UNIT 1: ELEMENTS AND COMPOUNDS

CHEMICAL NAMES AND FORMULAS

LEARNING TARGET

- Identify, name and write formulas for ionic (binary, multivalent, polyatomic, and hydrates) and molecular compounds, and acids using the IUPAC and classical systems.

ATOMS AND IONS

- Atoms are electrically neutral.
  - Because there is the same number of protons (+) and electrons (-).
- Ions are atoms, or groups of atoms, with a charge (positive or negative)
  - They have *different* numbers of protons and electrons.
- Only *electrons* can move, and **ions** are made by gaining or losing electrons.

AN ANION IS…

- A negative ion.
- Has gained electrons.
- Nonmetals can gain electrons.
- Charge is written as a superscript on the right.

F^{1-} Has gained one electron (-ide is new ending = fluoride)

O^{2-} Gained two electrons (oxide)

A Cation is…

- A positive ion.
- Formed by losing electrons.
- More protons than electrons.
- Metals can lose electrons

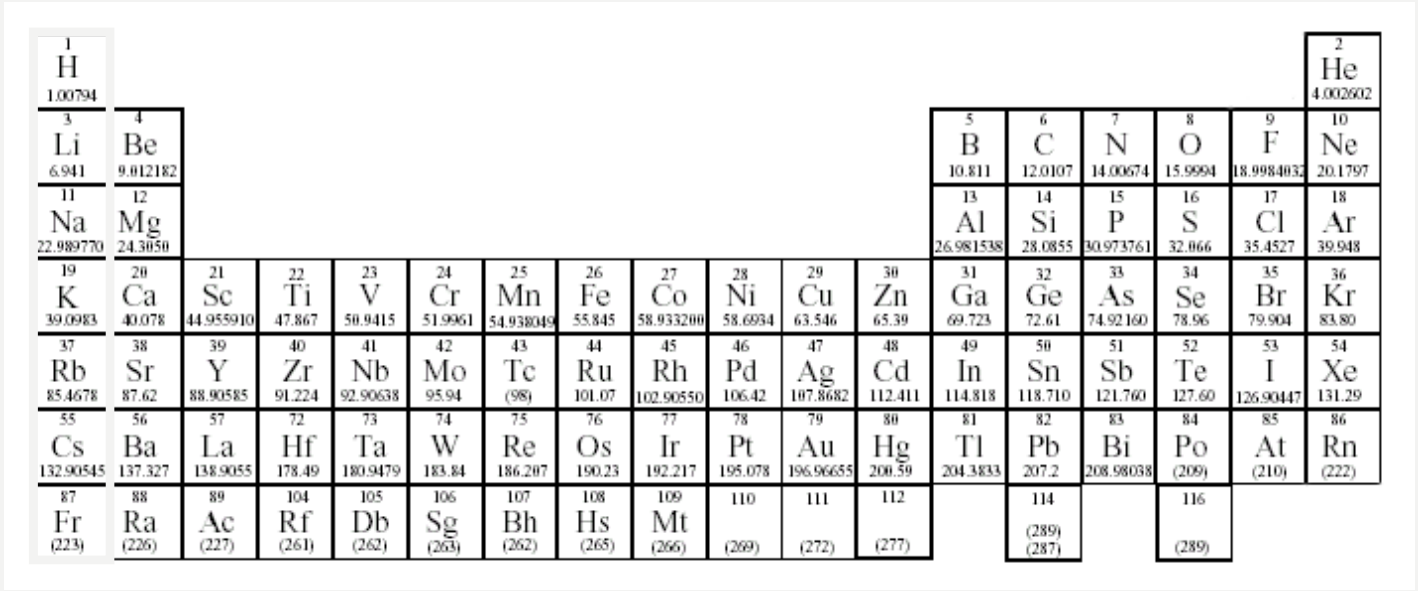
K^{1+} Has lost one electron (no name change for positive ions)

Ca^{2+} Has lost two electrons

PREDICTING IONIC CHARGES

<u>Group 1A</u>: Lose 1 electron to form 1+ ions

H^{1+} Li^{1+} Na^{1+} K^{1+} Rb^{1+}



1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.998403	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	84 Po (209)	85 At (210)	86 Rn (222)
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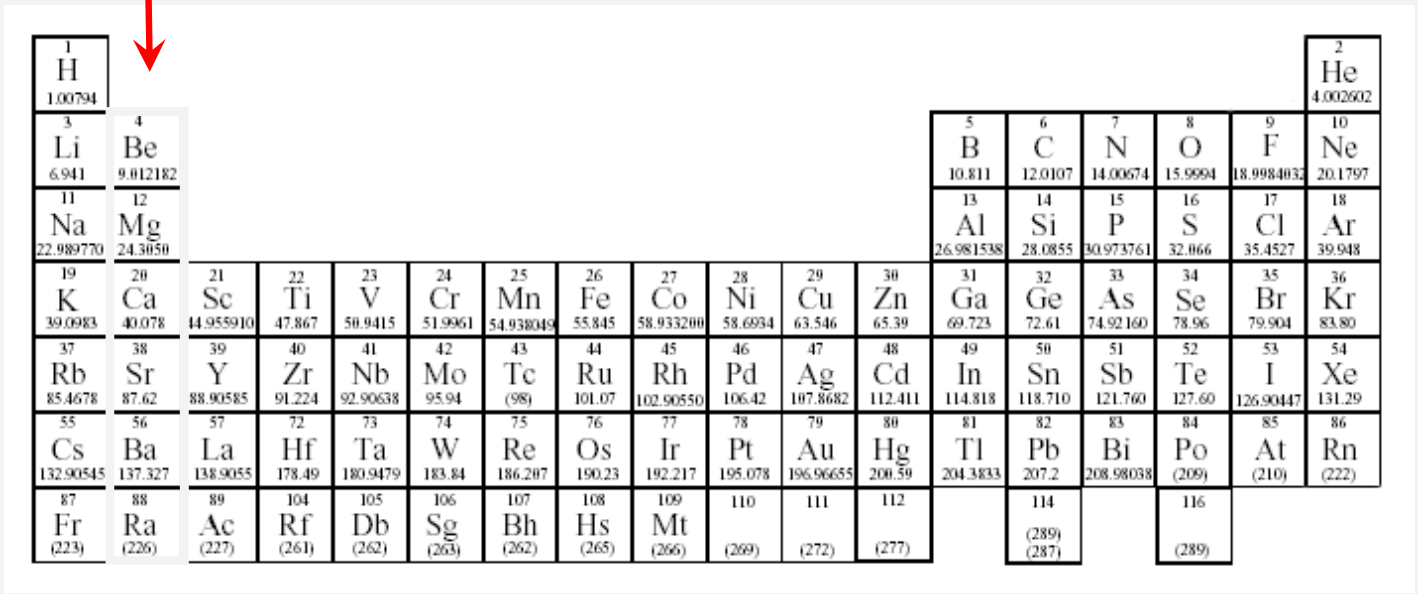
PREDICTING IONIC CHARGES

