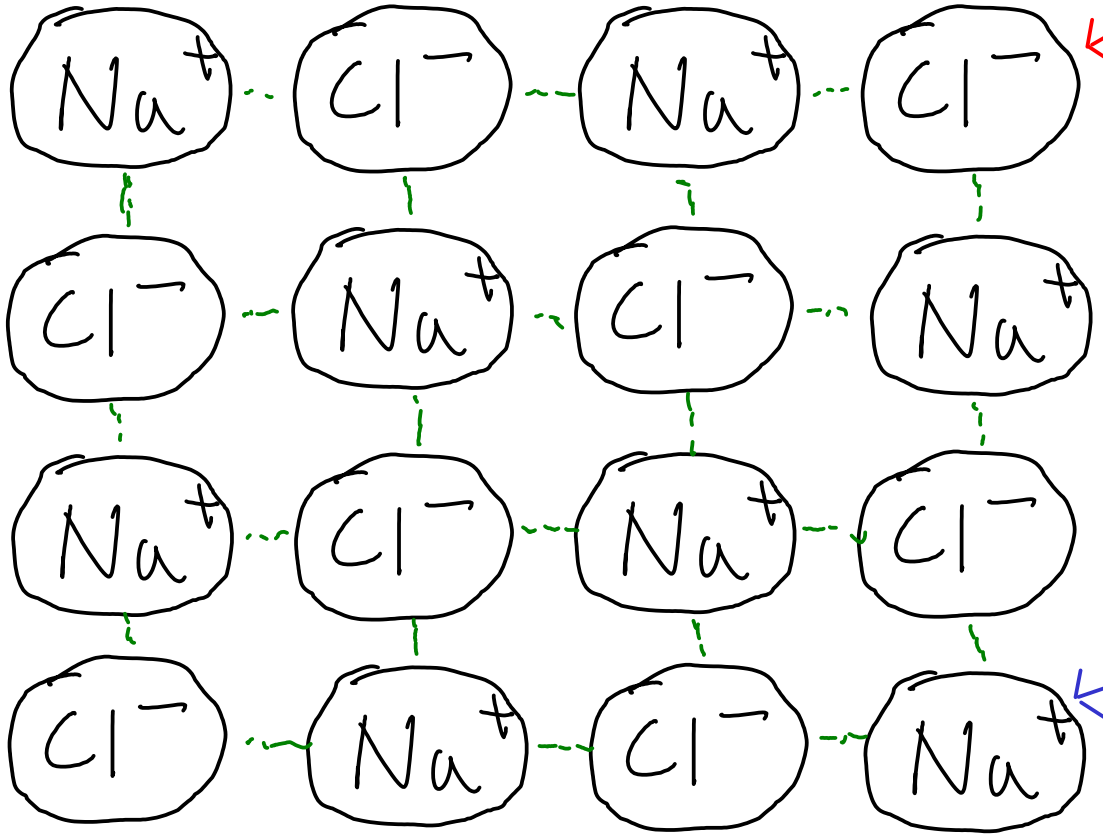
IONIC COMPOUNDS

- 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

Na^+ Cl^- make $NaCl$ (1:1 ratio)

Ca^{2+} Cl^- make $CaCl_2$ (1:2 ratio)

Na^+ N^{3-} make Na_3N (3:1 ratio)

Fe^{3+} O^{2-} make Fe_2O_3 (2:3 ratio)

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-} If a simple ionic compound is made of these two ions, what is its formula?

Mg^{2+}

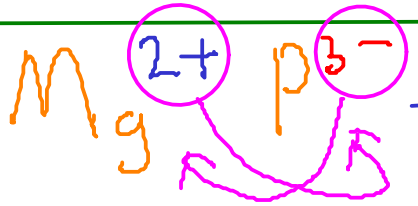
← more − than +, so add more Mg^{2+}

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!

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



→ Mg_3P_2 "cross method" to determine ratio

SUPERscript is charge!

More examples:

Ca^{2+} F^-

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

CaF_2

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

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

TiO_2

~~Ti_2O_4~~

Subscript = number of atoms, NOT charge!

