

## How Atoms Combine

### WORD BANK

|        |      |          |           |          |      |
|--------|------|----------|-----------|----------|------|
| gained | lose | positive | non-metal | negative | lose |
| equals | zero | positive | gain      | metals   | gain |

Remember that electrons have a \_\_\_\_\_ charge and protons have a \_\_\_\_\_ charge.

In a normal atom, the number of electrons \_\_\_\_\_ the number of protons, so there is \_\_\_\_\_ charge.

If electrons are lost, the charge on the atom will become \_\_\_\_\_.

If electrons are \_\_\_\_\_, the charge on the atom will become negative.

Atoms become more stable if they have a full outer shell of electrons.

Atoms of groups I, II and III and of V, VI and VII tend to react by gaining or losing electrons until they are like the closest element in Group VIII. Group VIII elements have 8 outer orbit electrons (except for helium since the first orbit only holds 2 electrons).

The elements of groups I, II and III \_\_\_\_\_ electrons.

These elements are called \_\_\_\_\_.

**Metals tend to \_\_\_\_\_ electrons.**

The elements of groups V, VI and VII \_\_\_\_\_ electrons.

These elements are called \_\_\_\_\_.

**Non-metals tend to \_\_\_\_\_ electrons.**

**Atoms that have gained or lost electrons so that they are positively or negatively charged are called ions.**

Examples:

$\text{Na} \rightarrow \text{Na}^{+1} + 1\text{e}^{-}$  Sodium, a metal, loses one electron to form a +1 ion.

$\text{S} + 2\text{e}^{-} \rightarrow \text{S}^{-2}$  Sulphur, a non-metal, gains two electrons to form a -2 ion.

Notice that adding two negative electrons to S is like adding -2 to zero.  $0 + (-2) = -2$

Taking a negative electron away from Na is like subtracting -1 from zero.  $0 - (-1) = +1$

## The Rule of Eight (The Octet Rule)

Many metal atoms **lose** their outer orbit electrons and non-metal atoms **gain** outer orbit electrons until they have **eight** like a Group VIII element (or two if they are close to helium). Complete the table below.

| Element | Group | Metal or Non-metal | Gains or Loses Electrons? | # of outer orbit electrons | # of e <sup>-</sup> s gained or lost | Ion formed and its charge |
|---------|-------|--------------------|---------------------------|----------------------------|--------------------------------------|---------------------------|
| Li      | I     | metal              | loses                     | 1                          | 1                                    | Li <sup>+</sup>           |
| Be      |       |                    |                           |                            |                                      |                           |
| B       |       |                    |                           |                            |                                      |                           |
| N       | V     | non-metal          | gains                     | 5                          | 3                                    | N <sup>3-</sup>           |
| O       |       |                    |                           |                            |                                      |                           |
| F       |       |                    |                           |                            |                                      |                           |
| Na      |       |                    |                           |                            |                                      |                           |
| Mg      |       |                    |                           |                            |                                      |                           |
| Al      |       |                    |                           |                            |                                      |                           |
| P       |       |                    |                           |                            |                                      |                           |
| S       |       |                    |                           |                            |                                      |                           |
| Cl      |       |                    |                           |                            |                                      |                           |
| K       |       |                    |                           |                            |                                      |                           |
| Ca      |       |                    |                           |                            |                                      |                           |

## Ionic Compounds

Positive metal ions attract negative non-metal ions. They join to form neutral ionic compounds.

The total positive and negative charges **must cancel out** to have a neutral formula.

To name the compound, name the metal element first and the non-metal second with the ending of the non-metal changed to **ide**.

Complete the charts following the examples in the first two rows.

| Elements |                  |    |                  | Chemical Formula | Ionic Compound Name |
|----------|------------------|----|------------------|------------------|---------------------|
|          | Ionic Charge     |    | Ionic Charge     |                  |                     |
| Na       | Na <sup>+1</sup> | F  | F <sup>-1</sup>  | NaF              | sodium fluoride     |
| Mg       | Mg <sup>+2</sup> | O  | O <sup>-2</sup>  | MgO              | magnesium oxide     |
| Na       | Na <sup>+1</sup> | Cl | Cl <sup>-1</sup> |                  | sodium _____ide     |
| Li       | Li <sup>+1</sup> | F  | F <sup>-1</sup>  |                  |                     |
| Al       | Al <sup>+3</sup> | P  | P <sup>-3</sup>  |                  |                     |
| Ca       | Ca <sup>+2</sup> | S  | S <sup>-2</sup>  |                  |                     |
| Li       |                  | Cl |                  |                  |                     |
| Ca       |                  | O  |                  |                  |                     |

Oppositely charged ions can also react even if the size of the charges are not the same.



Since each fluoride ion has a charge of only -1 while the magnesium is +2, two fluoride atoms are needed for each one magnesium atom.

When writing the chemical formula, the number of atoms is written as a subscript.

Complete the following and name the compounds formed. Follow the examples above. Fill all blanks.

| Ions                                  | Chemical Formula      | Ionic Compound Name |
|---------------------------------------|-----------------------|---------------------|
| $\text{Mg}^{+2} + 2\text{F}^{-}$      | $\text{MgF}_2$        | magnesium fluoride  |
| $2\text{Na}^{+1} + \text{S}^{-2}$     | $\text{Na}_2\text{S}$ | sodium sulfide      |
| $\text{Ca}^{+2} + 2\text{F}^{-1}$     |                       |                     |
|                                       |                       |                     |
| $\text{Mg}^{+2} + \_\_\text{F}^{-1}$  |                       |                     |
| $\_\_\text{Na}^{+1} + \text{O}^{-2}$  |                       |                     |
| $\text{Be}^{+2} + \_\_\text{Cl}^{-1}$ |                       |                     |
| $\text{Ca}^{+2} + \text{O}^{-2}$      |                       |                     |
| $\text{Al}^{+3} + \_\_\text{Cl}^{-1}$ |                       |                     |
| $\_\_\text{Na}^{+1} + \text{N}^{-3}$  |                       |                     |
| $\text{B}^{+3} + \_\_\text{Br}^{-1}$  |                       |                     |
|                                       |                       |                     |

**Extra Challenge**

Use the format above to name and show the formation of an ionic compound from ions of:

- aluminum and oxygen
- calcium and nitrogen
- $\text{Fe}^{+3}$  and oxygen
- $\text{Sn}^{+4}$  and fluorine