Group 2A: Loses 2 electrons to form 2+ ions

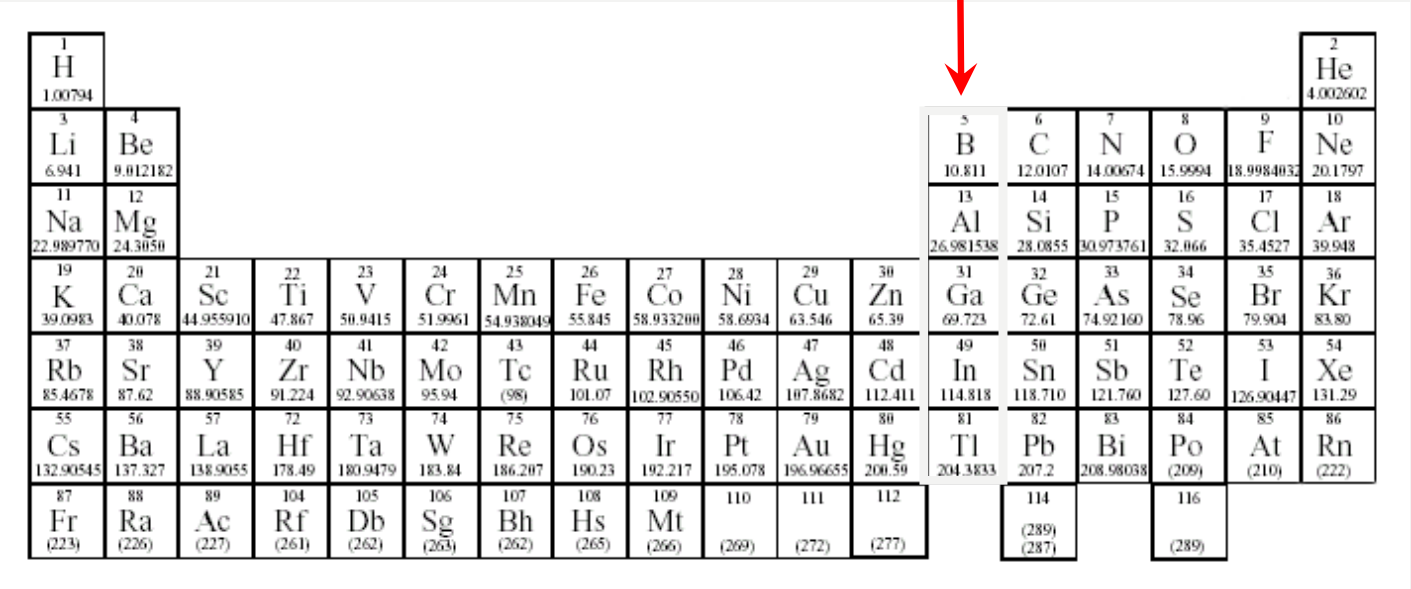
Be^{2+} Mg^{2+} Ca^{2+} Sr^{2+} Ba^{2+}



PREDICTING IONIC CHARGES

B^{3+} Al^{3+} Ga^{3+}

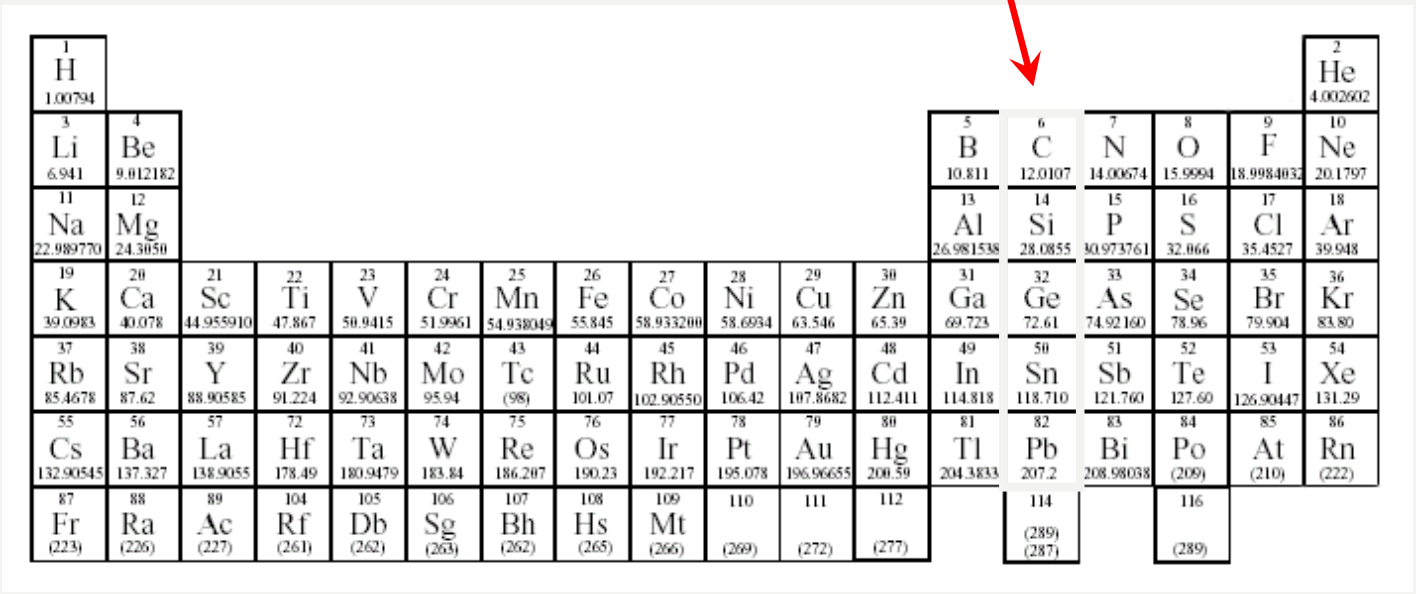
Group 3A: Loses 3 electrons to form 3+ ions