K^+ N^{3-}

K^+ N^{3-}

K^+

K^+

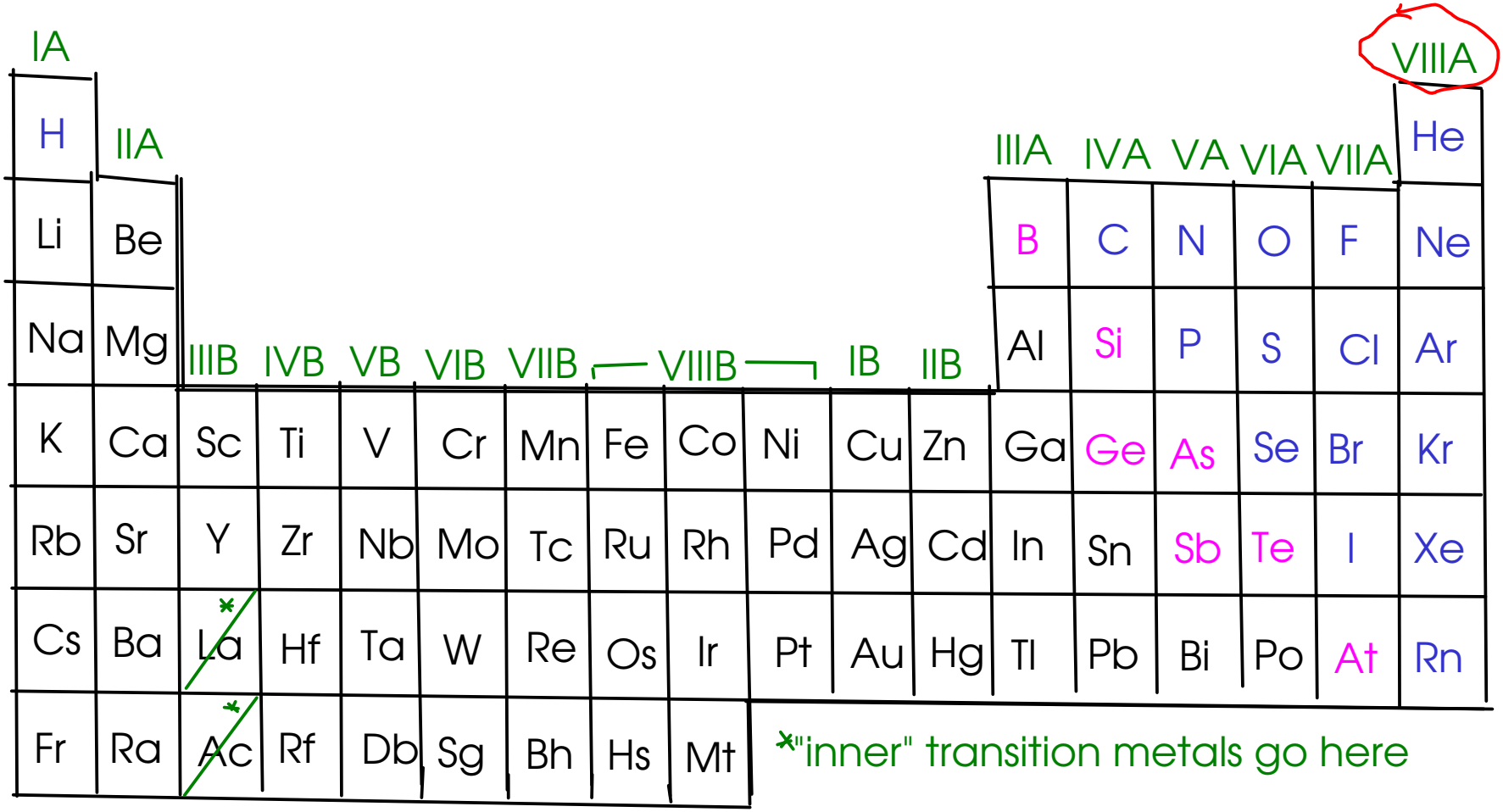
K_3N

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?

