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: Mg^{2+}, P^{3-} ... what is formula?

Mg^{2+} ← more − than +, so add more Mg^{2+}

P^{3-} ← more + than −, so add P^{3-}

Mg^{2+} ← more − than +, so add Mg^{2+}

Mg_3P_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: Mg^{2+} P^{3-} → Mg_3P_2

More examples:

Ca^{2+} F^-

Ca^{2+} F^-

F^-

CaF_2

Ti^{4+} O^{2-}

Ti^{4+} O^{2-}

O^{2-}

Ti_2O_4 → TiO_2

K^+ N^{3-}

K^+ N^{3-}

K^+

K^+

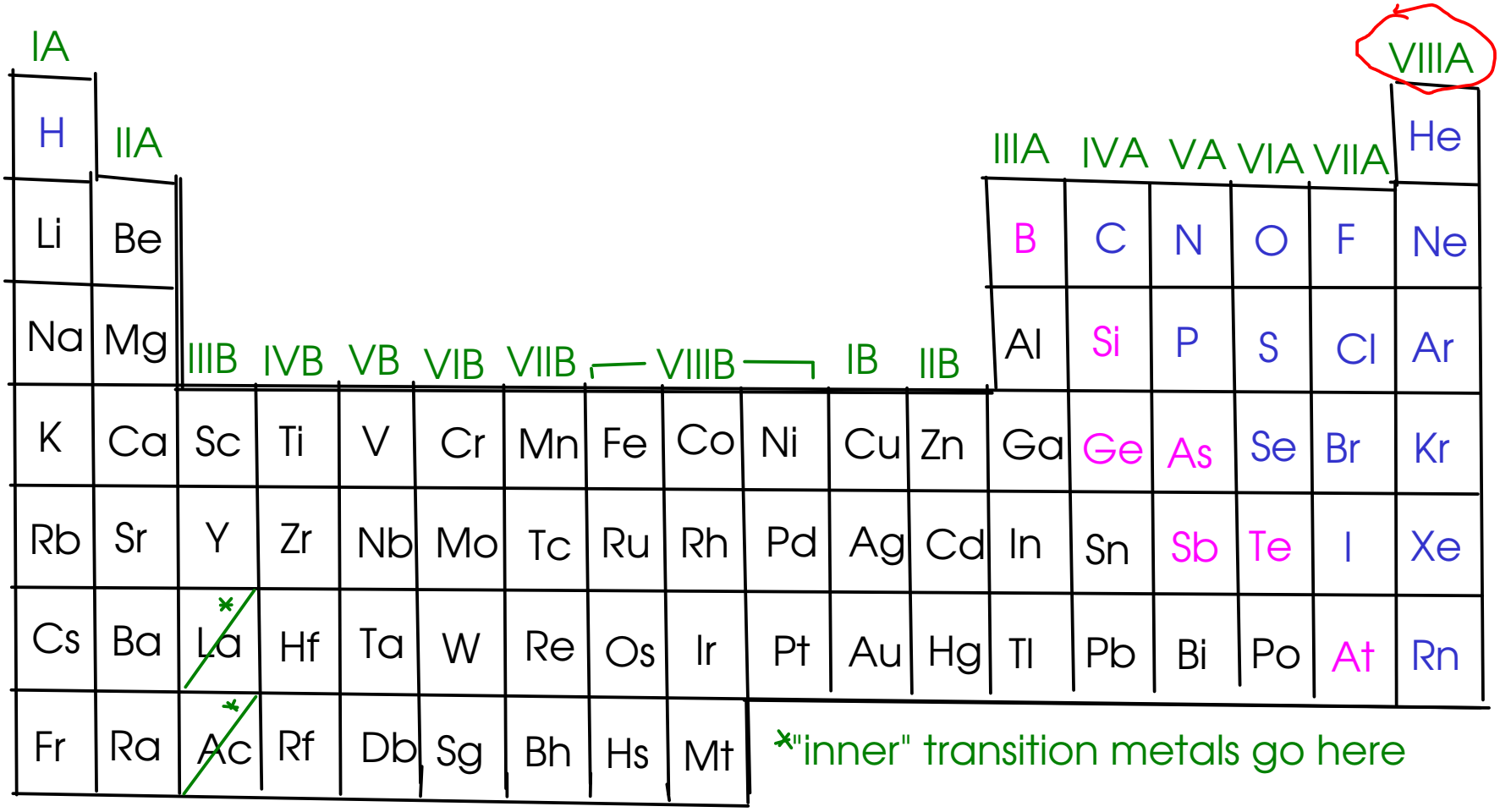
K_3N

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?

