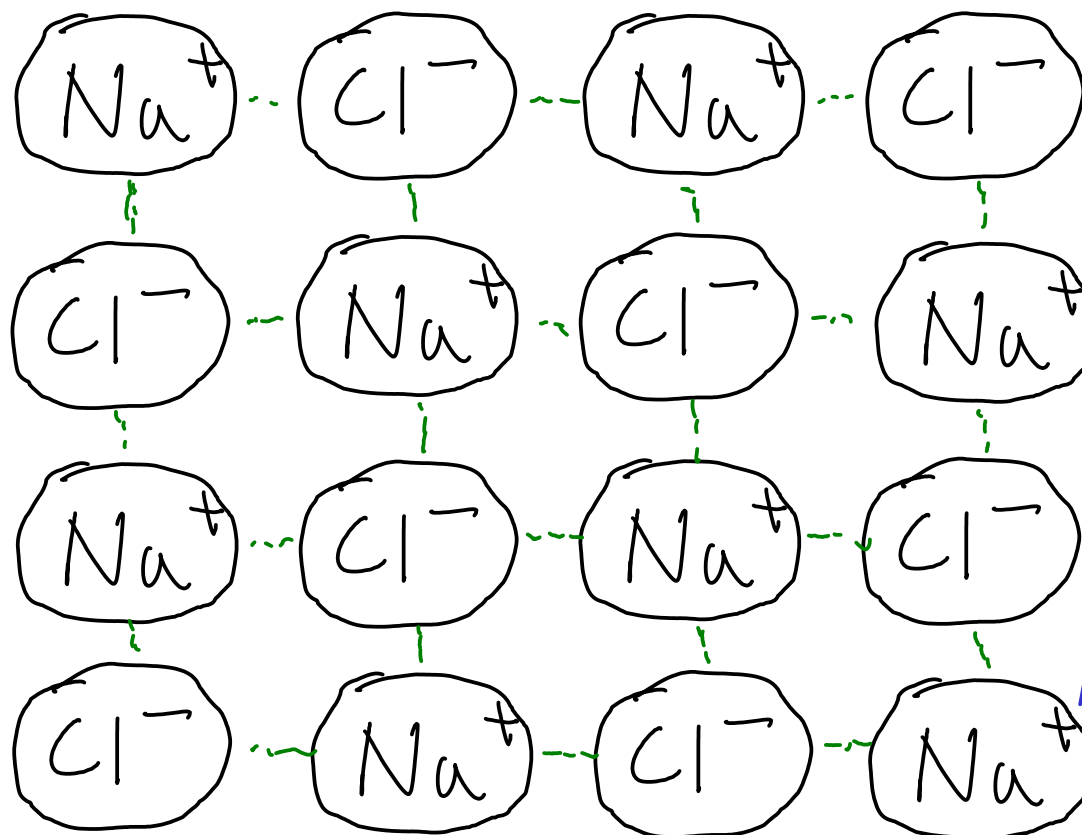


## IONIC COMPOUNDS

- ionic compounds are held together by ELECTROSTATIC INTERACTIONS

(in other words, the attraction between oppositely charged ions!)



