More examples:

Ca^{2+} F^-

Ca^{2+} F^-
F^-

CaF_2

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

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

TiO_2

K^+ N^{3-}

K^+ N^{3-}
K^+
K^+

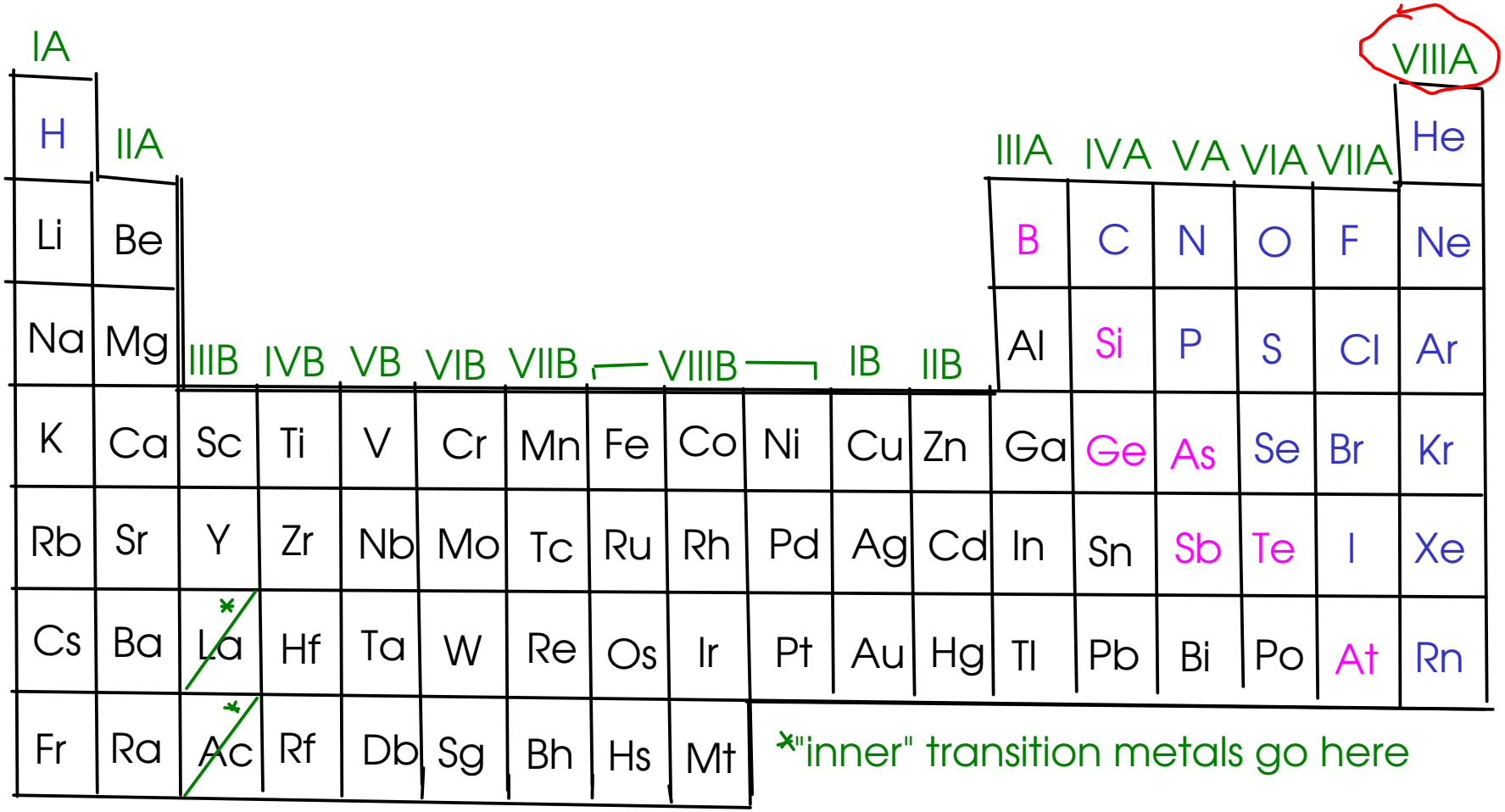
K_3N

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?