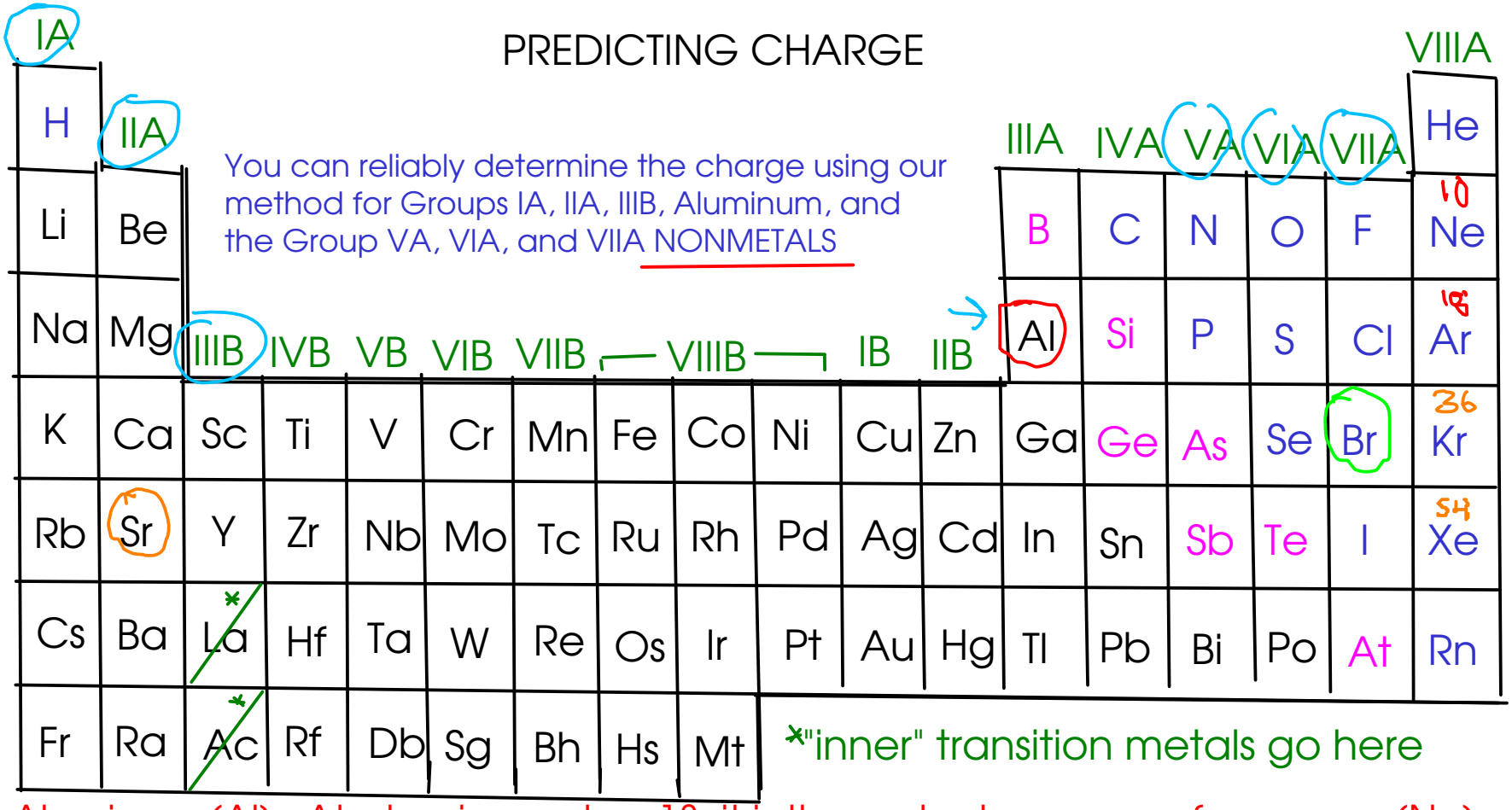
- for many main group elements, you cah predict the charge using the periodic table!