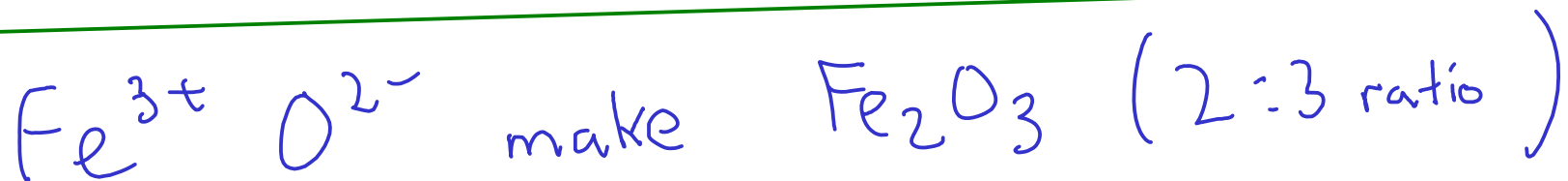
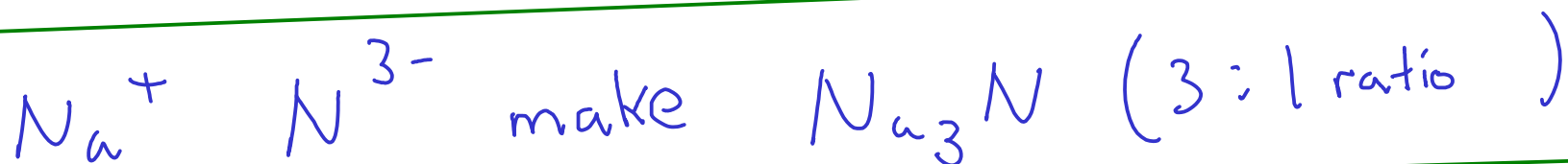
Each chloride ion is strongly attracted to ALL of the sodium ions surrounding it!

Each sodium ion is strongly attracted to ALL of the chlorine atoms surrounding it!

There are no "molecules" in ionic compounds - in the sense that you can't point to a discrete unit of atoms that are connected to only each other

IONIC FORMULAS

- since there are no "molecules", an ionic formula cannot describe how many and what kinds of atoms are in a molecule!
- all ionic compounds are observed to be (overall) electrically neutral, so the IONS they contain must be present in such a way that the charges BALANCE EACH OTHER
  - an ionic formula gives the SMALLEST WHOLE NUMBER RATIO OF CATION TO ANION in the ionic compound



## 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  $Mg^{2+}$

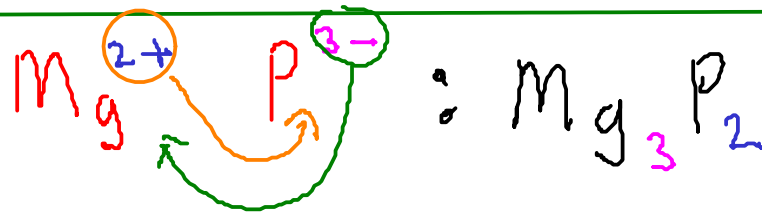


In the final formula, don't write the charges on the ions!

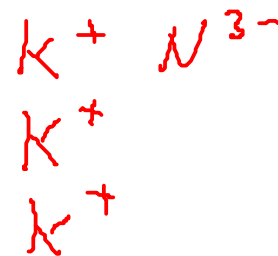
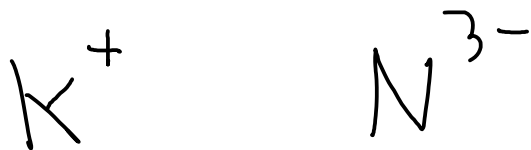
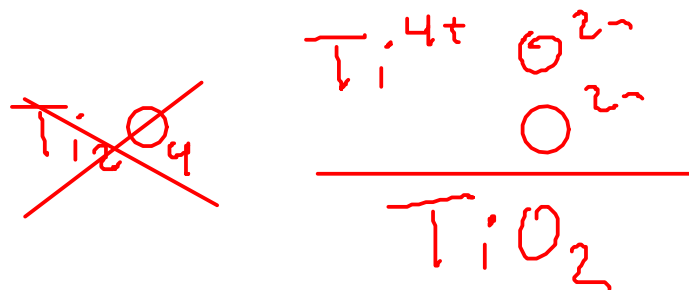
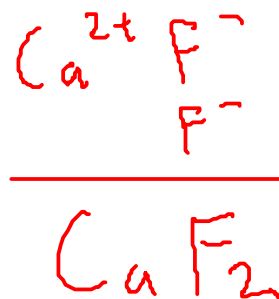
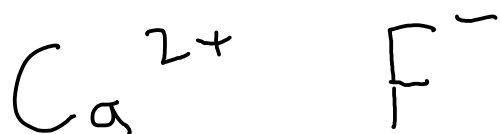
\* Remember, ionic compounds are written with the SMALLEST whole-number ratio!