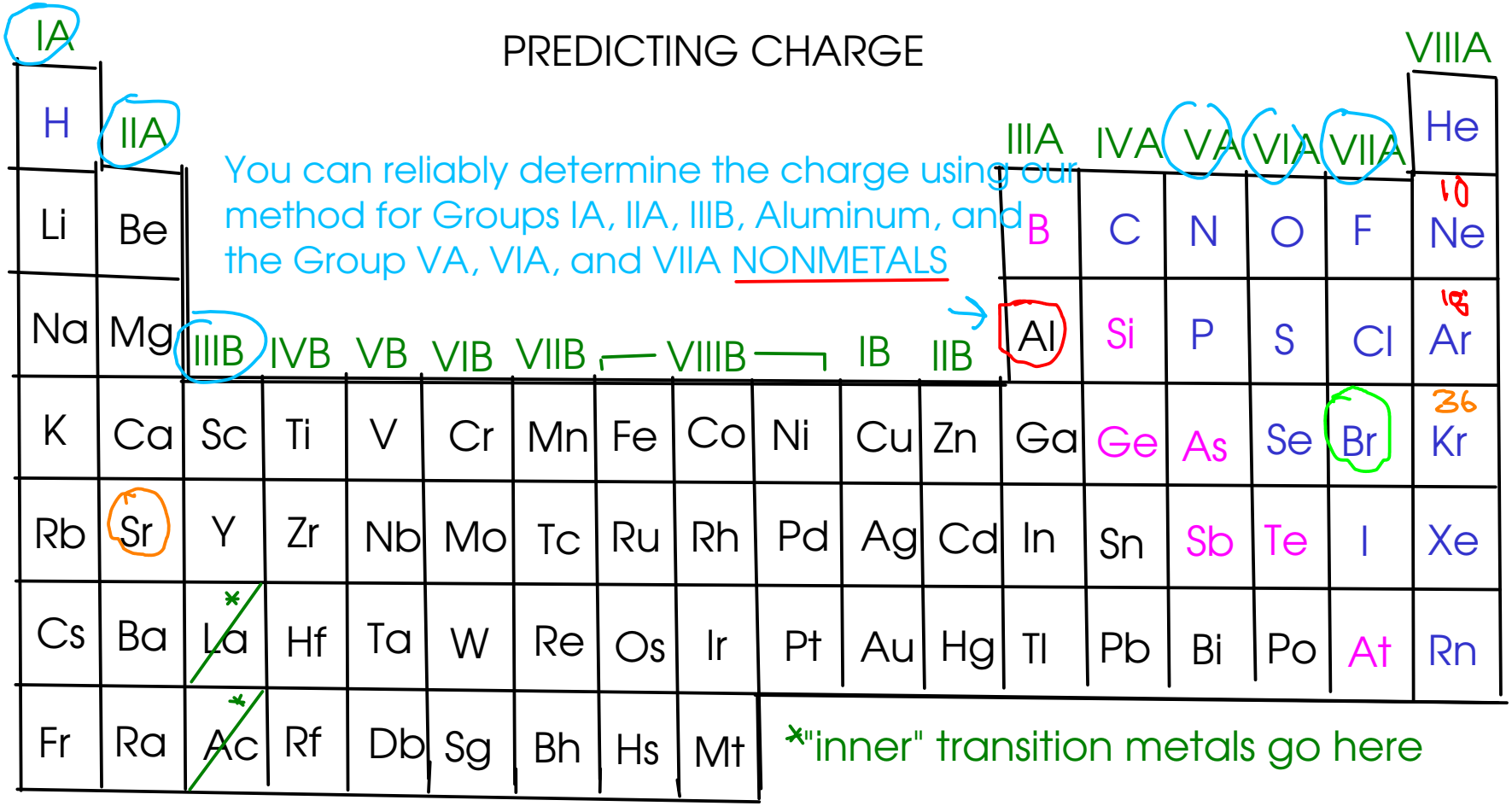
- for many main group elements, you cah predict the charge using the periodic table!