Elements in group VIIIA - 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



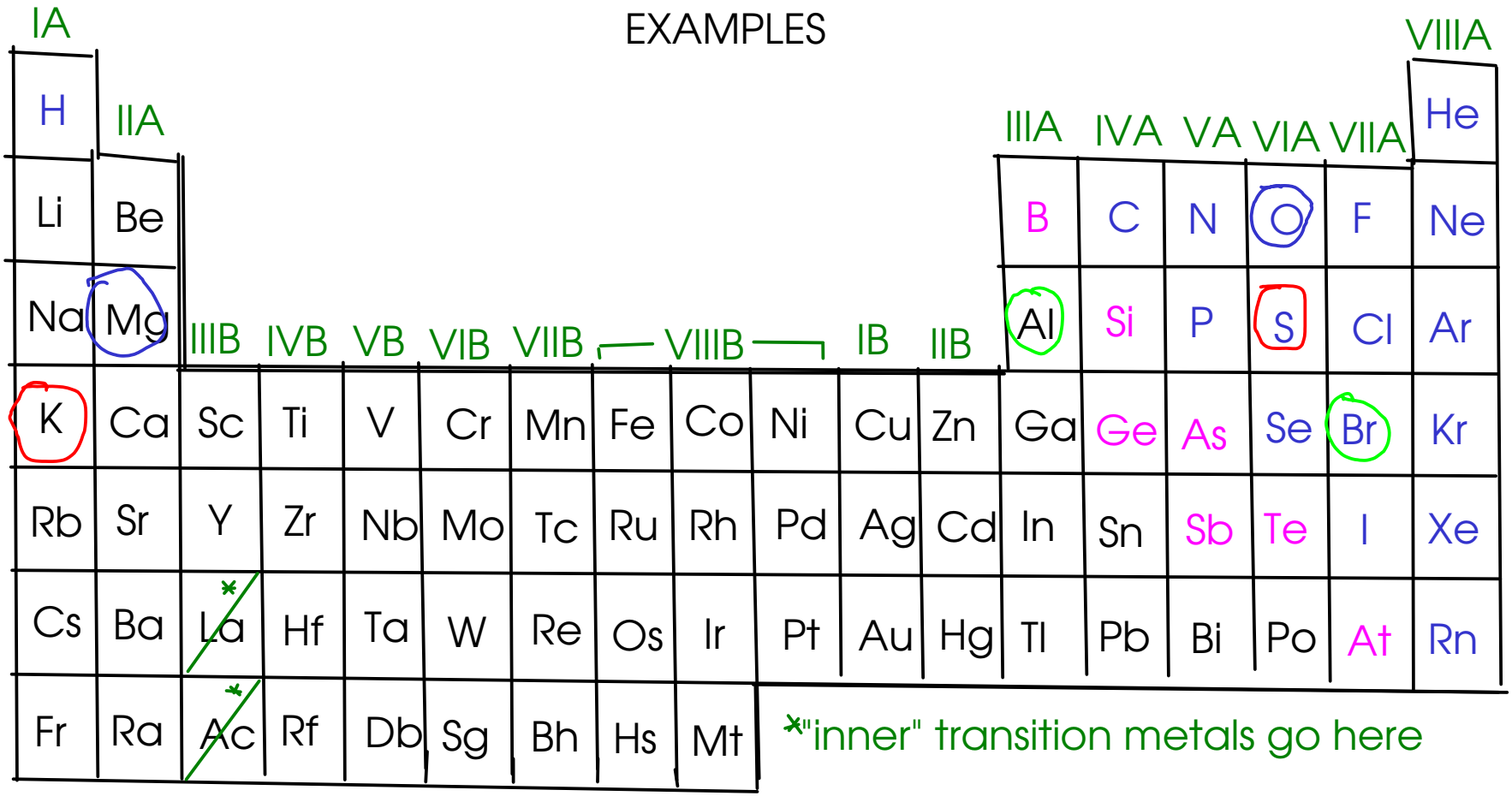
You can reliably determine the charge using our method for Groups IA, IIA, IIIB, Aluminum, and the Group VA, VIA, and VIIA NONMETALS

