CONCEPT 2

Elements in chemical groups have similar electron arrangements.

Activity

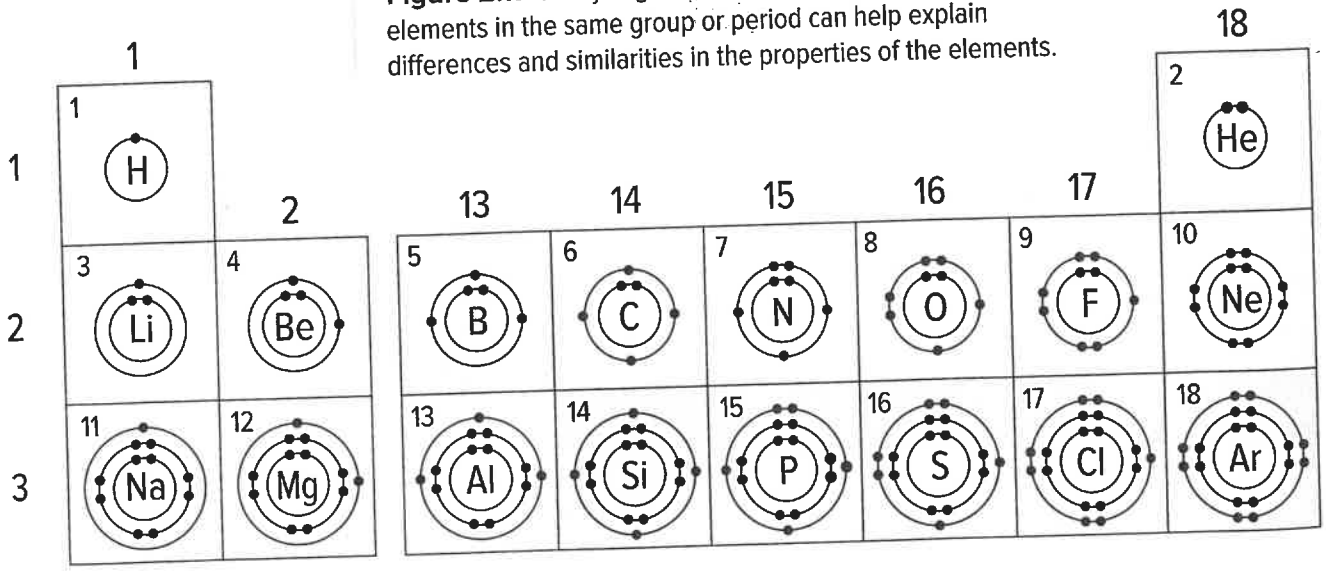
Valence Electrons and Group Numbers

Examine **Figure 2.17**. How do the valence electrons in each group relate to the group number?

Figure 2.17 shows Bohr diagrams for elements in the first three periods of the periodic table. If you look carefully at the electron arrangements, you will see that two key patterns emerge:

1. *Atoms in the same group have the same number of valence electrons.* Each element in Group 1 has one valence electron, and each element in Group 2 has two valence electrons. The elements in Groups 13 to 18 have 3, 4, 5, 6, 7, and 8 valence electrons, respectively. An exception is helium. Helium has only two valence electrons, but the other noble gases have eight.
2. *Atoms in the same period have the same number of occupied energy shells.* The two elements in the first period, hydrogen and helium, have only one occupied energy shell. The eight elements in the second period have two occupied energy shells. The eight elements in the third period have three.

Figure 2.17 Analyzing the electron arrangements of elements in the same group or period can help explain differences and similarities in the properties of the elements.



Noble Gas Stability: A Full Valence Shell

During a chemical reaction, atoms gain, lose, or share valence electrons with other atoms. Noble gases are special among the elements, because they all have full valence shells. This feature makes them unusually stable. Their atoms do not tend to gain, lose, or share electrons with other elements— for the most part, they are unreactive. As you can see in **Figure 2.18**, helium has two electrons, which is the maximum number of electrons for the first energy shell. The other noble gases have eight electrons in their valence shells.

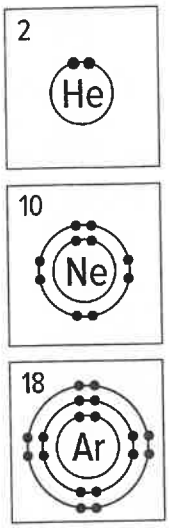


Figure 2.18 The noble gases have full valence shells.

How Other Elements Achieve Full Valence Shells

One way that atoms of elements other than the noble gases can achieve a full valence shell is by gaining or losing electrons during chemical reactions. When a neutral atom gains or loses an electron, it becomes charged—it becomes an **ion**. When an atom loses an electron, it becomes a positively charged ion. When an atom gains an electron, it becomes a negatively charged ion.

ion an atom with a positive or negative charge

The reactivity of an element is linked to how close it is to having a full valence shell. For this reason, the most reactive elements are those of Groups 1 and 17. The atoms of these elements are only one electron away from having a full set of valence electrons. As shown in **Figure 2.19**, Group 1 atoms can give up an electron, exposing the full energy shell underneath. Group 17 atoms can gain an electron, completing their valence shell.

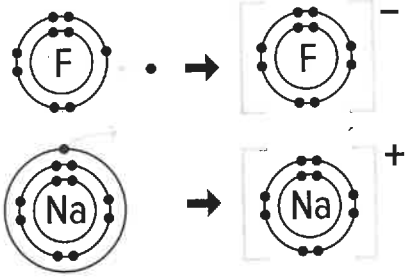


Figure 2.19 If a fluorine atom gains an electron, forming the ion F^-, it will have the same electron arrangement as neon, including a full valence shell. A sodium atom can have the same electron arrangement as neon by losing an electron and forming the ion Na^+.

Extending the Connections

A Noble Gas is Hard to Find

When Mendeleev developed his periodic table, he did not include a column for the noble gases, because they had not yet been discovered. Which noble gas was found first and how was it discovered? Who realized where the noble gases should be placed on the periodic table? Do research to find out.

Before you leave this page . . .

1. Explain why metals tend to lose electrons and non-metals tend to gain them.
2. Use diagrams to compare the electron arrangements of a chloride ion, a potassium ion, and an argon atom.