PREDICTING IONIC CHARGES

Neither! **Group 4A elements rarely form ions** (they tend to share)

Group 4A: Do they *lose* 4 electrons or *gain* 4 electrons?



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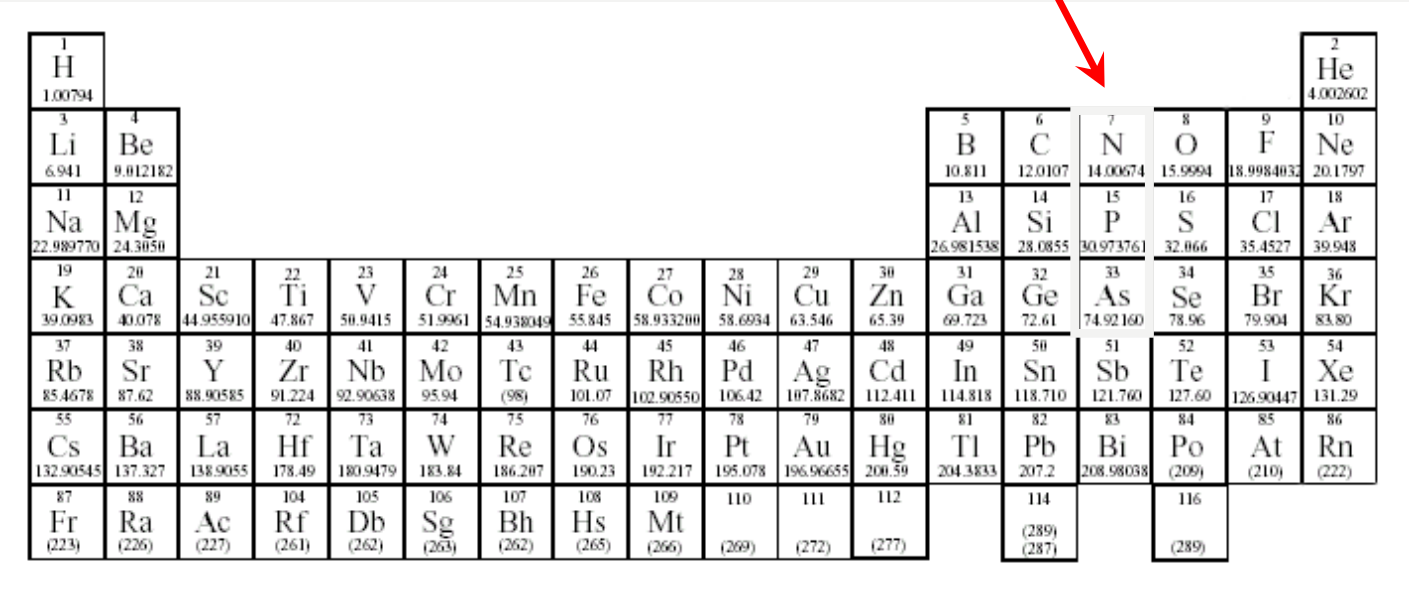
PREDICTING IONIC CHARGES