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 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 Br^-

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

EXAMPLES



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

Al^{3+} Br^{-}

Mg^{2+} O^{2-}

S^{2-} K^{+}

Find the formula of:
* an ionic compound containing Al and Br

Al^{3+} Br^-

Al^{3+} Br^-
Br^-
Br^-

$AlBr_3$

Find the formula of:
* an ionic compound containing Mg and O

Mg^{2+} O^{2-} ⟶ MgO

Find the formula of:
* an ionic compound containing S and K

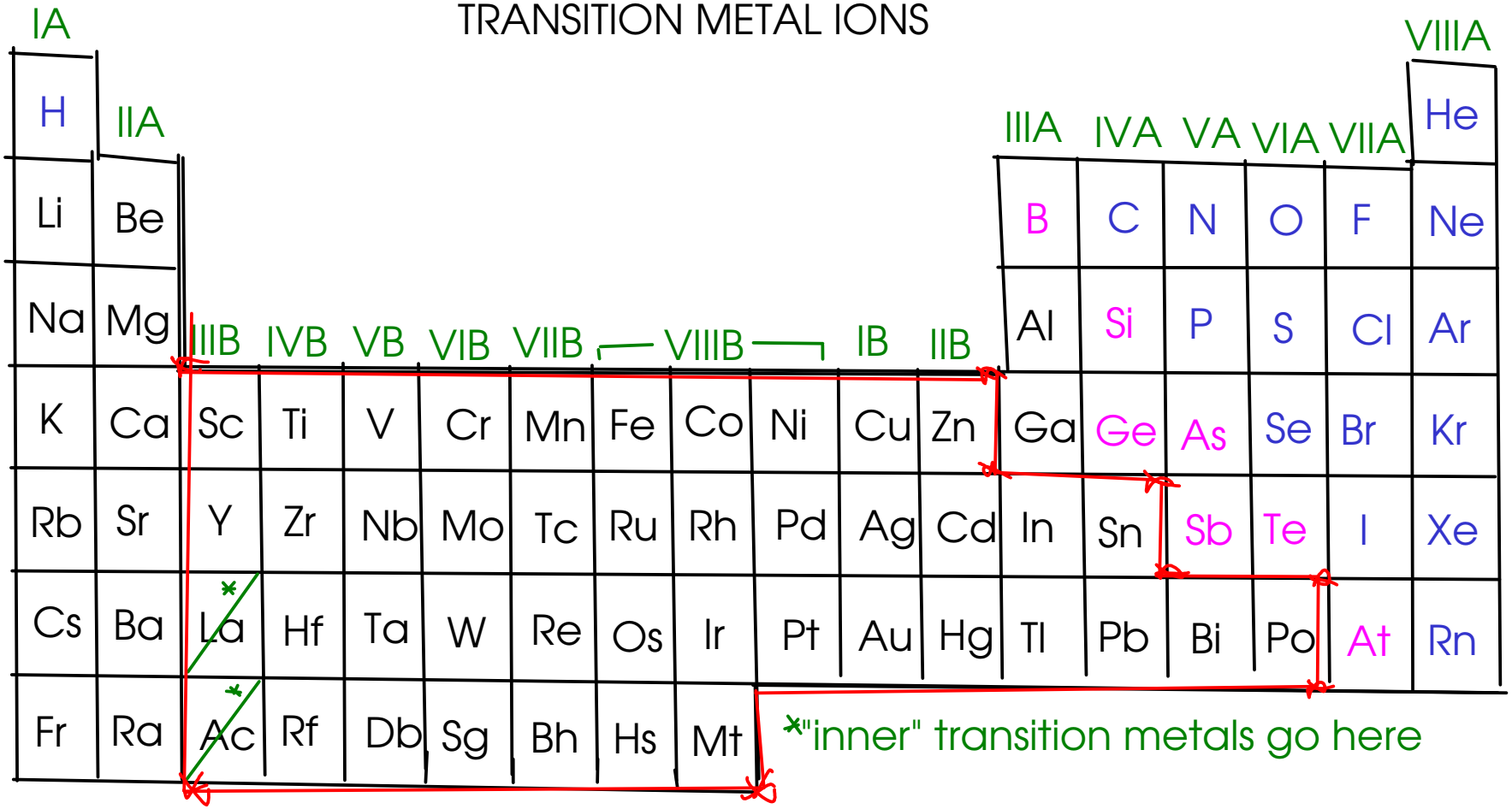
S^{2-} K^+

S^{2-} K^+
K^+

K_2S

Reminder: Write the cation (+) first in an ionic formula! ---------->

TRANSITION METAL IONS



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: Fe^{2+} or 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:

Fe_3N_2

$Fe^{2+}\ N^{3-}$

$Fe^{2+}\ N^{3-}$

Fe^{2+}

$+6\quad -6$

* The charge of iron in this compound is +2. We call these ions "iron(II)" ions ... pronounced "iron two". The compound is called "iron(II) nitride".

FeN

$Fe^{3+}\ N^{3-}$

$+3\quad -3$

* The charge of iron in this compound is +3. We call these ions "iron(III)" ions ... pronounced "iron three". The compound is called "iron(III) nitride".

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: CO_3^{2-} : CARBONATE ION

*Compare to Al_2O_3

From Al^{3+} O^{2-}

Al^{3+} CO_3^{2-}

Al^{3+} CO_3^{2-}

CO_3^{2-}

$Al_2(CO_3)_3$

