

## WRITING AN IONIC FORMULA

- if you know the ions that make up a compound, all you need to do is find the smallest ratio of cation to anion the compound needs to have an overall charge of zero

Example:



← more - than +, so add more  $Mg^{2+}$ !



← more + than -, so add  $P^{3-}$

← more - than +, so add  $Mg^{2+}$

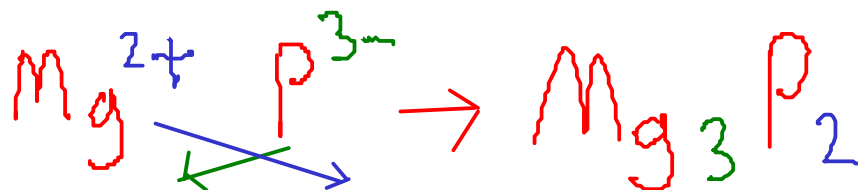


In the final formula, don't write the charges on the ions!

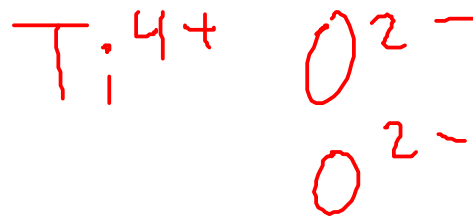
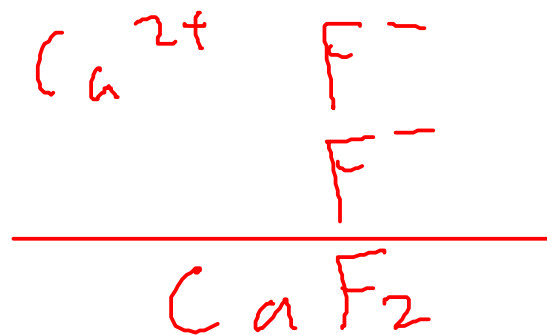
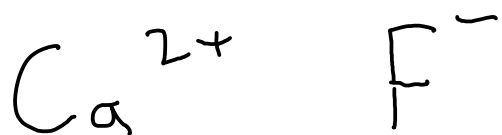
\* Remember, ionic compounds are written with the SMALLEST whole-number ratio!

Ionic formulas are ALWAYS written with the cation first, and the anion second!

Cross method:



More examples:



You can also use the "cross method", as described in your textbook, to write formulas. Use caution, as the "cross method" will sometimes give you the wrong formula! It would give you the wrong answer for this one!

## PREDICTING CHARGES

- how do you figure out the charge that an element might take when it becomes an ion?
- for many main group elements, you can predict the charge using the periodic table!

IA												VIII A					He
H	IIA											III A	IVA	VA	VIA	VIIA	Ne
Li	Be											B	C	N	O	F	Ar
Na	Mg	IIIB	IVB	VB	VIB	VII B	VIII B		IB	IIB	Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	* "inner" transition metals go here								

Elements in group VIII A - the "noble gases" - do not form ions!

Many OTHER main-group elements form either anions or cations that have the same overall number of electrons as the NEAREST (in terms of atomic number) noble gas!

## PREDICTING CHARGE

IA												VIII A					
H	IIA											III A	IV A	V A	VIA	VII A	He
Li	Be											B	C	N	O	F	Ne
Na	Mg	IIIB	IVB	VB	VIB	VII B	VIII B	IB	IIB	Al	Si	P	S	Cl	Ar		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	*inner transition metals go here								

You can reliably determine the charge using our method for Groups IA, IIA, IIIB, Aluminum, and the Group VA, VIA, and VIIA NONMETALS

Aluminum (Al): At atomic number 13, it is three electrons away from neon (Ne), and 5 electrons away from argon (Ar). Prediction: Aluminum will lose three electrons to form the cation  $\text{Al}^{3+}$

Bromine (Br): At atomic number 35, bromine is one electron away from krypton (Kr). Prediction: Bromine will gain one electron to form the anion  $\text{Br}^-$

