10.6: Valence Electrons

Learning Objectives

- Determine the number of valence electrons for an element based on its place in the periodic table.

In almost all cases, chemical bonds are formed by interactions of valence electrons in atoms. Valence electrons are the electrons that reside in the outermost energy level of an atom and are, therefore, the most accessible for the formation of chemical bonds.

The number of valence electrons in one atom of each element is easily determined based on its position in the periodic table. For the main group elements (groups designated with a Roman numeral followed by the letter A), the number of valence electrons is equal to the Roman numeral. It would also be equal to the last digit of the group numbers that are written in their standard form. For example, silicon is in Group IVA (Group 14), so each atom would have four valence electrons. Chlorine is in Group VIIA (Group 17), so it would have seven valence electrons. Calcium would have two valence electrons, since it is in Group IIA (Group 2).

Helium is the only exception for the main group elements. The first energy level holds a maximum of two valence electrons. Since helium atoms only have two electrons and the outermost energy level *is* the first energy level, there can only be two valence electrons. When the outermost energy level is any other level beyond the first energy level, it may contain up to eight valence electrons. In other words, the maximum number of valence electrons that an atom may have is eight.

Transition elements (groups designated with a Roman numeral followed by the letter B) usually have two valence electrons, though we will not be working with valence electrons for the transition elements in this text.

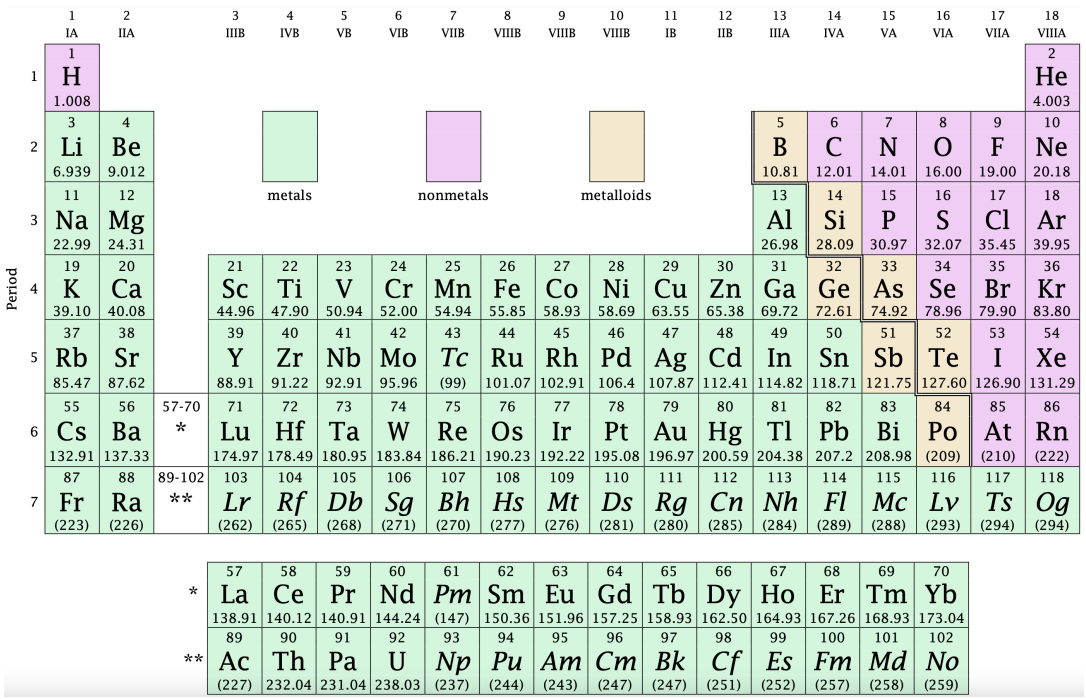

Figure 10.6.1: The modern version of the periodic table. An interactive periodic table may be found here.

✅ Example 10.6.1: Number of Valence Electrons

How many valence electrons are in one atom of each element?

A. sulfur
B. helium
C. potassium

D. aluminum

Solution

A. Sulfur (S) is located in Group VIA (Group 16), so it has 6 valence electrons.
B. Helium (He) is located in Group VIIIA (Group 18). However, one atom only has two electrons, so it could never have more than 2 valence electrons. As noted above, helium is the only exception for the main group elements.
C. Potassium (K) is located in Group IA (Group 1), so it has 1 valence electron.
D. Aluminum (Al) is located in Group IIIA (Group 13), so it has 3 valence electrons.

Exercise 10.6.1

Tell which group of elements (alkali metals, alkaline earth metals, halogens, noble gases) has atoms with the specified number of valence electrons?

A. 1 valence electron
B. 2 valence electron
C. 7 valence electrons
D. 8 valence electrons

Answer A

alkali metals

Answer B

alkaline earth metals

Answer C

halogens

Answer D

noble gases

Summary

- The number of valence electrons in an atom may be predicted based on its position in the periodic table.

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