N^{3-} Nitride

P^{3-} Phosphide

As^{3-} Arsenide

Group 5A: Gains 3 electrons to form 3- ions



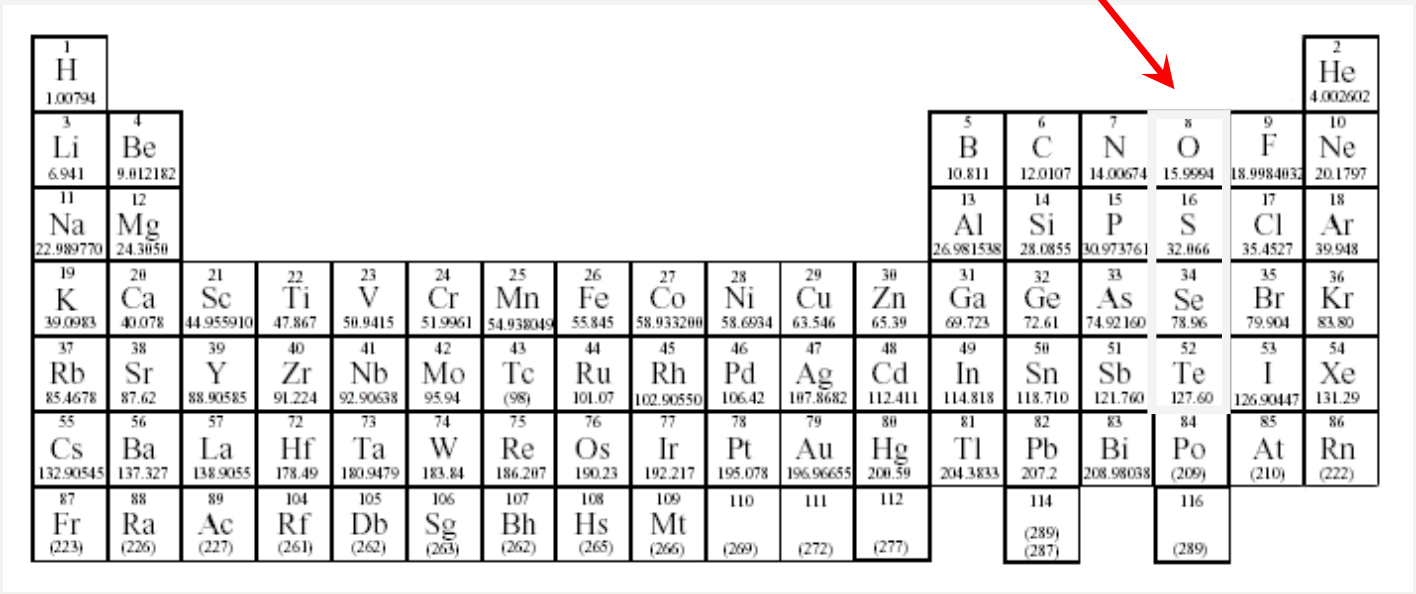
PREDICTING IONIC CHARGES

O^{2-} Oxide

S^{2-} Sulfide

Se^{2-} Selenide

Group 6A: Gains 2 electrons to form 2- ions



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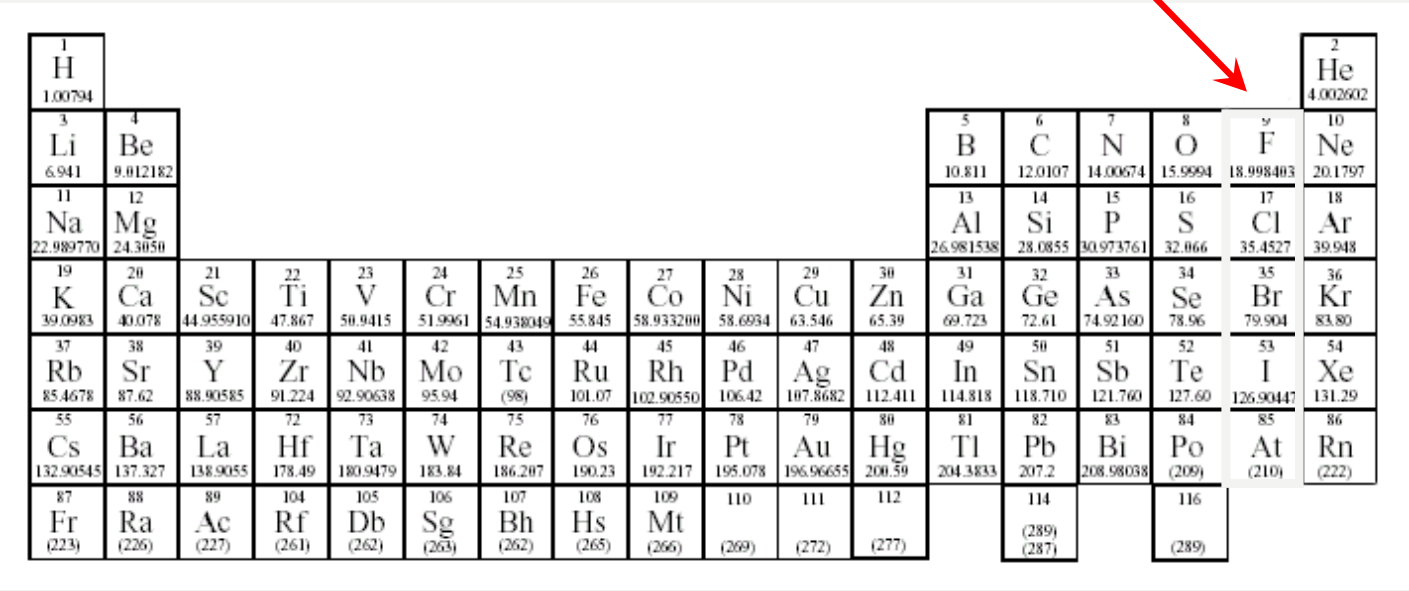
PREDICTING IONIC CHARGES