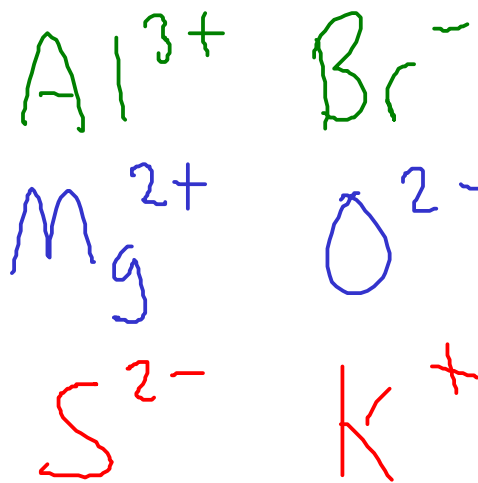
Strontium (Sr): At atomic number 38, strontium is two electrons away from krypton. Prediction: Strontium will lose two electrons to form the cation  $\text{Sr}^{2+}$

## EXAMPLES

IA		EXAMPLES										VIII A						
IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA											
H	Li	Be											B	C	N	O	F	Ne
Na	Mg												Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	*"inner" transition metals go here									

Find the formulas of:

- (1) an ionic compound containing Al and Br
- (2) an ionic compound containing Mg and O
- (3) an ionic compound containing S and K



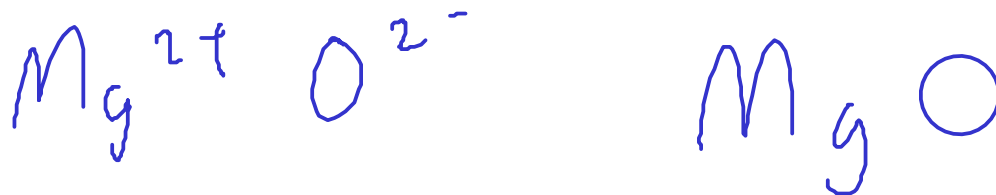
Find the formula of:

\* an ionic compound containing Al and Br



Find the formula of:

\* an ionic compound containing Mg and O



Find the formula of:

\* an ionic compound containing S and K



Remember ...

cations written first! ----->



## TRANSITION METAL IONS

IA		TRANSITION METAL IONS										VIII A					
I A	II A	III B	IV B	V B	VI B	VII B	VIII B	IB	IIB	III A	IV A	V A	VI A	VII A	He		
H	Li														He		
	Be																
	Mg																
Na	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	*"inner" transition metals go here								

The transition metals always form CATIONS!

However, many transition metals are capable of forming SEVERAL DIFFERENT CATIONS!

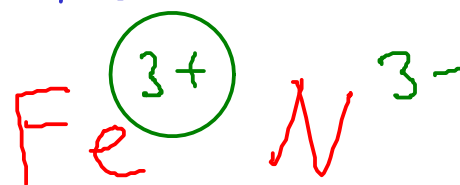
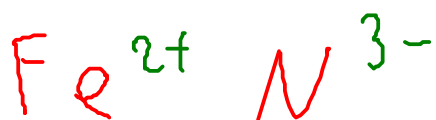
Example: Iron (Fe) forms two cations, depending on the situation:  $\text{Fe}^{2+}$  or  $\text{Fe}^{3+}$

## TRANSITION METAL CATIONS

- So how do you know which cation you're dealing with? For now, you'll have to be told

- Either the chemical formula of an ionic compound or the name of an ionic compound can tell you what charge is on the transition metal cation.

Examples:



\* We call this form of iron ion "iron(III)" ... pronounced "iron three". The compound above is called "iron(III) nitride" because it contains iron ions with a +3 charge!

\* We call this form of iron ion "iron(II)" ... pronounced "iron two". The compound above is called "iron(II) nitride" because it contains iron ions with a +2 charge!



## POLYATOMIC IONS

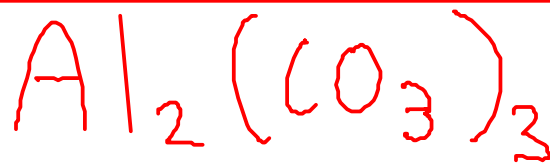
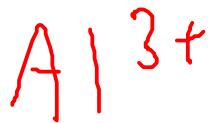
- Some MOLECULES can gain or lose electrons to form CATIONS or ANIONS. These are called POLYATOMIC IONS

- Polyatomic ions form ionic compounds in the same way that single-element ions do.