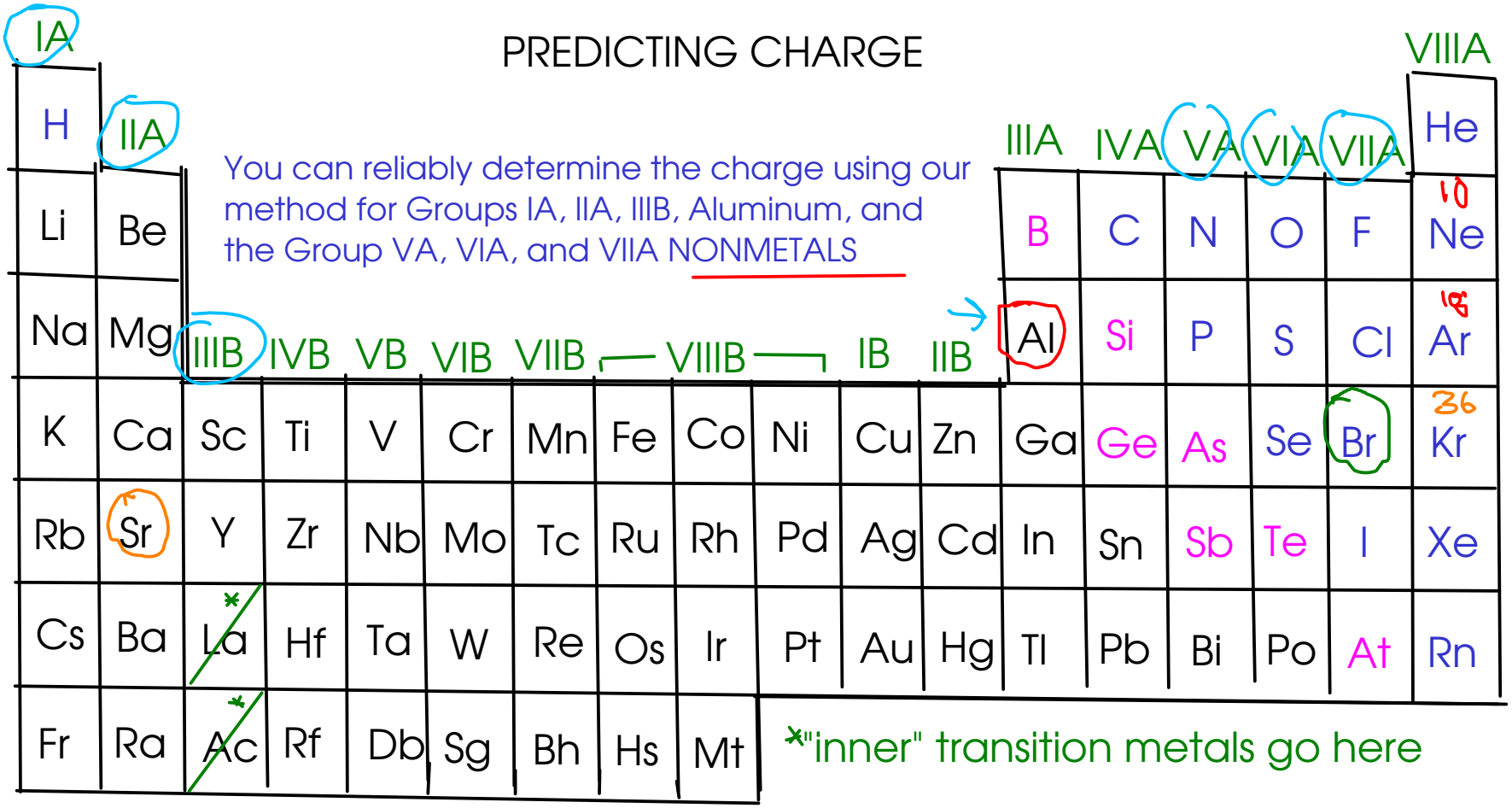
- for many main group elements, you can predict the charge using the periodic table!



