

Ions and Ionic Bonding

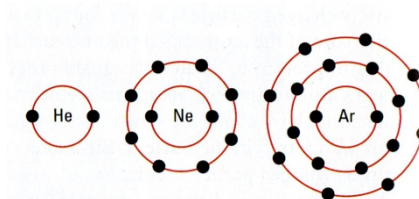
What are ionic compounds and how do they form?

Noble Gases

For the noble gases, the outer shells (energy levels) are full. Helium has 2 electrons in its outer shell, the most it can hold. Neon and argon have 8 electrons in their outer shells, the most that they can hold.

The noble gases are "stable."

They do not react with other elements to form compounds.



Sodium

When elements form compounds, the way in which electrons are arranged around the element change.

For example, let's start with sodium.

This atom has 11 electrons.

The outer shell has 1 electron.

This atom is not stable.

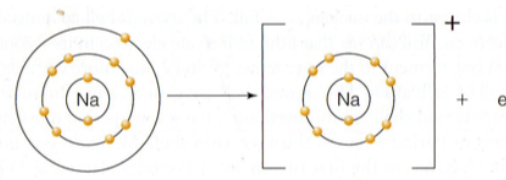


Sodium Atom and Ion

If sodium gave away 1 electron, then it would be stable.

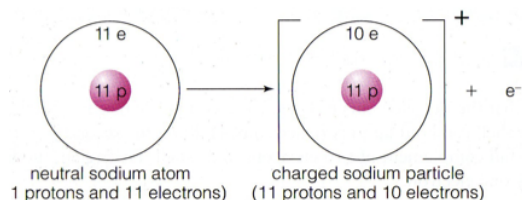
When sodium gives away one electron, it has 8 electrons left in its outer shell.

Now it resembles neon with 8 electrons in the outer shell.



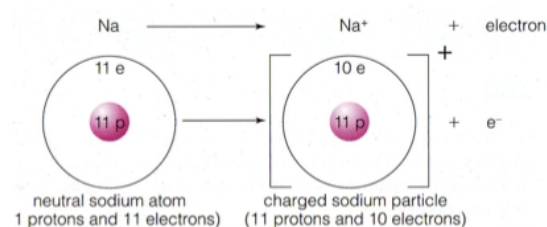
When it was neutral, sodium had 11 electrons and 11 protons. When it gives away 1 electron, it has only 10 electrons.

With 11 protons (+11) and 10 electrons (-10), the sum $+11 + -10 = +1$.



Now sodium is not neutral. It has a net charge of +1. It is now a positive ion.

Ions are atoms (or groups of atoms) that carry a charge. All positive ions are called **cations**. The symbol for the sodium ion is Na^+ .



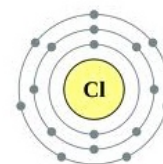
Chlorine

Now let's look at chlorine.

This atom has 17 electrons.

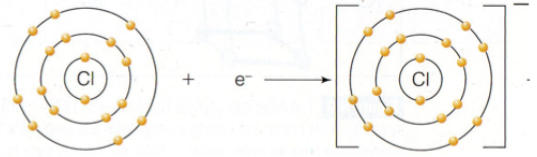
The outer shell has 7 electrons.

This atom is not stable.

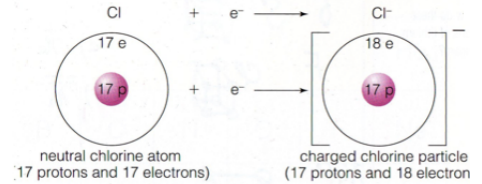


Chlorine Atom and Ion

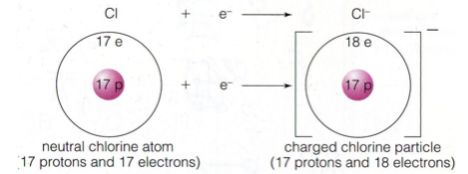
If chlorine gained 1 electron, then it would be stable. When chlorine gains one electron, it has 8 electrons in its outer shell. Now it resembles neon with 8 electrons in the outer shell.



When it was neutral, chlorine had 17 electrons and 17 protons. When it gains 1 electron, it has 18 electrons. With 17 protons (+17) and 18 electrons (-18), the sum $+17 + -18 = -1$.



Now chlorine is not neutral. It has a net charge of -1 . It is now a negative ion. The symbol for the chloride ion is Cl^- .

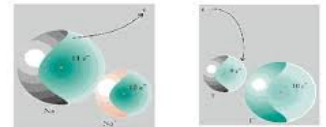


Cations and Anions

Sodium because a positive ion because it gave away electrons. All positive ions are called **cations**.

