

## 5.1.1: Ions

### Learning Objectives

- Describe how an ion is formed.
- Distinguish the difference between the two types of ions.

### Ions

As introduced previously, atoms contain a nucleus with neutrons and positively charged protons, surrounded by negatively charged electrons. In an atom, the total number of electrons, negative charge, *equals* the total number of protons, positive charge, and therefore, atoms are electrically neutral or uncharged. If an atom loses or gains electrons, it will become a positively or negatively charged particle, called an **ion**. The *loss* of one or more electrons results in more protons than electrons and an overall positively charged ion, called a **cation**. For example, a sodium atom with one less electron is a cation,  $\text{Na}^+$ , with a +1 charge (Figure 5.1.1.1).

Figure 5.1.1.1: A sodium atom (Na) has equal numbers of protons and electrons (11) and is uncharged. When it loses an electron, the resulting sodium cation has one more proton (11) than electrons (10), giving it an overall positive one charge,  $\text{Na}^+$ .

When an atom *gains* one or more electrons, it becomes a negatively charged **anion**, because there are more electrons than protons. When chlorine gains one electron it forms a chloride ion,  $\text{Cl}^-$ , with a -1 charge (Figures 5.1.1.2)

The names for positive and negative ions are pronounced CAT-eye-ons (cations) and ANN-eye-ons (anions), respectively.

Figure 5.1.1.2: A chlorine atom (Cl) has equal numbers of protons and electrons (17) and is uncharged. When it gains an electron, the resulting chlorine anion has one more electron (18) than protons (17), giving it an overall negative one charge,  $\text{Cl}^-$ .

### Note Naming Ions

Cations are named using the element name plus "*ion*" to indicate it is charged. Anions are named by changing the element name ending to "*ide*". For example, a magnesium ion is formed when neutral magnesium loses electrons and a *fluoride* ion is formed when neutral fluorine gains electrons.

### ✓ Example 5.1.1.1

A calcium (Ca) atom loses two electrons and a sulfur (S) atom gains two electrons. Determine if the resulting ions are cations or anions? Write the ion symbols for each.

#### Solution

When calcium ( $Z = 20$ ) gains two electrons the resulting ion will have 18 electrons and 20 protons and therefore a charge of +2 (there are two more positive protons than negative electrons), it is a cation. The symbol for a calcium ion is  $\text{Ca}^{2+}$ .

When sulfur ( $Z = 16$ ) gains two electrons the resulting ion will have 18 electrons and 16 protons and therefore a charge of -2 (there are two more negative electrons than positive protons), it is an anion. The symbol for a sulfide ion is  $\text{S}^{2-}$ .

### Key Takeaways

- Ions are formed when atoms gain or lose electrons.
- Ions can be positively charged (cations) or negatively charged (anions).

### Contributors

- Lisa Sharpe Elles, University of Kansas

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