

Module 7: Succeeding in College Chemistry

Lingering Questions Revisited

Fundamentals of Chemistry Open Course

Learning Objectives | Module 7

1. Recognize and avoid common misconceptions related to the study of chemistry.
2. Apply productive study skills to learn efficiently and effectively in college.
3. Reflect on key lingering questions that will guide future studies in introductory and organic chemistry.

- The material here is just the beginning of your study of chemistry.
- We have encountered numerous “lingering questions” that will be explored in your future studies.
- Answering these questions will lead to additional questions. Don’t let those go—write them down, and if you’re interested in the answers, ask your professors!
- Additional resources for exploring and learning chemistry:
 - [AP Chemistry](#) at Khan Academy
 - [Chemistry 2e](#), an OpenStax textbook
 - [LibreTexts Chemistry](#), open resources for learning chemistry
 - [The Periodic Table of Videos](#)
 - [PhET simulations for chemistry](#), interactive demonstrations of chemical phenomena
 - [Concord Consortium resources](#), resources and interactives for learning chemistry

- **What is a Chemical Species?**

- How do we think about atomic mass in a macroscopic sample of an element with multiple isotopes?
- Do the charges of monatomic ions formed by the elements follow any sort of pattern?
- How similar are the properties of isotopes? Do they display the same chemistry?
- Do electrons really “orbit” the nucleus like planets around the sun? What does an electron really “look like”?
- How can we measure the number ratios of atoms in a compound, particularly given their extremely small size?
- Many practical ionic salts have formulas like “ $\text{CuSO}_4 \cdot 6\text{H}_2\text{O}$.” What does the dot signify?
How do we visualize these compounds?
- There are [known compounds](#) with fractional or decimal number ratios of atoms. How is this possible?
- Here, we focused on submicroscopic models of pure substances. How do we think about submicroscopic models of mixtures, particularly homogeneous mixtures (**solutions**)?
- How do particles in a substance interact with *each other*? In what ways does our submicroscopic model of a substance affect how we think about interactions *between* particles?
- Chemical bonds are commonly represented as sticks or lines in symbolic and submicroscopic representations. What exactly is a chemical bond? Why do atoms “stick together”?
- Why is the periodic table arranged the way it is? For example, why are there two columns in the s block, six in the p block, ten in the d block, and fourteen in the f block?
- One reason the periodic table is useful is that the elements display **periodic trends** in their properties. What are these properties and how do they vary across the periodic table?
- How do we name compounds with more complex structures? What kinds of naming conventions are needed?

- **Representing Amounts of Substances**

- Can the mole and Avogadro's number be defined with respect to a mass unit other than the gram?
- What about substances dissolved in solutions and other substances that we can't weigh?
How do we count particles of these substances?
- How are moles used in planning and carrying out chemical reactions?
- What other units of concentration are in common use? What about the very small units parts per million (ppm) and parts per billion (ppb)?
- When an ionic salt is dissolved in water, the ions **dissociate**. How does dissociation affect the molarities of ions? Are the molarities of ions in a solution always equal to the molarity of the formula unit?
- What properties of solutions are related to molarity? How can we use measurement of these properties to determine molarity?
- What other relations between gas variables can we infer from the ideal gas law?
How might we use these equations?
- Does the ideal gas law apply to a mixture of two or more gases? Why or why not?
- How can we use the ideal gas law to plan and carry out reactions involving gases?
- What happens when a gas deviates from ideal behavior? How do we model real gases?

- **Describing Chemical and Physical Changes**

- Some chemical substances can react with one another in more than one way. How can we predict the outcome when substances are mixed?
- What makes a chemical equation physically plausible? What natural laws must chemical reactions follow?
- How do we make use of balanced chemical equations to plan and carry out chemical reactions?
- How do we determine experimentally the chemical formulas of reactants and products and the number ratios in which they combine?
- Why do chemical reactions happen? What are the driving forces that govern when and how chemical reactions take place?
- Most chemical reactions occur over two or more collisions between atoms or molecules. How do we think about and study reactions that require multiple steps?

- **Energy and Chemistry**

- What kinds of processes are involved in thermodynamics problems? What specific examples of transfers of matter and energy come up?
- Once we define the system and surroundings, what's next? What concepts and equations are used to guide problem solving in chemical thermodynamics?
- There are three other laws of thermodynamics. What are they and how do we apply them to solve problems?
- The first law says that energy is conserved but places no constraints on the form of energy. Can heat be converted fully into work or *vice versa*?
- The laws of thermodynamics are used to define the important thermodynamic quantities enthalpy (H), entropy (S), and free energy (G). What are these quantities and how can we apply them?

- **Drawing and Interpreting Lewis Structures**

- Why are electrons organized into shells and subshells in the atom?
What underlying physics results in this organization?
- Why do atoms share electrons to form chemical bonds?
- What kinds of information can be gleaned from a molecular structure? How do we think about that process?
- Why does the octet rule generally hold? What is special about a total electron count of 8?
- We have seen that hydrogen “violates” the octet rule by bearing only two electrons in Lewis structures.
What other common exceptions to the octet rule are observed?
- In the structures we have examined so far, the vast majority of the atoms have been neutral. However, ions must contain at least one charged atom. How do we determine the charge of an atom in a Lewis structure?
- It is sometimes possible to draw more than one Lewis structure for a molecule, even when keeping the connectivity of the atoms and the total number of valence electrons the same. Why does this happen? How do we decide which Lewis structure is “best” in this case?
- Are formal charges physically realistic? Do they actually represent regions of positive and negative charge density in molecules? Why or why not?