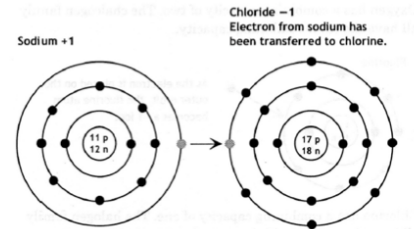
Chlorine because a negative ion because it gained electrons. All negative ions are called **anions**.

Cations and Anions



Sodium +1 and Chloride -1

The sodium ion and the chloride ion have a perfect relationship. The electron that sodium gives away is accepted by chlorine.



Bohr Model for Formation of LiCl

In your practice questions, you will be asked to use Bohr models to illustrate the formation of compounds from their ions. Here is another example of how to do this.

- Use Bohr model diagrams to illustrate the compounds formed from the following ions.

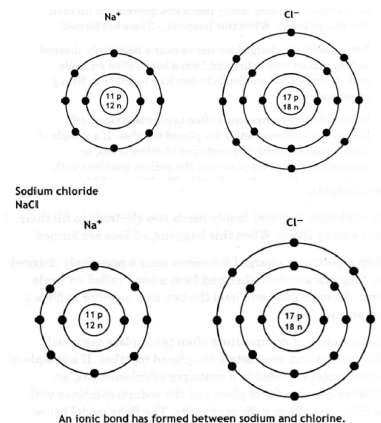
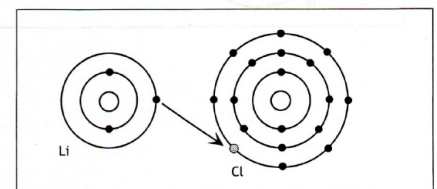
a) Li^{+1} and Cl^{-1}

Ionic Bond

When the positively charged sodium ion is near the negatively charged chloride ion, they attract each other. They form a bond called an **ionic bond**.

Sodium Chloride

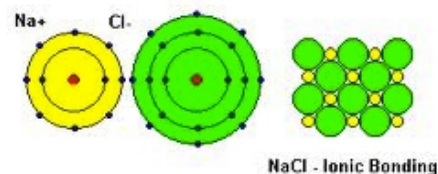
The ionic bond holds the two ions together to form a **compound**.



An ionic bond has formed between sodium and chlorine.

Ionic Compound

Sodium chloride is an example of an **ionic compound**. This is a compound formed from positive and negative ions that have resulted in a transfer of electrons from a metal (like sodium) to a nonmetal (like chlorine).



Formula Unit

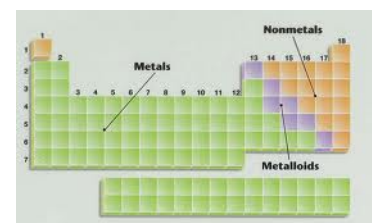
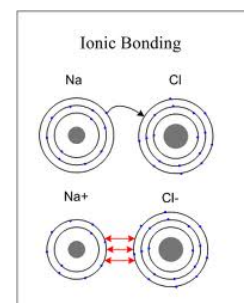
One particle of sodium chloride is not called a molecule (more on this later). It is called a **formula unit**. All ionic compounds are referred to as formula units.

Metals

Sodium is an example of a metal (left of the staircase on the periodic table). Metals give away electrons and become cations. Metals have three or fewer electrons in the outer energy level.

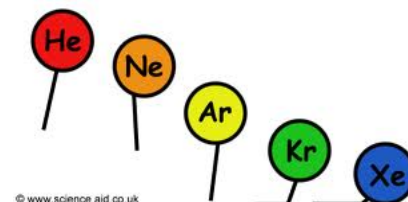
Non-Metals

Chlorine is an example of a non-metal (right of the staircase). Non-metals accept electrons and become anions. Non-metals have five or more electrons in the outer energy level.



Metalloids

Some elements have properties that are like metals and non-metals. These elements are called metalloids. Examples are silicon (Si) and germanium (Ge).



Nearest Noble Gas

Whenever elements gain or receive electrons, they do so to have a valence energy level closest to the nearest noble gas neighbour. Na^+ with $10 e^-$ resembles Ne. Cl^- with $18 e^-$ resembles Ar.

Checklist

1. Define the terms "ion" "cation" "anion" "ionic compound" "formula unit".
2. Explain what is meant by a stable atom.
3. Explain how atoms become stable when they donate or receive electrons.
4. Explain how positive and negative ions are formed and what the resulting charge is for the ion.
5. Explain how **ionic bonds** are formed.
6. Draw a Bohr diagram for an atom and an ion.
7. State the electrical charge formed for ions of a particular family on the periodic table.
8. Draw a Bohr diagram for the formation of an ionic compound.
9. Explain how metals, nonmetals, and metalloids behave in terms of donating or accepting electrons.