Name: _____ Date: _____

CONTENT 16.1

16.1 Dot Diagrams

READ

You have learned that atoms are composed of protons, neutrons, and electrons. The electrons occupy energy levels that surround the nucleus in the form of an "electron cloud." The electrons that are involved in forming chemical bonds are called **valence electrons**. Atoms can have up to eight valence electrons. These electrons exist in the outermost region of the electron cloud, often called the "valence shell."

The most stable atoms have eight valence electrons. When an atom has eight valence electrons, it is said to have a complete *octet*. Atoms will gain or lose electrons in order to complete their octet. In the process of gaining or losing electrons, atoms will form chemical bonds with other atoms. One method we use to show an atom's valence state is called a *dot diagram,* and you will be able to practice drawing these in the following exercise.

What is a dot diagram?

Dot diagrams are composed of two parts—the chemical symbol for the element and the dots surrounding the chemical symbol. Each dot represents one valence electron.

- If an element, such as oxygen (O), has six valence electrons, then six dots will surround the chemical symbol as shown to the right.

- Boron (B) has three valence electrons, so three dots surround the chemical symbol for boron as shown to the right.

There can be up to eight dots around a symbol, depending on the number of valence electrons the atom has. The first four dots are single, and then as more dots are added, they fill in as pairs.

PRACTICE

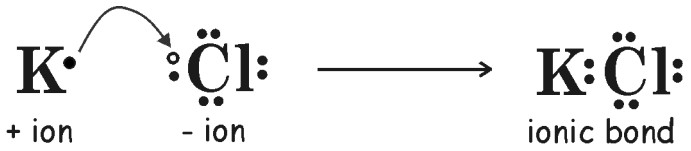
Using a periodic table, complete the following chart. With this information, draw a dot diagram for each element in the chart. Remember, only the valence electrons are represented in the diagram, not the total number of electrons.

Element	Chemical symbol	Total number of electrons	Number of valence electrons	Dot diagram
Potassium	K			
Nitrogen	N			
Carbon	C			
Beryllium	Be			
Neon	Ne			
Sulfur	S			

READ

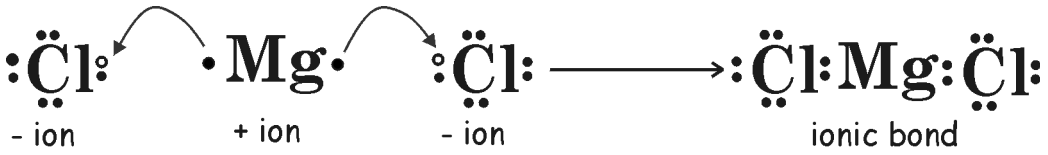
Using dot diagrams to represent chemical reactivity

Once you have a dot diagram for an element, you can predict how an atom will achieve a full valence shell. For instance, it is easy to see that chlorine has one empty space in its valence shell. It is likely that chlorine will try to gain one electron to fill this empty space rather than lose the remaining seven. However, potassium has a single dot or electron in its dot diagram. This diagram shows how much easier it is to lose this lone electron than to find seven to fill the seven empty spaces. When the potassium loses its electron, it becomes *positively* charged. When chlorine gains the electron, it becomes *negatively* charged. Opposite charges attract, and this attraction draws the atoms together to form what is termed an **ionic bond**, a bond between two charged atoms or ions.



Because chlorine needs one electron, and potassium needs to lose one electron, these two elements can achieve a complete set of eight valence electrons by forming a chemical bond. We can use dot diagrams to represent the chemical bond between chlorine and potassium as shown above.

For magnesium and chlorine, however, the situation is a bit different. By examining the electron or Lewis dot diagrams for these atoms, we see why magnesium requires two atoms of chlorine to produce the compound, magnesium chloride, when these two elements chemically combine.



Magnesium can easily donate one of its valence electrons to the chlorine to fill chlorine's valence shell, but this still leaves magnesium unstable; it still has one lone electron in its valence shell. However, if it donates that electron to another chlorine atom, the second chlorine atom has a full shell, and now so does the magnesium.

The chemical formula for potassium chloride is KCl. This means that one unit of the compound is made of one potassium atom and one chlorine atom.

The formula for magnesium chloride is $MgCl_2$. This means that one unit of the compound is made of one magnesium atom and two chlorine atoms.

PRACTICE

Now try using dot diagrams to predict chemical formulas. Fill in the table below:

Elements	Dot diagram for each element	Dot diagram for compound formed	Chemical formula
Na and F			
Br and Br			
Mg and O			