Example:  $\text{CO}_3^{2-}$  : CARBONATE ION

\* Compare  
to  
 $\text{Al}_2\text{O}_3$

from  
 $\text{Al}^{3+}$   $\text{O}^{2-}$



\* Use parenthesis when an ionic compound's formula contains more than one of a polyatomic ion.

See the web site or page 63 - table 2.5 (9th ed) or table 2.6 (10th ed) - for a list of common polyatomic ions!

## NAMES OF IONS

- To properly discuss ions and ionic compounds, we have to know how to name them!

### CATIONS

3 kinds:

① Main group cations (metals that take only one charge when forming ions)

- The element's name is the same as the ion's name!



② Transition metal cations (from metals that can form several cations)

- The CHARGE of the cation must be given. Use a ROMAN NUMERAL after the element name to indicate charge!



③ Polyatomic cations

- Memorize list.



## ANIONS

2 kinds

①

Main-group nonmetals

- Use the STEM NAME of the element, then add "-ide" suffix

 $\text{N}^{3-}$  : "nitride" ion $\text{P}^{3-}$  : "phosphide ion" $\text{S}^{2-}$  : sulfide ion $\text{O}^{2-}$  : "oxide ion" $\text{F}^{-}$  : "fluoride ion"

②

Polyatomic ions

- Memorize list.(see web site)

 $\text{C}_2\text{H}_3\text{O}_2^-$  : "acetate ion" $\text{SO}_4^{2-}$  : "sulfate ion" $\text{NO}_3^-$  : "nitrate ion" $\text{SO}_3^{2-}$  "sulfite ion" $\text{NO}_2^-$  : "nitrite ion"

\* Polyatomic ions ending in "-ate" and "-ite" suffixes always contain oxygen! "-ate" ions have more oxygen atoms than their "-ite" counterparts.

## NAMING IONIC COMPOUNDS

- The name of the compound is based on the name of the ions in the compound
- Cation first, anion second

Examples:



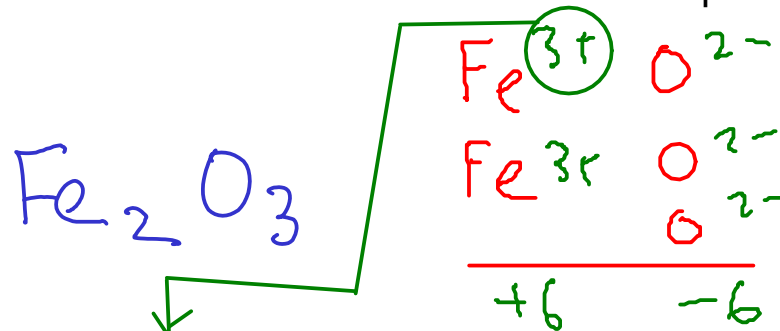
magnesium hydroxide



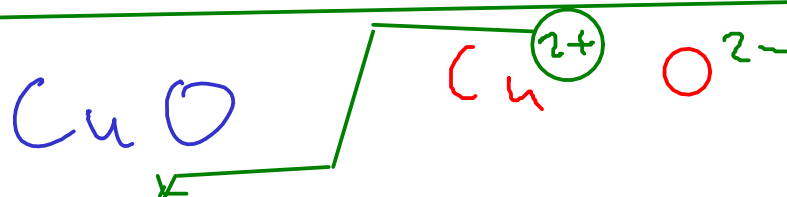
sodium sulfide



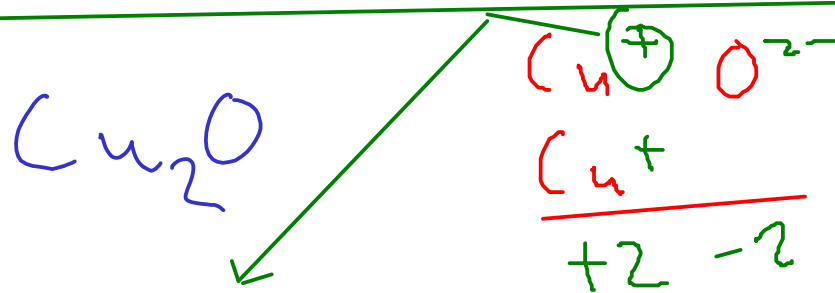
beryllium bromide



iron(III) oxide



copper(II) oxide



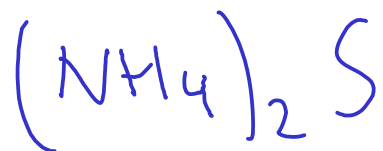
copper(I) oxide

\* Remember to include the Roman numeral for CHARGE when you're writing transition metal compound names!

