

Group	1	2	13	14	15	16	17	18
Electron Configuration	[He]2s ¹	[He]2s ²	[He]2s ² 2p ¹	[He]2s ² 2p ²	[He]2s ² 2p ³	[He]2s ² 2p ⁴	[He]2s ² 2p ⁵	[He]2s ² 2p ⁶
Lewis Dot Symbol	Li·	·Be·	·B·	·C·	·N·	:O·	:F·	:Ne:

The Octet Rule

Lewis's major contribution to bonding theory was to recognize that atoms tend to lose, gain, or share electrons to reach a total of eight valence electrons, called an *octet*. This so-called octet rule explains the stoichiometry of most compounds in the *s* and *p* blocks of the periodic table. We now know from quantum mechanics that the number eight corresponds to having one *ns* and three *np* valence orbitals filled, which together can accommodate a total of eight electrons. We also know that the configuration ns^2np^6 is the one in a period which with the highest ionization energy and the lowest electron affinity. This level is the most difficult to take a valence electron away from or add one to. Atoms which can achieve an ns^2np^6 by sharing, borrowing or lending electrons to another atom which also achieves this configuration in the exchange will form a bond.

Remarkably, though, Lewis's insight was made nearly a decade before Rutherford proposed the nuclear model of the atom and more than two before Schrödinger had explained the electronic structure of hydrogen.

For some time helium was treated as an exception to the octet rule. Today we know that helium's $1s^2$ electron configuration gives it a full $n = 1$ shell, and hydrogen, why gains its one electron to achieve the electron configuration of helium. We understand this as a consequence of only two electrons being able to fit in the $n = 1$ shell, in Lewis' time this was a mystery, something that was simply accepted. It is the ability to understand the atomic orbital basis of *ad hoc* rules developed in the past that motivates our atoms first approach to chemistry.

Lewis dot symbols can also be used to represent the ions in ionic compounds. The reaction of cesium with fluorine, for example, to produce the ionic compound CsF can be written as follows:



No dots are shown on Cs^+ in the product because cesium has lost its single valence electron to fluorine. The transfer of this electron produces the Cs^+ ion, which has the valence electron configuration of Xe, and the F^- ion, which has a total of eight valence electrons (an octet) and the Ne electron configuration. This description is consistent with the statement in [Chapter 3](#) that among the main group elements, ions in simple binary ionic compounds generally have the electron configurations of the nearest noble gas. The charge of each ion is written in the product, and the anion and its electrons are enclosed in brackets. This notation emphasizes that the ions are associated electrostatically; no electrons are shared between the two elements.

As you might expect for such a qualitative approach to bonding, there are exceptions to the octet rule, which we describe in [Section 4.5](#). These include molecules in which one or more atoms contain fewer or more than eight electrons. In [Section 4.4](#), however, we explain how to form molecular compounds by completing octets.

Summary

One convenient way to predict the number and basic arrangement of bonds in compounds is by using **Lewis electron dot symbols**, which consist of the chemical symbol for an element surrounded by dots that represent its valence electrons, grouped into pairs often placed above, below, and to the left and right of the symbol. The structures reflect the fact that the elements in period 2 and beyond tend to gain, lose, or share electrons to reach a total of eight valence electrons in their compounds, the so-called **octet rule**. Hydrogen, with only two valence electrons, does not obey the octet rule.

Key Takeaway

- Lewis dot symbols can be used to predict the number of bonds formed by most elements in their compounds.

Conceptual Problems

- The Lewis electron system is a simplified approach for understanding bonding in covalent and ionic compounds. Why do chemists still find it useful?
- Is a Lewis dot symbol an exact representation of the valence electrons in an atom or ion? Explain your answer.

3. How can the Lewis electron dot system help to predict the stoichiometry of a compound and its chemical and physical properties?
4. How is a Lewis dot symbol consistent with the quantum mechanical model of the atom described in [Chapter 2](#) ? How is it different?

Answer

- 1.
- 2.
3. Lewis dot symbols allow us to predict the number of bonds atoms will form, and therefore the stoichiometry of a compound. The Lewis structure of a compound also indicates the presence or absence of lone pairs of electrons, which provides information on the compound's chemical reactivity and physical properties.
- 4.

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