F^{1-} Fluoride Br^{1-} Bromide

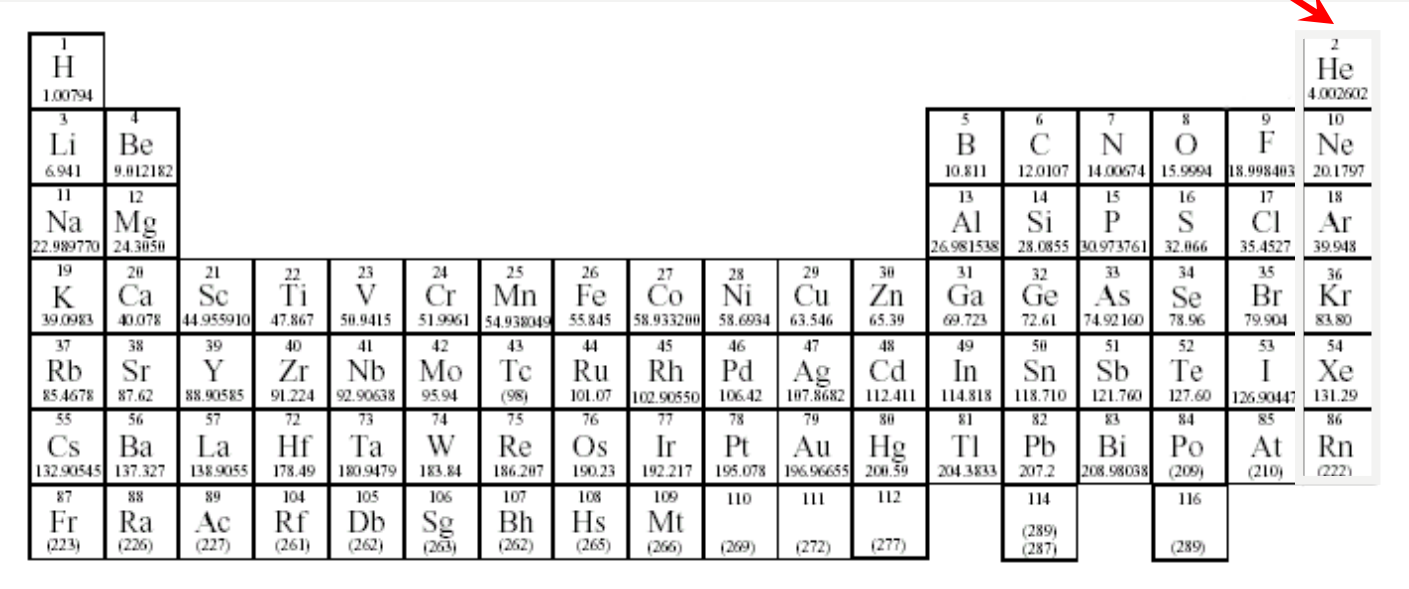
Cl^{1-} Chloride I^{1-} Iodide

Group 7A: Gains 1 electron to form 1- ions



PREDICTING IONIC CHARGES

<u>Group 8A</u>: Stable noble gases <u>do not</u> form ions!



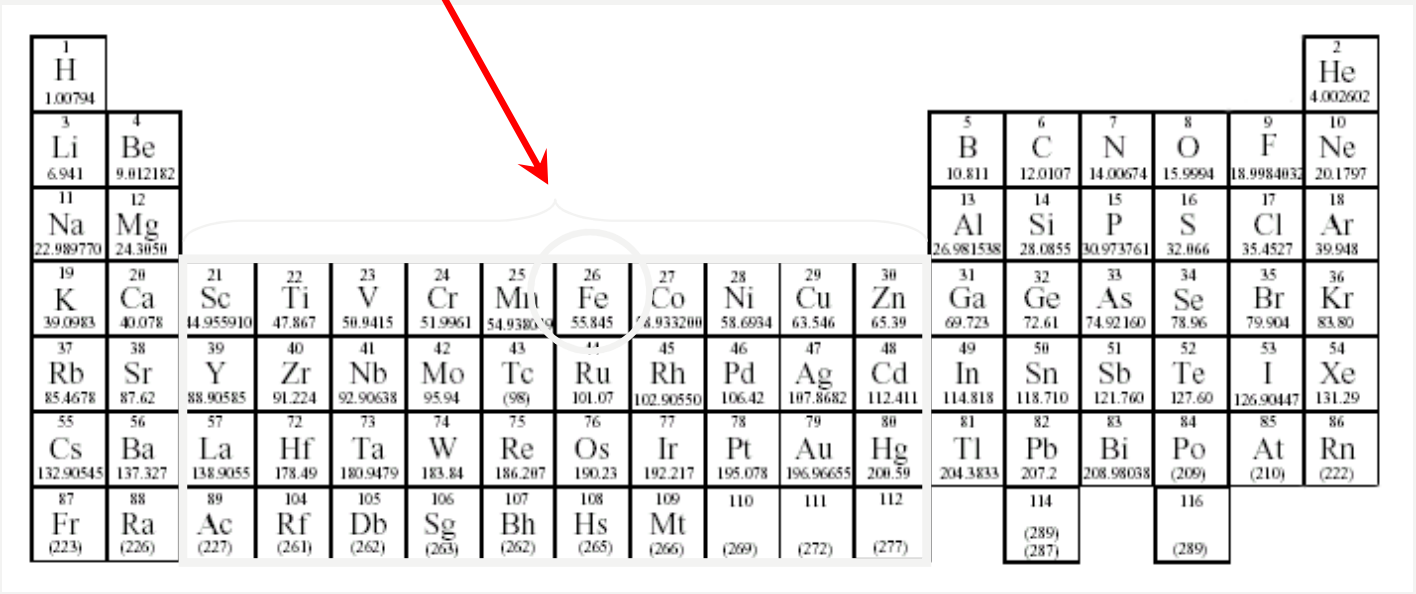
PREDICTING IONIC CHARGES

<u>Group B elements</u>: Many transition elements have *more than one* possible positive ion.