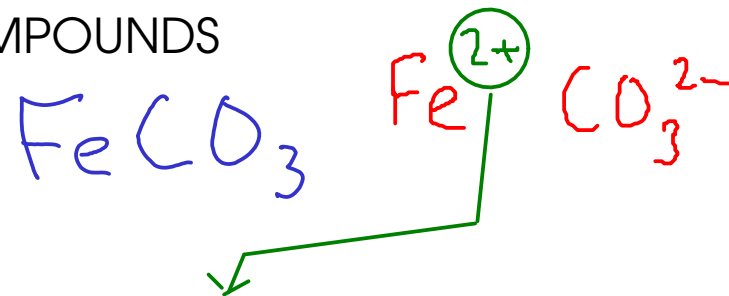
Page 63 (9th edition): Chart of polyatomic ions

Page 64 (10th edition)

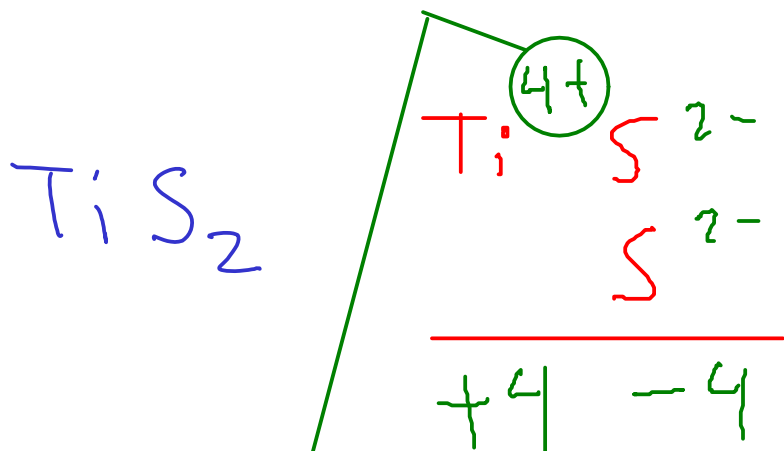
## NAMING IONIC COMPOUNDS



ammonium sulfide



iron(II) carbonate



titanium(IV) sulfide



barium phosphate

Spelling matters!