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	III B	IV B	V B	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, III B, Aluminum, and the Group VA, VIA, and VII A 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  $\text{Br}^-$

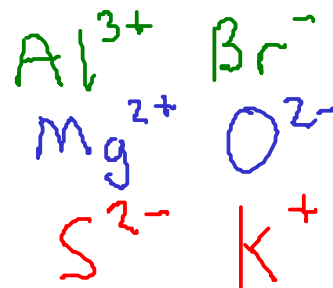
Strontium (Sr): At atomic number 38, strontium is two electrons away from krypton. Prediction: Strontium will lose two electrons to form the cation  $\text{Sr}^{2+}$

## EXAMPLES

IA		EXAMPLES										VIII A					
IA	IIA	III B	IV B	VB	VIB	VII B	VIII B	IB	IIB	III A	IV A	VA	VIA	VII A	VIII A		
H	Li	Be								B	C	N	O	F	He		
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								

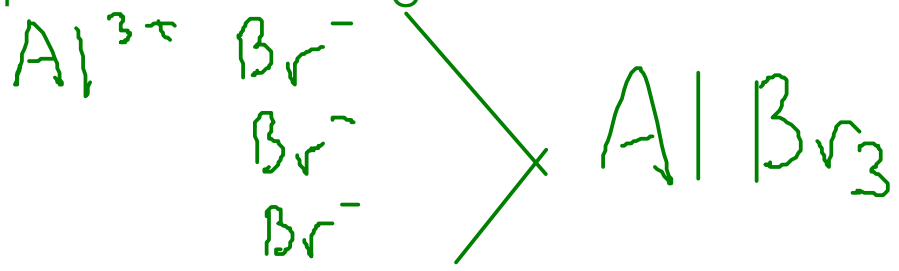
Find the formulas of:

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



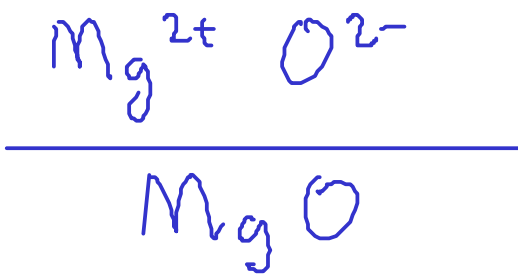
Find the formula of:

\* an ionic compound containing Al and Br



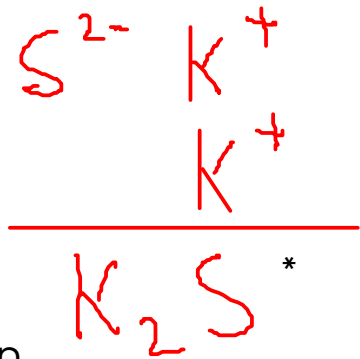
Find the formula of:

\* an ionic compound containing Mg and O



Find the formula of:

\* an ionic compound containing S and K



\* Remember: Write the cation first in ionic formulas!





## TRANSITION METAL IONS

IA		TRANSITION METAL IONS										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								

The transition metals always form CATIONS!