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

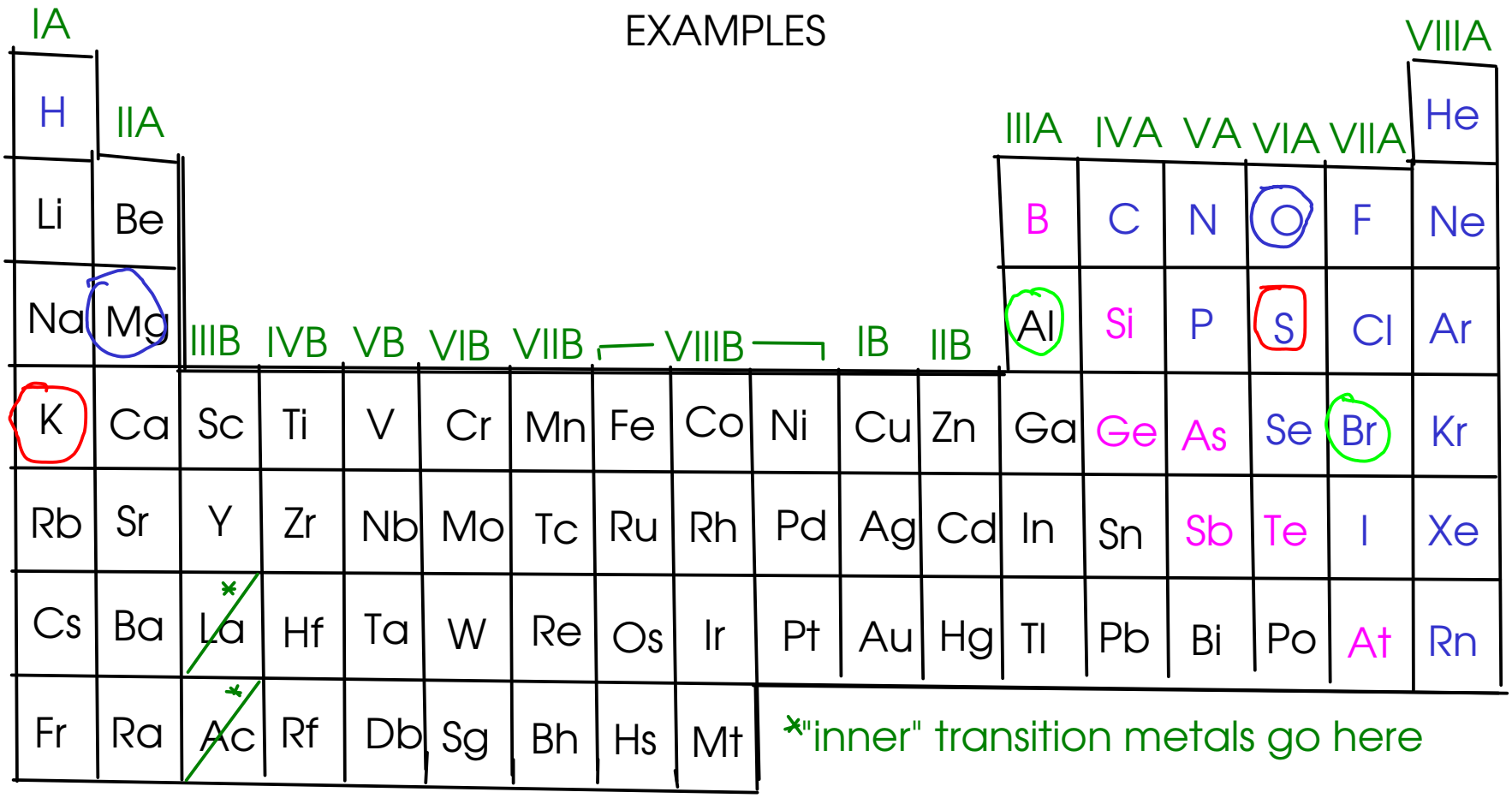


Aluminum (Al): At atomic number 13, it is three electrons away from neon (Ne), and 5 electrons away from argon (Ar). Prediction: Aluminum will lose three electrons to form the cation Al^{3+}

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 Al^{3+} Br^{-}

(2) an ionic compound containing Mg and O Mg^{2+} O^{2-}

(3) an ionic compound containing S and K S^{2-} K^{+}

Find the formula of:

* an ionic compound containing Al and 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