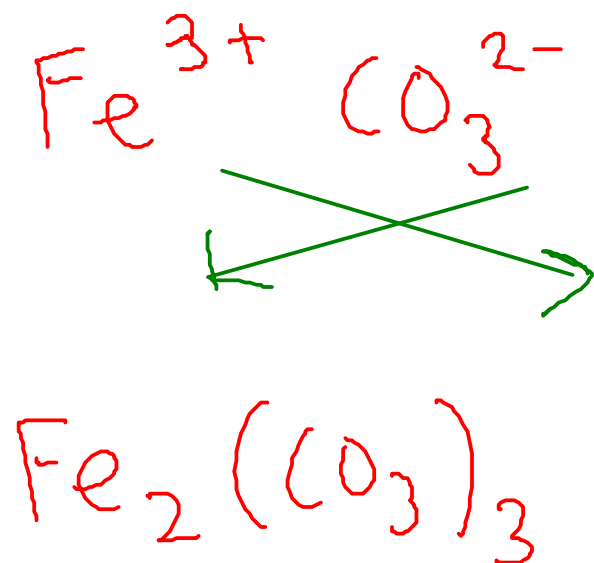
barium phosphide

## DETERMINING THE FORMULA OF AN IONIC COMPOUND FROM THE NAME

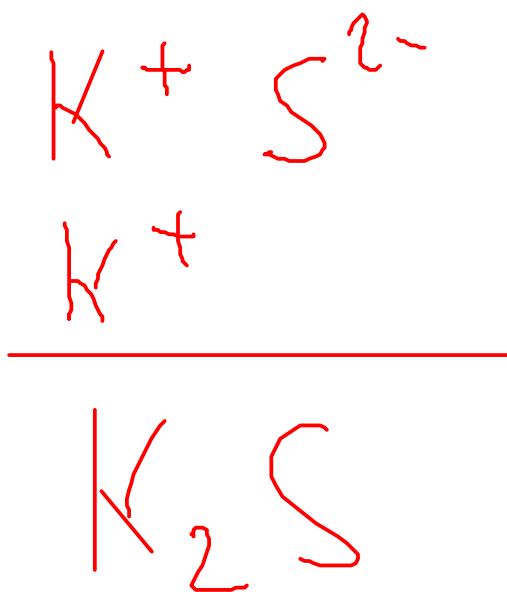
- The name of an ionic compound is made of the names of the CATION and ANION in the compound.
  - To get the FORMULA, you must figure out the SMALLEST RATIO of cation to anion that makes the charges balance out
- 

Examples:

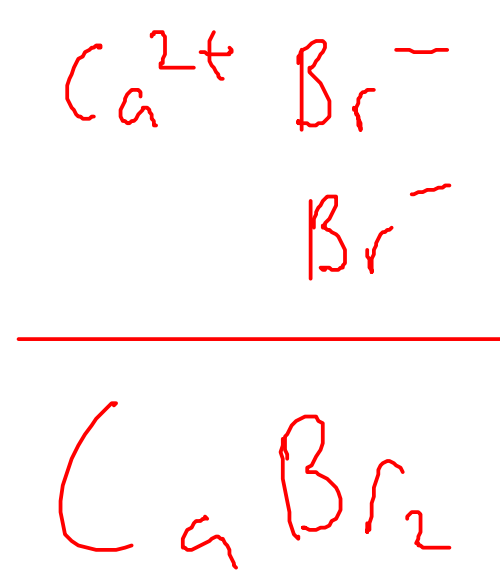
iron(III) carbonate



potassium sulfide

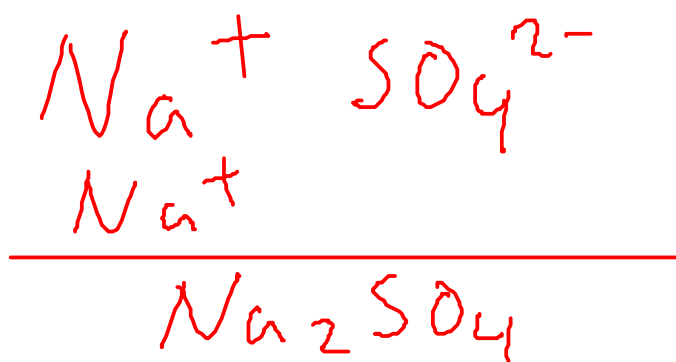


calcium bromide

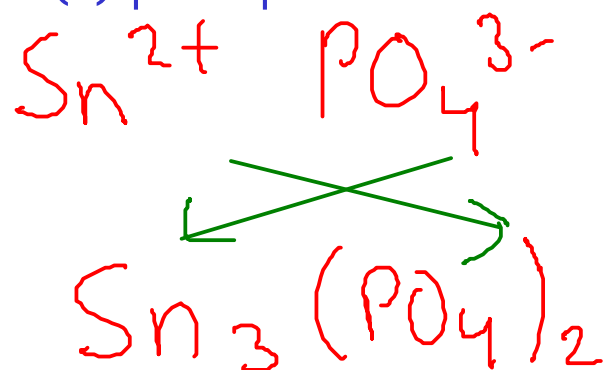


## DETERMINING IONIC FORMULAS

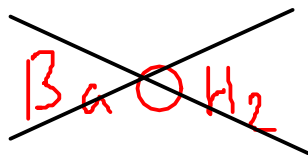
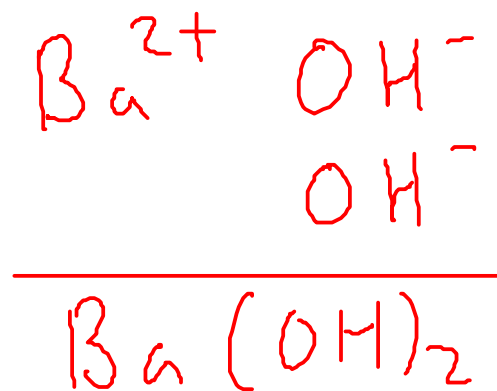
sodium sulfate