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



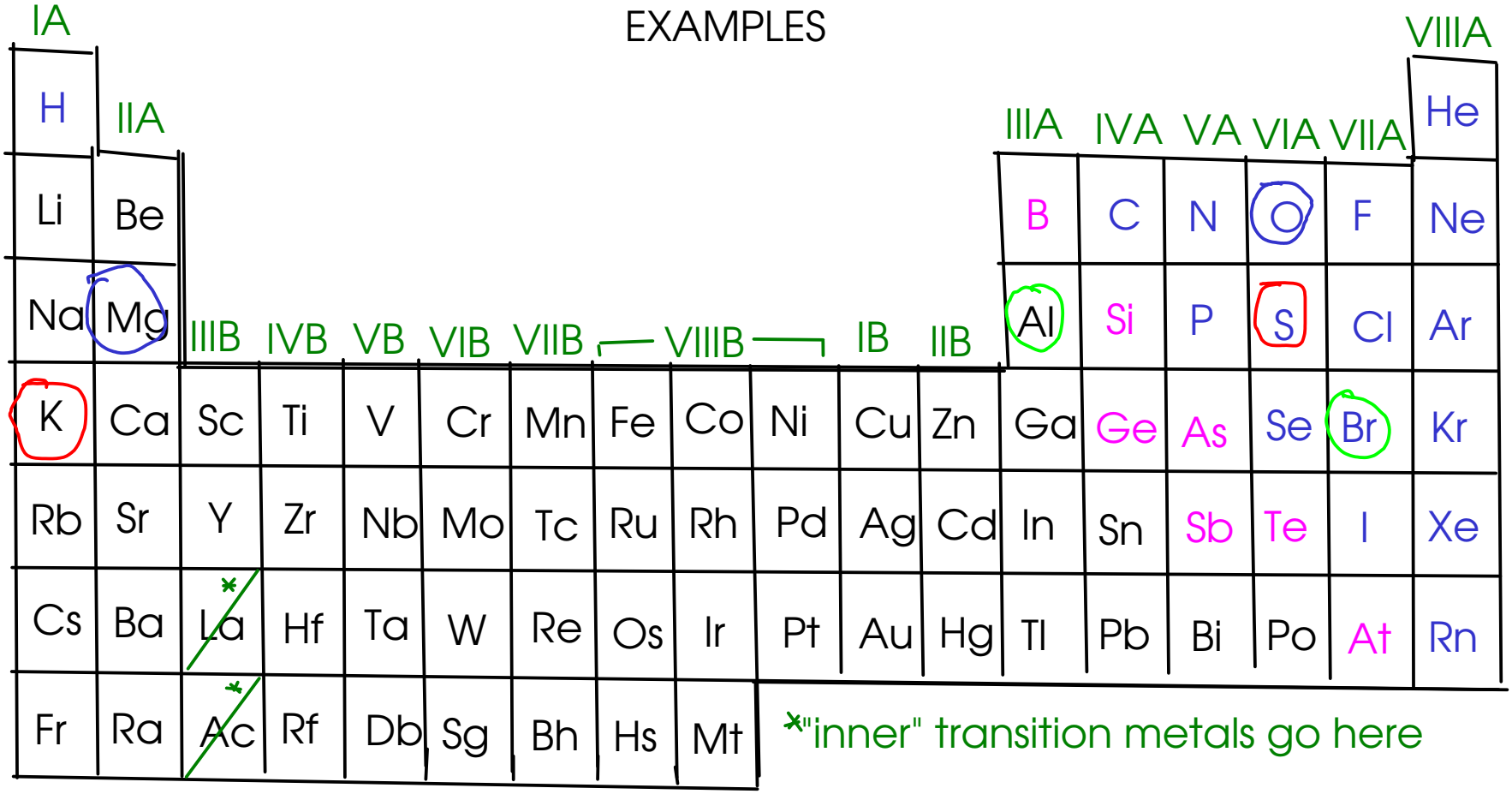
You can reliably determine the charge using our method for Groups IA, IIA, IIIB, Aluminum, and the Group VA, VIA, and VIIA NONMETALS

