Module 6: Drawing and Interpreting Lewis Structures

The Structure of the Periodic Table; Core and Valence Electrons

Fundamentals of Chemistry Open Course

Learning Objectives | Module 6

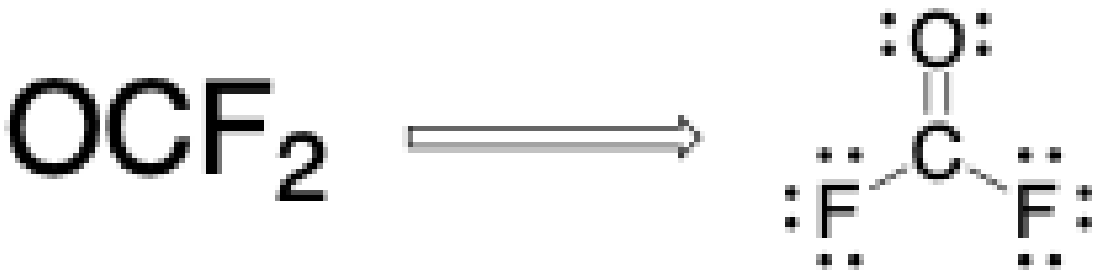
1. Infer the number of valence electrons in a neutral atom from the position of its element on the periodic table.
2. Draw Lewis symbols for atoms with the appropriate number of electrons.
3. Infer the most likely skeletal structure of a simple molecule from the molecular formula.
4. Distinguish between bonding and nonbonding electrons in Lewis structures.
5. Define and apply the octet rule when drawing Lewis structures.
6. Draw Lewis structures for simple molecules containing only single bonds and formally neutral atoms.
7. Draw Lewis structures for simple molecules containing multiple bonds.
8. Deduce the formal charge of an atom in a Lewis structure.

Our Goal: From Molecular Formula to Structure

- The **structure** of a molecule is a representation of the distribution of nuclei and electrons in the molecule. Structures include:
  - Element symbols
  - Bonding pairs electrons (—)
  - Nonbonding pairs of electrons or **lone pairs** (:)

- Molecular structure provides an *immense* amount of information about physical and chemical properties.

- Our goal for this module will be to reason from a molecular formula to a structural representation that shows how atoms are connected along with the distribution of important electrons that do not participate in bonding.



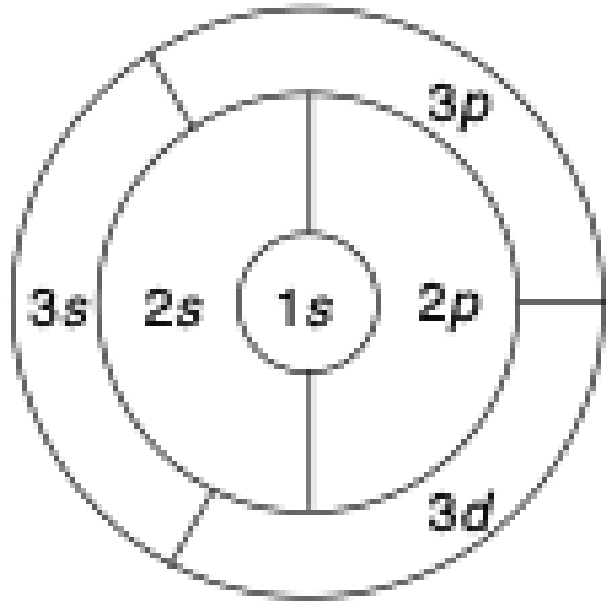
Electrons in Atoms

- In CHEM 1211K and 1310, we will study the nature of electrons in atoms in detail. For now, the important idea for drawing structures is that atomic electrons are organized in layers.

- Within each **shell** (n = 1, 2, 3, 4, …) there are one or more **subshells** (s, p, d, or f) that contain electrons.
  - Each shell only contains certain subshells.
  - Each subshell can only hold a certain maximum number of electrons.
  - Subshells "fill" with electrons in the order $s \rightarrow p \rightarrow d \rightarrow f$.

