4.14: Noble Gas Configuration

Figure 4.14.1 (Credit: User:Danbold/Wikipedia; Source: http://commons.wikimedia.org/wiki/File:Set_dinner_table.jpg(opens in new window); License: Public Domain)

How does it feel to be full after a meal?

Envision that you have nearly finished a great meal, but cannot put another bite in your mouth because there is no place for it to go. The noble gases have the same problem—there is no room for any more electrons in their outer shells. They are completely full and cannot handle any more.

Noble Gas Configuration

Sodium, element number 11, is the first element in the third period of the periodic table. Its electron configuration is $1s^2 2s^2 2p^6 3s^1$. The first ten electrons of the sodium atom are the inner-shell electrons and the configuration of just those ten electrons is exactly the same as the configuration of the element neon $(Z = 10)$. This provides the basis for a shorthand notation for electron configurations called the noble gas configuration. The elements that are found in the last column of the periodic table are an important group of elements called the noble gases. They are helium, neon, argon, krypton, xenon, and radon. A **noble gas configuration** of an atom consists of the elemental symbol of the last noble gas prior to that atom, followed by the configuration of the remaining electrons. So for sodium, we make the substitution of $[\text{Ne}]$ for the $1s^2 2s^2 2p^6$ part of the configuration. Sodium's noble gas configuration becomes $[\text{Ne}]\, 3s^1$. Table $4.14.1$ shows the noble gas configurations of the third period elements.

Table 4.14.1: Electron Configurations of Third-Period Elements

Element Name	Symbol	Atomic Number	Noble Gas Electron Configuration
Sodium	Na	11	$[\text{Ne}]\, 3s^1$
Magnesium	Mg	12	$[\text{Ne}]\, 3s^2$
Aluminum	Al	13	$[\text{Ne}]\, 3s^2 3p^1$
Silicon	Si	14	$[\text{Ne}]\, 3s^2 3p^2$
Phosphorus	P	15	$[\text{Ne}]\, 3s^2 3p^3$
Sulfur	S	16	$[\text{Ne}]\, 3s^2 3p^4$
Chlorine	Cl	17	$[\text{Ne}]\, 3s^2 3p^5$
Argon	Ar	18	$[\text{Ne}]\, 3s^2 3p^6$

Again, the number of valence electrons increases from one to eight across the third period.

The fourth and subsequent periods follow the same pattern, except for the use of a different noble gas. Potassium has nineteen electrons, one more than the noble gas argon, so its configuration could be written as $[\text{Ar}]\, 4s^1$. In a similar fashion, strontium has two more electrons than the noble gas krypton, which would allow us to write its electron configuration as $[\text{Kr}]\, 5s^2$. All elements can be represented in this fashion.

Summary

- The noble gas configuration system allows some shortening of the total electron configuration by using the symbol for the noble gas of the previous period as part of the pattern of electrons.

Review

1. What is the element represented by $[\mathrm{Ne}]\,3s^2 3p^2$?
2. What element has this electron configuration $[\mathrm{Ar}]\,3d^7 4s^2$?
3. What noble gas would be part of the electron configuration notation for Mn?
4. How would you write the electron configuration for Ba?