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^- Br^- Br^-

$AlBr_3$

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

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

MgO

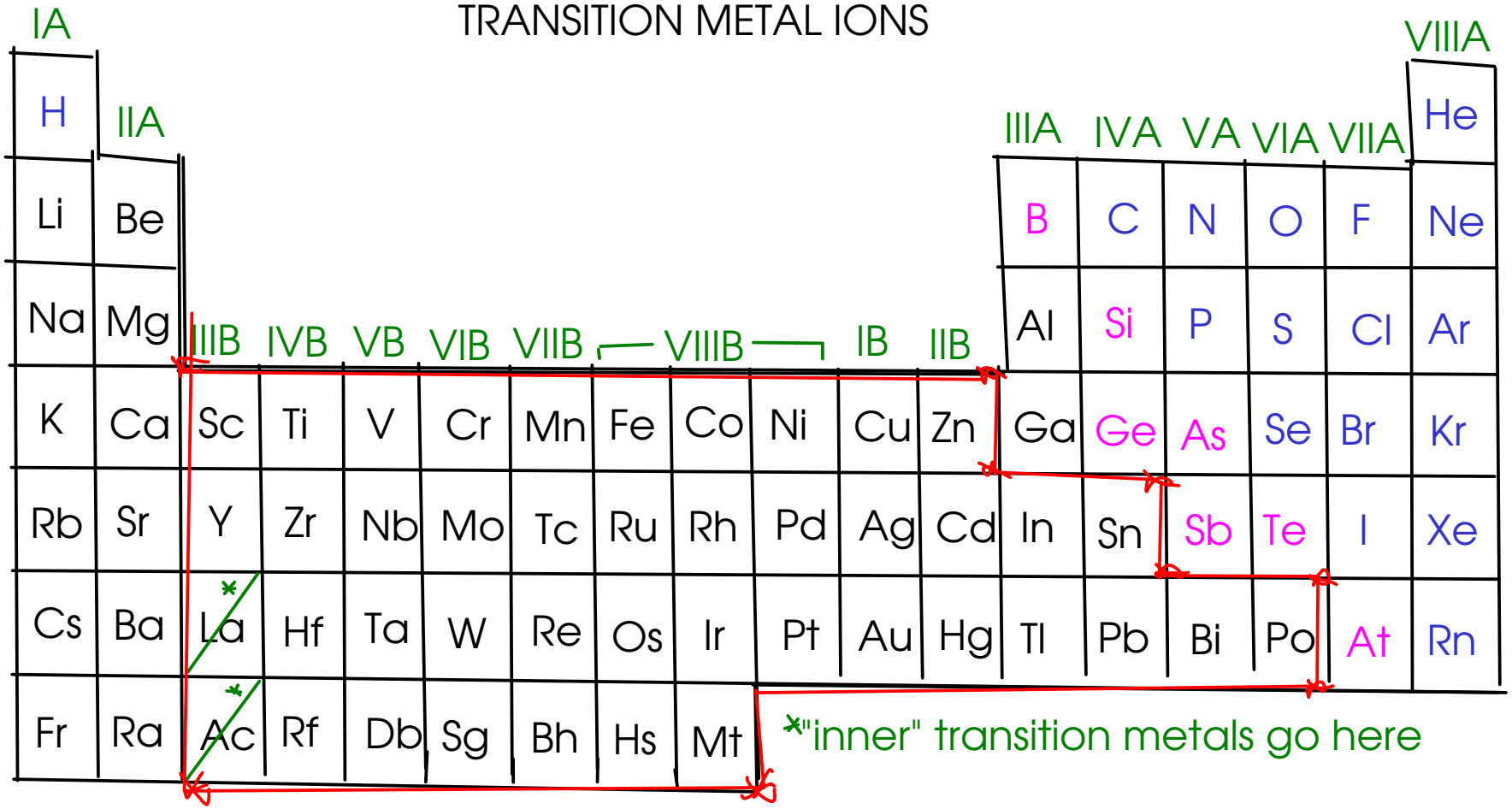
Find the formula of:
* an ionic compound containing S and K

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

K_2S ~~SK_2~~

Remember: When writing the formulas of ionic compounds, write them with CATION FIRST

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+}

$+6$ -6

This compound has iron ions with a +2 charge. This form of iron is called "iron(II)" pronounced "iron two"!

FeN

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

$+3$ -3

This compound has iron ions with a +3 charge. This form of iron is called "iron(III)" pronounced "iron three"!

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 these formulas!

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

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.

A chart of common polyatomic ions is available on the course web site!

(p130 - 7th edition)