Note the use of **Roman numerals** to show charges →

Iron (II) = Fe^{2+}

Iron (III) = Fe^{3+}



NAMING CATIONS

- Two methods can clarify when more than one charge is possible:

1) **Stock system** – uses ***roman numerals*** in parenthesis to indicate the numerical value
2) **Classical method** – uses root word with ***suffixes*** (-ous, -ic)
    - Does not give true value

NAMING CATIONS

- We will use the **Stock system**.
- Cation - if the charge is always the same (like in the Group A metals) just write the name of the metal.
- Transition metals can have more than one type of charge.
  - Indicate their charge as a ***roman numeral*** in parenthesis after the name of the metal (Table 9.2, p.255)

PREDICTING IONIC CHARGES

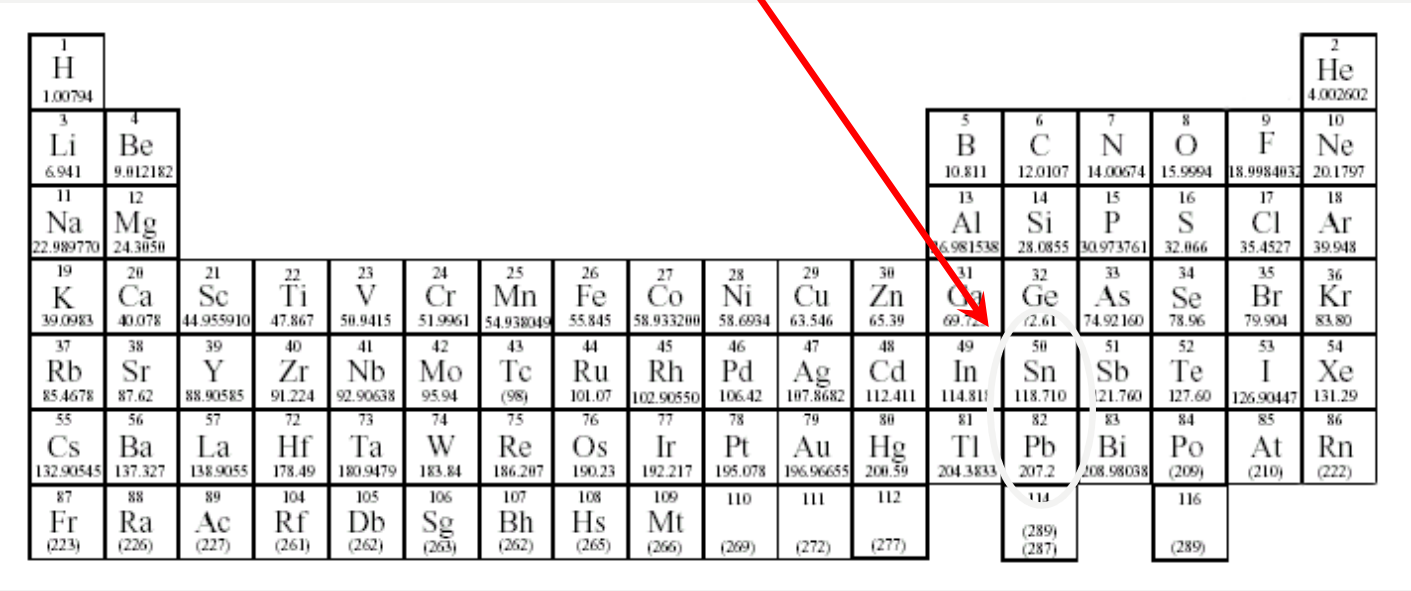
Some of the post-transition elements also have *more than one* possible ionic charge.