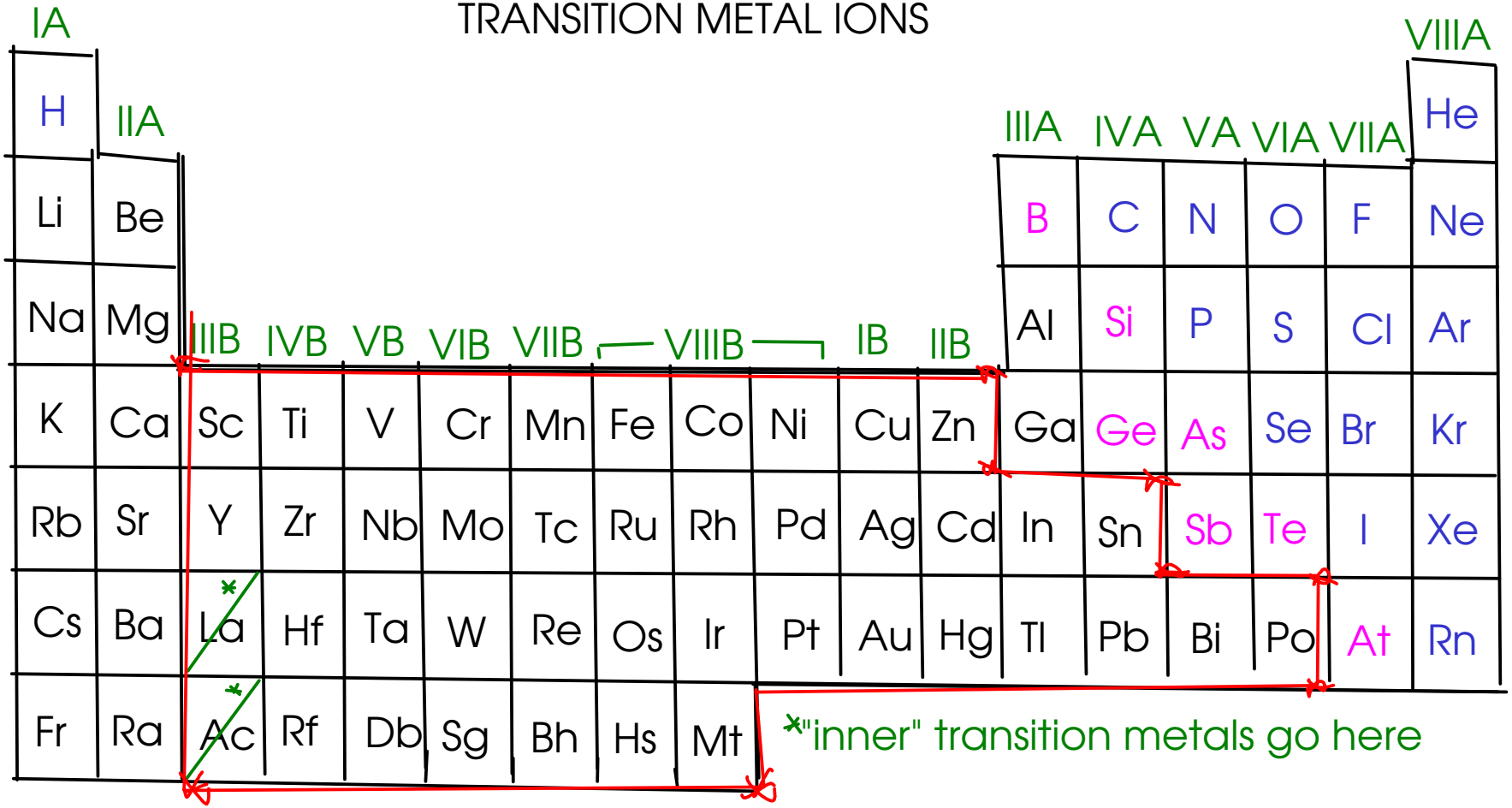
S^{2-} K^+

K^+

K_2S ← Formula should be written cation first!

~~SK_2~~

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+}

$+6\quad -6$

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

FeN

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

$+3\quad -3$

* 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: CO_3^{2-} : carbonate ion

*Compare to Al_2O_3

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.

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!

   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

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

copper(II) oxide

Cu_2O

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

Cu^{+}

$+2\ -2$

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

NAMING IONIC COMPOUNDS

$(NH_4)_2S$

ammonium sulfide

$FeCO_3$ Fe^{2+} CO_3^{2-}

iron(II) carbonate

TiS_2

titanium(IV) sulfide

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

-4

$Ba_3(PO_4)_2$

barium phosphate

Spelling matters!

$Ca(NO_3)_2$

calcium nitrate

Na_3P

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

CO_3^{2-}

$Fe_2(CO_3)_3$

potassium sulfide

K^+ S^{2-}

K^+

K_2S

calcium bromide

Ca^{2+} Br^-

Br^-

$CaBr_2$

DETERMINING IONIC FORMULAS

sodium sulfate

$Na^+ \quad SO_4^{2-}$

Na^+

Na_2SO_4

strontium oxide

$Sr^{2+} \quad O^{2-}$

SrO

tin(II) phosphate

$Sn^{2+} \quad PO_4^{3-}$

$Sn^{2+} \quad PO_4^{3-}$

Sn^{2+}

$Sn_3(PO_4)_2$

chromium(III) nitrate

$Cr^{3+} \quad NO_3^-$

NO_3^-

NO_3^-

$Cr(NO_3)_3$

barium hydroxide

$Ba^{2+} \quad OH^-$

OH^-

$Ba(OH)_2$

titanium(IV) chloride

$Ti^{4+} \quad Cl^-$

Cl^-

Cl^-

Cl^-

$TiCl_4$

Don't forget the parenthesis when you have more than one hydroxide ion!

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.

ex: $CuSO_4 \cdot 5H_2O$

water molecules per formula unit of compound

dot indicates that the water is weakly bound to the ionic compound

- 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