Shell	Subshells
1	1*s*
2	2*s*, 2*p*
3	3*s*, 3*p*, 3*d*
4	4*s*, 4*p*, 4*d*, 4*f*

Subshell	Maximum Electrons
s	2
p	6
d	10
f	14



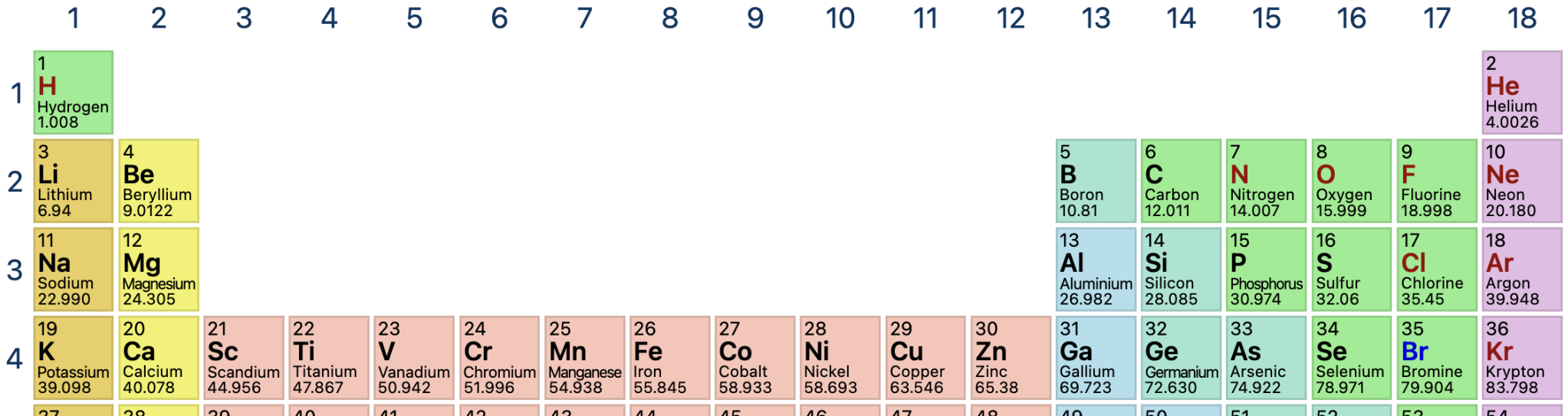
Valence and Core Shells

- Only the outermost shell contains reactive electrons. The outermost shell that contains electrons in an atom is called the **valence shell**. Inner shells are known as **core shells**.

- The period number of an element is equal to the shell number of the valence shell.
  - For hydrogen, the valence shell is $n = 1$.
  - For nitrogen, the valence shell is $n = 2$.
  - For chlorine, the valence shell is $n = 3$.

- The group number of an element tells us the number of valence electrons in the neutral atom.

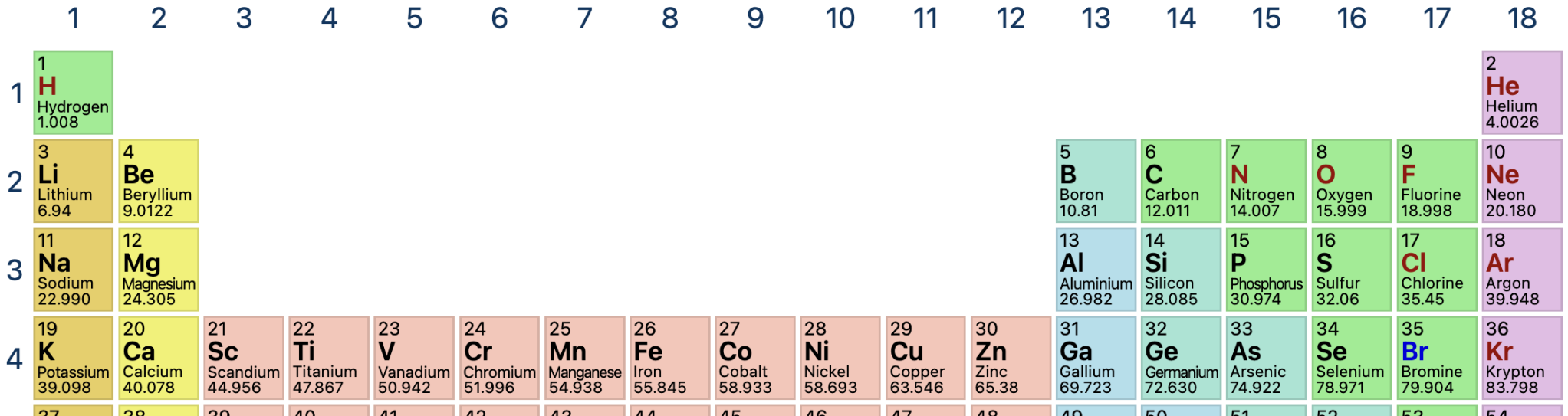
- The names of the *s*, *p*, *d*, and *f* blocks reflect the subshell of the outermost electron in each element.



Valence and Core Shells

- Only valence electrons are involved in bonding and chemical reactivity. Two important corollaries:
  - We can ignore core electrons completely, “hiding” them in element symbols when drawing structures.
  - Elements with the same number of valence electrons display analogous chemistry.

Example. How many valence electrons are present in a neutral oxygen atom? What about a neutral sulfur atom? What do you notice about the valence electron counts of these elements?



Lingering Questions

- 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?