Tin (II) = Sn^{2+}

Tin (IV) = Sn^{4+}

Lead (II) = Pb^{2+}

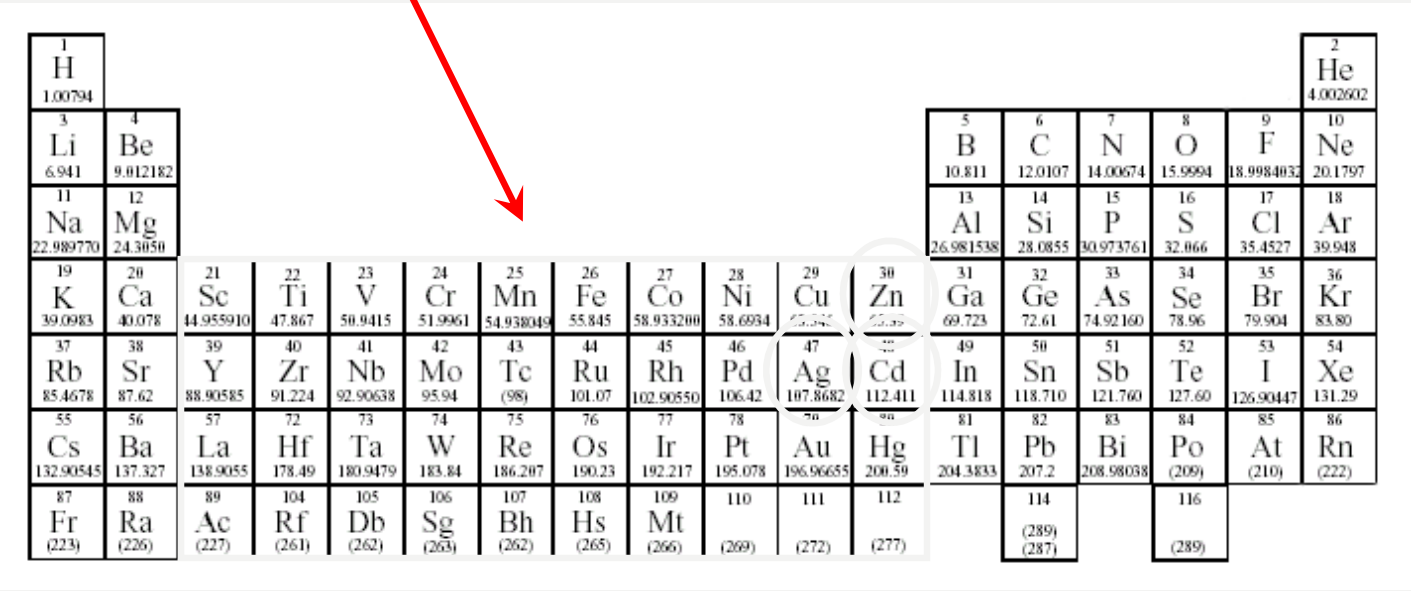
Lead (IV) = Pb^{4+}



PREDICTING IONIC CHARGES

Group B elements: Some transition elements have ***only one*** possible ionic charge, such as these three:

Silver = Ag^{1+} Zinc = Zn^{2+} Cadmium = Cd^{2+}



EXCEPTIONS:

- Some of the transition metals have only one ionic charge:
  - **Do not** need to use roman numerals for these:
  - Silver is **always** 1+ (**Ag^{1+}**)
  - Cadmium and Zinc are **always** 2+ (**Cd^{2+}** and **Zn^{2+}**)

PRACTICE BY NAMING THESE:

- Na^{1+}
- Ca^{2+}
- Al^{3+}
- Fe^{3+}
- Fe^{2+}
- Pb^{2+}
- Li^{1+}

WRITE SYMBOLS FOR THESE:

- Potassium ion
- Magnesium ion
- Copper (II) ion
- Chromium (VI) ion
- Barium ion
- Mercury (II) ion

NAMING ANIONS

- Anions are always the same charge
- Change the monatomic element ending to – ide
- **F^{1-}** a Fluorine atom will become a Fluoride ion.

PRACTICE BY NAMING THESE:

- Cl^{1-}
- N^{3-}
- Br^{1-}
- O^{2-}
- Ga^{3+}

WRITE SYMBOLS FOR THESE:

- Sulfide ion
- Iodide ion
- Phosphide ion
- Strontium ion

POLYATOMIC IONS ARE…

- Groups of atoms that stay together and have an overall charge, and one name.
- **Usually end in –ate or -ite**
- Acetate: $C_2H_3O_2^{1-}$
- Nitrate: NO_3^{1-}
- Nitrite: NO_2^{1-}
- Permanganate: MnO_4^{1-}
- Hydroxide: OH^{1-} and Cyanide: CN^{1-}

Table 9.3 on page 257

- Sulfate: SO_4^{2-}
- Sulfite: SO_3^{2-}
- Carbonate: CO_3^{2-}
- Chromate: CrO_4^{2-}
- Dichromate: $Cr_2O_7^{2-}$
- Phosphate: PO_4^{3-}
- Phosphite: PO_3^{3-}
- Ammonium: NH_4^{1+}
  (One of the few positive polyatomic ions)

If the polyatomic ion begins with H, then combine the word hydrogen with the other polyatomic ion present:

$H^{1+} + CO_3^{2-} \rightarrow HCO_3^{1-}$

hydrogen + carbonate → hydrogen carbonate ion

REVIEW QUESTIONS

- Page 258
  - #s 3 – 9.
  - Guided Reading Sheet

NAMING AND WRITING FORMULAS FOR IONIC COMPOUNDS

- OBJECTIVES:
  - Apply the rules for *naming and writing formulas* for binary ionic compounds.

NAMING AND WRITING FORMULAS FOR IONIC COMPOUNDS

- OBJECTIVES:
  - Apply the rules for *naming and writing formulas* for compounds containing polyatomic ions.

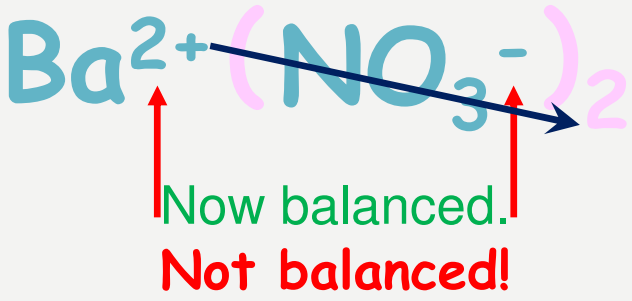
WRITING IONIC COMPOUND FORMULAS

Example: Barium nitrate (note the 2 word name)

1. Write the formulas for the cation and anion, including CHARGES!

2. Check to see if charges are balanced.

3. Balance charges , if necessary, using subscripts. Use parentheses if you need more than one of a polyatomic ion. Use the *criss-cross* method to balance subscripts.