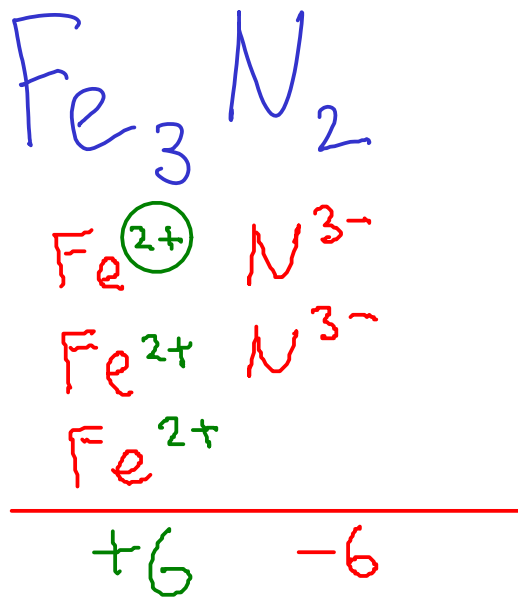
However, many transition metals are capable of forming SEVERAL DIFFERENT CATIONS!

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

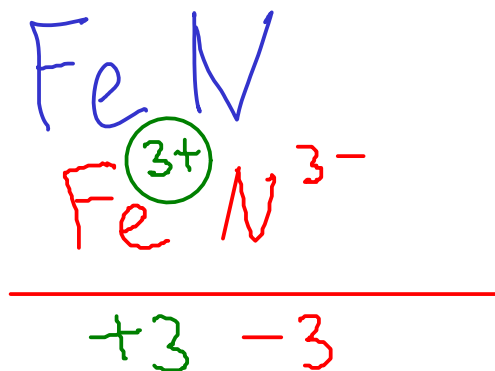
## TRANSITION METAL CATIONS

- 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(II)"!



\* We call this form of iron ion "iron(III)"!

## POLYATOMIC IONS

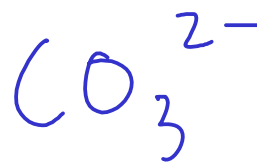
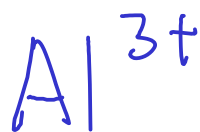
- Some MOLECULES can gain or lose electrons to form CATIONS or ANIONS. These are called POLYATOMIC IONS

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

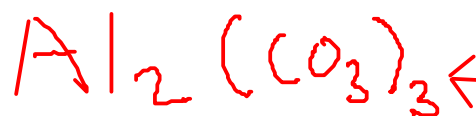
Example:  $\text{CO}_3^{2-}$  : CARBONATE ION

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



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



YOU MUST MEMORIZE THE NAMES AND FORMULAS OF THE MOST COMMON POLYATOMIC IONS. CHECK THE COURSE WEB SITE FOR A LIST!

## 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:



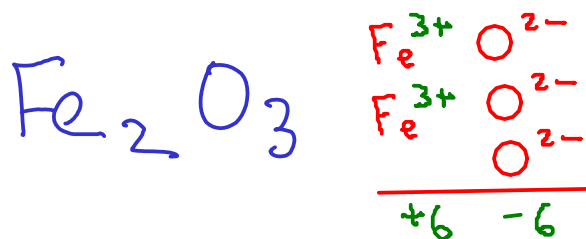
magnesium hydroxide



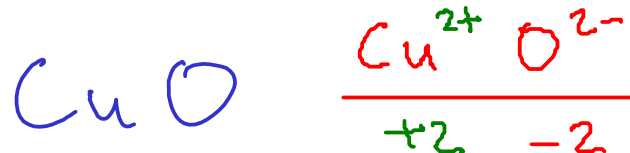
sodium sulfide



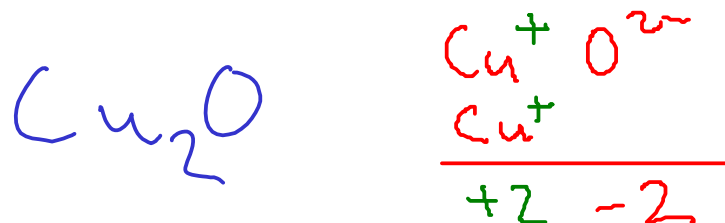
beryllium bromide



iron(III) oxide



copper(II) oxide



copper(I) oxide

Remember to include the Roman numeral for CHARGE in the name of transition metal compounds!

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