9 (10 pages)

Problems: 7.11, 7.12, 7.13, 7.52, 7.55*, 7.57*,

Objectives:

18.1. Explain the concept of equilibrium for a reversible chemical reaction including its dynamic nature (7.52).

18.2. Write the equilibrium constant expression for a chemical equilibrium and calculate it based on equilibrium concentrations (7.11, 7.13, 7.55*, 7.57*).

18.3. Use the equilibrium constant to predict whether the reactants or products are favored in a chemical equilibrium (7.12, 7.55).

Unit: IV. Chemistry in Water. Solutions

19. Intermolecular Forces and Solutions

Reading: 5.8-5.9, 8.11, 9.1-9.2 (16 pages)

Problems: 5.77*, 5.79*, 5.85*, 8.18, 8.20, 8.90, 8.116, 9.40, 9.42, 9.43

Objectives:

19.1. Describe the forces that hold molecules together, their relative strength, and their relation to molecular structure (8.18, 8.20, 8.90, 8.116).

19.2. Relate the strength of intermolecular forces to boiling point (8.18, 8.116).

19.3. Describe a polar covalent bond.

19.4. Define electronegativity and how it changes across the periodic table (5.77*).

19.5. Use electronegativity difference to predict whether a bond is covalent, polar covalent, or ionic (5.79*).

19.6. Based on electronegativity and molecular structure, predict whether or not a molecule is polar (5.85*).

19.7. Identify solutions (9.42).

19.8. Use knowledge of intermolecular forces to predict or rationalize solution formation (9.40, 9.43).

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20. Concentration and Dilution of Solutions

Reading: 9.7-9.9 (12 pages)

Problems: 9.8, 9.9, 9.11, 9.36, 9.52, 9.66, 9.72, 9.73, 9.80

Objectives:

20.1. Define solute, solvent, and solution

20.2. Define and calculate molarity (9.8, 9.52).

20.3. Use molarity to interconvert amount (moles or grams) of solute and liters of solution (9.9, 9.11, 9.66, 9.80).

20.4. Relate the molarity of solutions resulting from dilution (9.36, 9.72, 9.73).

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21. Acids and Bases

Reading: 10.1-10.4 (8 pages)

Problems: 10.32, 10.38, 10.40, 10.47, 10.48, 10.49, 10.53

Objectives:

21.1. Define Arrhenius acids and bases and write the chemical equation for an Arrhenius acid or base reacting with water (10.38, 10.40).

21.2. Define Brønsted-Lowry acids and bases and use this definition to identify the acids and bases in an acid base reaction (10.32, 10.47, 10.53).

21.3. Identify conjugate acid/base pairs in an acid/base reaction (10.47, 10.48, 10.49, 10.53,).

21.4. Identify common acids or bases based on their chemical equation.

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22. Acid Strength

Reading: 10.5-10.7 (5 pages)

Problems: 10.5, 10.35, 10.44, 10.50, 10.51, 10.54, 10.56, 10.61, 10.62

Objectives:

22.1. Write the acid dissociation reaction for the reaction of water with an acid.

22.2. Explain the difference between a strong and weak acid (10.35).

22.3. Use Table 10.1 to classify the relative strength of acids or bases (10.44, 10.62)

22.4. Write the expression for the acid dissociation constant K_a for an acid (10.54).

22.5. Use K_a to classify the strength of acids (10.61).

22.6. Use values of K_a to predict which side of an acid/base equilibrium is favored (10.51).

22.7. Define amphoteric and recognize water acting as an acid or a base in chemical reactions (10.5, 10.50).

22.8. Write the expression for the ion-product constant K_w of water and use it to explain how concentration of H_3O^+ ($[H_3O^+]$) and concentration of OH^- ($[OH^-]$)in water are related (10.56).

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23. pH

Reading: 10.8-10.10 (6 pages)

Problems: 10.11, 10.12, 10.16, 10.63, 10.70, 10.71, 10.72, 10.110

Objectives:

23.1. Classify solutions as acidic, basic or neutral based on $[H_3O^+]$, $[OH^-]$, pH or pOH (10.11, 10.16, 10.63).

23.2. Use the ion-product constant of water and the definition of the p-function to interrelate $[H_3O^+]$, $[OH^-]$, pH and pOH in water (10.12, 10.70, 10.71, 10.72, 10.110).

Unit: V. Molecules of Life: Organic Compounds

24. Organic Compounds and Functional Groups

Reading: 12.1-12.3 (10 pages)

Problems: 12.4, 12.22, 12.26, 12.33*, 12.35*, 12.37, 12.45*, 12.47*

Objectives:

24.1. Define organic compound (12.26).

24.2. Define hydrocarbon.

24.3. Define isomer (12.37).

24.4. Identify and draw structural formula that correspond to the same compound, different compounds, or constitutional isomers (12.4, 12.45*, 12.47*)

24.5. Recognize the functional groups characteristic of alkanes, alkenes, aromatics, alcohols, amines, and carboxylic acids. Others if provided Table 12.1 (12.22, 12.33*, 12.35*).

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25. Drawing and Naming Organic Compounds

Reading: 12.4-12.6 (15 pages)

Problems: 12.6, 12.20, 12.21, 12.43, 12.50, 12.53, 12.56

Objectives:

25.1. Use common bonding rules and octet rule to add hydrogens to the carbons of an organic structure that omits them (12.19).

25.2. Structural formula, condensed structure, line structure: given one, draw the others (12.6, 12.20, 12.21,12.43).

25.3. Name an alkane based on its structure and vice versa (12.50, 12.53*, 12.56)