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

(p64)

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!

   Mg^{2+}: "magnesium ion"

---

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!

   Fe^{2+}: "iron(II) ion"

   Cu^{+}: "copper(I) ion"

   Fe^{3+}: "Iron(III) ion"

---

3. Polyatomic cations

   - Memorize list.

   NH_4^{+}: "ammonium ion"

ANIONS

2 kinds

1. Main-group nonmetals

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

N^{3-} : "nitride" ion P^{3-} : "phosphide ion" S^{2-}: sulfide ion

O^{2-} : "oxide ion" F^{-} : "fluoride ion"

---

2. Polyatomic ions

- Memorize list.(see web site)

$C_2H_3O_2^{-}$: "acetate ion" SO_4^{2-} : "sulfate ion"

NO_3^{-} : "nitrate ion" SO_3^{2-} "sulfite ion"

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:

$Mg(OH)_2$

magnesium hydroxide

Na_2S

sodium sulfide

$BeBr_2$

beryllium bromide

Fe_2O_3

Fe^{3+} O^{2-}

Fe^{3+} O^{2-}

O^{2-}

+6 −6

iron(III) oxide

CuO

Cu^{2+} O^{2-}

+2 −2

copper(II) oxide

Cu_2O

Cu^{+} O^{2-}

Cu^{+}

+2 −2

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

$(NH_4)_2S$

ammonium sulfide

$FeCO_3$

Fe^{2+} CO_3^{2-}

+2 -2

iron(II) carbonate

TiS_2

Ti^{4+} S^{2-} S^{2-}

+4 −4

titanium(IV) sulfide

$Ba_3(PO_4)_2$

barium phosphate

Spelling matters!

Ba_3P_2

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

Fe^{3+} CO_3^{2-}

$Fe_2(CO_3)_3$

potassium sulfide

K^+ S^{2-}

K^+

K_2S

calcium bromide

Ca^{2+} Br^-

Br^-

$CaBr_2$