ChemQuest 25

Advanced

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ionic Bonding

Hour: \_\_\_\_\_

# **Information**: Polyatomic Ions

The word, “polyatomic” means “many atoms”. A polyatomic ion, therefore, is an ion that is made of more than one atom. An example of a polyatomic ion is the sulfate ion, SO42-. Sulfate is composed of one sulfur atom and four oxygen atoms and overall sulfate has a negative two charge.

Some polyatomic ions are listed below.

 Many polyatomic ions end in “-ate”:

 Acetate: C2H3O2-1

Carbonate: CO32-

Chlorate: ClO3-1

Nitrate: NO3-1

Phosphate: PO43-

Sulfate: SO42-

 Some other polyatomic ions:

 Ammonium: NH4+1

Cyanide: CN-1

Hydroxide: OH-1

# **Critical Thinking Questions**

1. What do all of the polyatomic ions that have the suffix “-ate” have in common? (ie, What atom exists in all of the polyatomic ions that end in “-ate”?)
2. Which two atoms do you think compose the polyatomic ion called “silicate”?
3. What is the difference between calcium nitride and calcium nitrate?

# **Information**: Writing Formulas With Polyatomic Ions

First of all, you must remember that you can never change the formula for a polyatomic ion. Sulfate is always SO42- and never S2O84- or something else. Following are some examples of chemical formulas that contain polyatomic ions.

Sodium sulfate, Na2SO4:



Magnesium nitrate, Mg(NO3)2:



Consider calcium hydroxide. Calcium has a positive two charge (Ca2+) and hydroxide has a negative one charge (OH-). We need two hydroxide ions to combine with one calcium ion so that the overall charge ends up being zero. We write calcium hydroxide like Ca(OH)2.

Following are some more examples:

 potassium acetate: KC2H3O2 magnesium nitrate: Mg(NO3)2

barium phosphate: Ba3(PO4)2 calcium carbonate: CaCO3

# **Critical Thinking Questions**

1. In the expression Mg(CN)2, there is one magnesium atom, two carbon atoms, and \_\_\_\_\_\_ nitrogen atoms. how many?
2. In the expression MgCN2, there is \_\_\_\_\_\_ magnesium atom, \_\_\_\_\_ carbon atom, and \_\_\_\_\_ nitrogen atoms? how many? how many? how many?
3. As mentioned above, calcium hydroxide is written like Ca(OH)2. Why can’t it be written like CaOH2?
4. As mentioned above, magnesium nitrate is written as Mg(NO3)2. Why can’t it be written like MgNO32?
5. Name the following compounds. Each includes at least one polyatomic ion.

a) Na3PO4 b) (NH4)2SO4 c) Mg(C2H3O2)2

 d) (NH4)2S e) CaCO3 f) Ba(NO3)2

1. Write formulas for the following ionic compounds. Note that each includes a polyatomic ion.

a) lithium phosphate b) ammonium oxide c) barium hydroxide

 d) calcium cyanide e) sodium chlorate f) potassium sulfate

1. In question 3, you were asked the difference between calcium nitride and calcium nitrate. Now write the formula for each of them.

calcium nitride: calcium nitrate:

**Information**: Formulas for Acids

Acids are compounds that contain positive hydrogen ions (H+) bonded to a negative ion. For example, carbonic acid is formed when the carbonate ion (CO32-) bonds with two hydrogen ions (H+) to give H2CO3. Other common acids are listed below:

 Hydrochloric acid: HCl

 Sulfuric acid: H2SO4

 Nitric Acid: HNO3

 Acetic Acid: HC2H3O2

# **Critical Thinking Questions**

1. Why do carbonic and sulfuric acid require two H+ ions to bond, but HCl and HNO3 only have one H+?
2. Phosphoric acid is made from the phosphate ion and H+ ions. Write the formula for phosphoric acid.