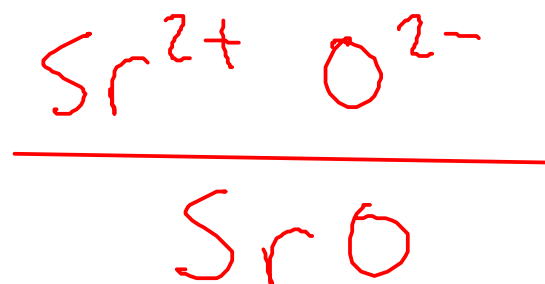
tin(II) phosphate



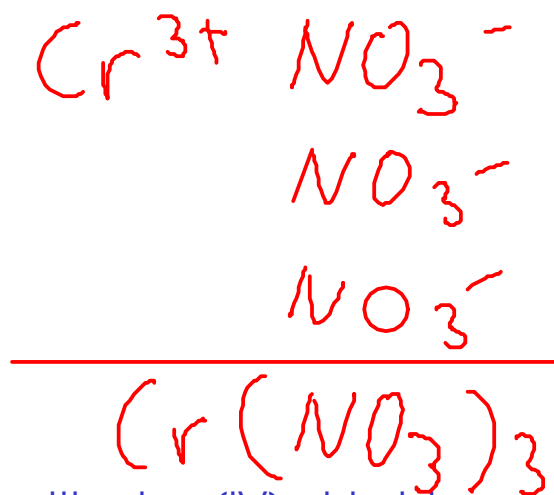
barium hydroxide



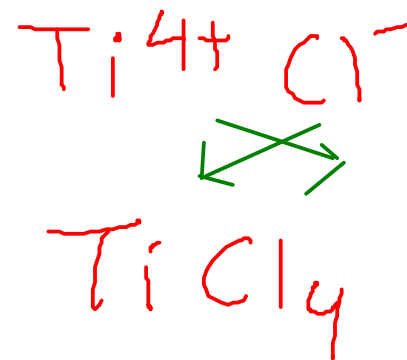
strontium oxide



chromium(III) nitrate



titanium(IV) chloride

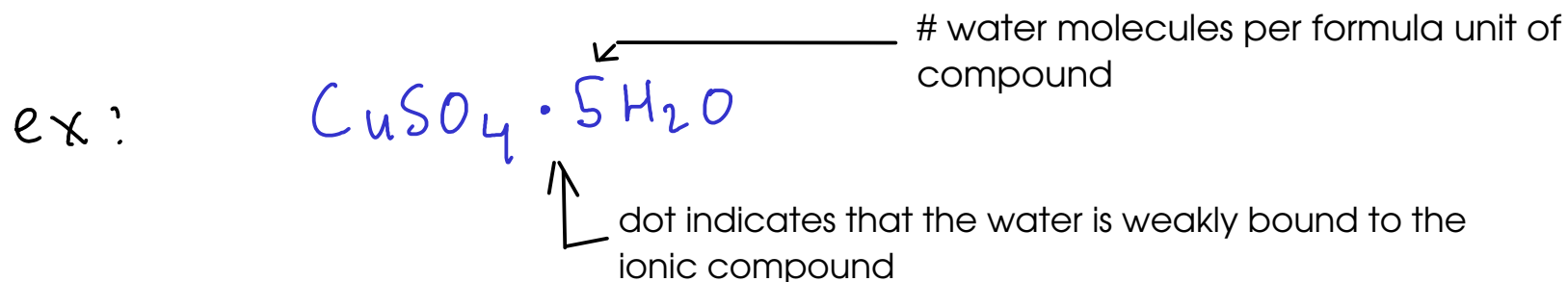


Don't forget parenthesis when writing multiple HYDROXIDE or CYANIDE (or hypochlorite) ions!

## HYDRATES

- many ionic compounds are formed by crystallizing the compound from water. Sometimes, this causes water molecules to become part of the crystal structure.

- This water is present in a definite ratio to the ions in the compound. Can be removed by heating, but will NOT evaporate if the compound is left standing.



- many DESSICANTS are hydrates that have had their water molecules driven off. They will slowly reabsorb water from the air (and keep the environment in a dessicator at a low humidity)

- Hydrates are named using the name of the ionic compound, and a Greek prefix in front of the word "hydrate" to indicate how many water molecules are associated

Copper (II) sulfate pentahydrate

