

Ionic Bonding Advanced

Name: _____

Date: _____

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, SO_4^{2-} . Sulfate is composed of one sulfur atom and four oxygen atoms and overall sulfate has a negative two charge.

Some polyatomic ions:

Sulfate: SO_4^{2-} Phosphate: PO_4^{3-} Nitrate: NO_3^- Cyanide: CN^- Ammonium: NH_4^+ Chlorate: ClO_3^- Acetate: $\text{C}_2\text{H}_3\text{O}_2^-$ Hydroxide: OH^- Carbonate: CO_3^{2-}

Critical Thinking Questions

1. What do all of the polyatomic ions that have the suffix “-ate” have in common?
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 SO_4^{2-} and never $\text{S}_2\text{O}_8^{4-}$ or something else. Following are some examples of chemical formulas that contain polyatomic ions.

Ammonium chloride is formed from one ammonium ion (NH_4^+) and one chloride ion (Cl^-) to give the formula: NH_4Cl . Sodium sulfate requires two sodium ions (Na^+) because sulfate (SO_4^{2-}) has a negative two charge; the formula is: Na_2SO_4 .

Consider calcium hydroxide. Calcium has a positive two charge (Ca^{2+}) 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 $\text{Ca}(\text{OH})_2$.

Following are some more examples:

potassium acetate: $\text{KC}_2\text{H}_3\text{O}_2$ magnesium nitrate: $\text{Mg}(\text{NO}_3)_2$

barium phosphate: $\text{Ba}_3(\text{PO}_4)_2$

calcium carbonate: CaCO_3

Critical Thinking Questions

- As mentioned above, calcium hydroxide is written like $\text{Ca}(\text{OH})_2$. Why can't it be written like CaOH_2 ?
- As mentioned above, barium phosphate is written as $\text{Ba}_3(\text{PO}_4)_2$. Why can't it be written like Ba_3PO_4 ?
- Name the following compounds. Each includes at least one polyatomic ion.
 - Na_3PO_4
 - $(\text{NH}_4)_2\text{SO}_4$
 - $\text{Mg}(\text{C}_2\text{H}_3\text{O}_2)_2$
 - $(\text{NH}_4)_2\text{S}$
 - CaCO_3
 - $\text{Ba}(\text{NO}_3)_2$
- Write formulas for the following ionic compounds. Note that each includes a polyatomic ion.
 - lithium phosphate
 - ammonium oxide
 - barium hydroxide
 - calcium cyanide
 - sodium chlorate
 - potassium sulfate
- 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 (CO_3^{2-}) bonds with two hydrogen ions (H^+) to give H_2CO_3 .

Other common acids are listed below:

Hydrochloric acid: HCl

Sulfuric acid: H_2SO_4

Nitric Acid: HNO_3

Acetic Acid: $\text{HC}_2\text{H}_3\text{O}_2$

Critical Thinking Questions

- Why do carbonic and sulfuric acid require two H^+ ions to bond, but HCl and HNO_3 only have one H^+ ?
- Phosphoric acid is made from the phosphate ion and H^+ ions. Write the formula for phosphoric acid.