$= Ba(NO_3)_2$

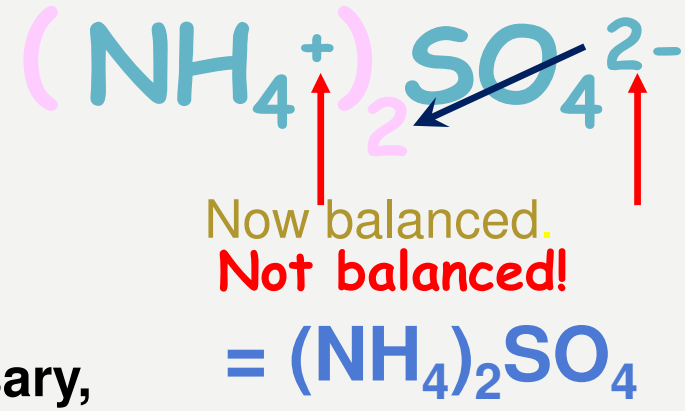
WRITING IONIC COMPOUND FORMULAS

Example: Ammonium sulfate (note the 2 word name)

1. Write the formulas for the cation and anion, including CHARGES!

2. Check to see if charges are balanced.

3. Balance charges , if necessary, using subscripts. Use parentheses if you need more than one of a polyatomic ion. Use the *criss-cross* method to balance the subscripts.



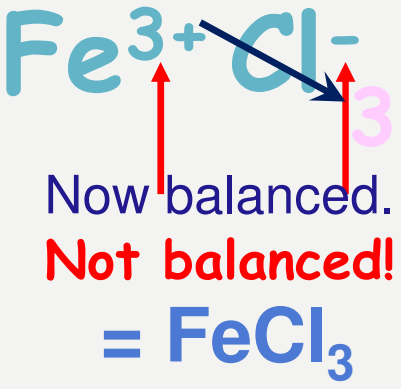
WRITING IONIC COMPOUND FORMULAS

Example: Iron (III) chloride (note the 2 word name)

1. Write the formulas for the cation and anion, including CHARGES!

2. Check to see if charges are balanced.

3. Balance charges , if necessary, using subscripts. Use parentheses if you need more than one of a polyatomic ion. Use the *criss-cross* method to balance the subscripts.



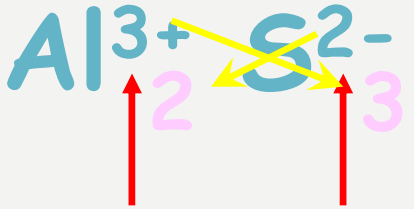
WRITING IONIC COMPOUND FORMULAS

Example: Aluminum sulfide (note the 2 word name)

1. Write the formulas for the cation and anion, including CHARGES!

2. Check to see if charges are balanced.

3. Balance charges , if necessary, using subscripts. Use parentheses if you need more than one of a polyatomic ion. Use the *criss-cross* method to balance the subscripts.



Not balanced!

Now balanced.

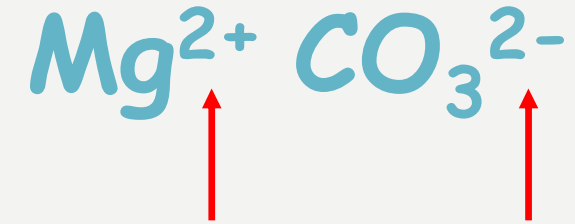
= Al_2S_3

WRITING IONIC COMPOUND FORMULAS

Example: Magnesium carbonate **(note the 2 word name)**

1. Write the formulas for the cation and anion, including CHARGES!

2. Check to see if charges are balanced.



They are balanced!

$= MgCO_3$

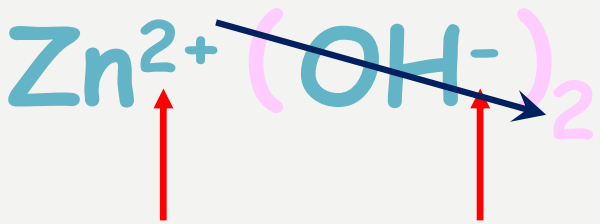
WRITING IONIC COMPOUND FORMULAS

Example: Zinc hydroxide (note the 2 word name)

1. Write the formulas for the cation and anion, including CHARGES!

2. Check to see if charges are balanced.

3. Balance charges , if necessary, using subscripts. Use parentheses if you need more than one of a polyatomic ion. Use the *criss-cross* method to balance the subscripts.



Not balanced!

$= Zn(OH)_2$

Now balanced.

WRITING IONIC COMPOUND FORMULAS

Example: Aluminum phosphate **(note the 2 word name)**

1. Write the formulas for the cation and anion, including CHARGES!

2. Check to see if charges are balanced.

Al^{3+} PO_4^{3-}

They ARE balanced!

= $AlPO_4$

NAMING IONIC COMPOUNDS

- 1. Name the cation first, then anion
- 2. Monatomic cation = name of the element

Ca^{2+} = calcium ion

- 3. Monatomic anion = root + -ide

Cl^- = chloride

$CaCl_2$ = calcium chloride

NAMING IONIC COMPOUNDS

(Metals with multiple oxidation states)

- some metals can form more than one charge (usually the transition metals)
- use a Roman numeral in their name:

$PbCl_2$ – use the ***anion*** to find the charge on the cation (chloride is always 1-)

Pb^{2+} is the lead (II) cation

$PbCl_2$ = lead (II) chloride

THINGS TO LOOK FOR:

1) If cations have ( ), the number in parenthesis is their charge.
2) If anions end in -ide they are probably off the periodic table (Monoatomic)
3) If anion ends in -ate or –ite, then it is polyatomic

PRACTICE BY WRITING THE FORMULA OR NAME AS REQUIRED…

- Iron (II) Phosphate
- Stannous Fluoride
- Potassium Sulfide
- Ammonium Chromate
- $MgSO_4$
- $FeCl_3$

PRACTICE

- Page 267
  - #s 17 – 19.
  - Chapter 9.2 practice problems from worksheet.