Chemical Names & Formulas

Chapter 9

Quick Reminders (*or brand new?*)

- A compound is a chemical combination of two or more elements (like the pre-class ones).

- **Subscripts** indicate how many atoms of an element are present.
  - H_2O = 2 Hydrogen, 1 Oxygen
  - CO_2 = 1 Carbon, 2 Oxygen

- *Note that subscripts only apply to the letter next to them (unless there are parentheses).*

Quick Reminders (*or brand new?*)

- Chemists don't write ones.
  - Na^+ has a charge of 1+.
  - Cl^- has a charge of 1-.
  - K_2S has **<u>one</u>** sulfur atom.

Quick Reminders (*or brand new?*)

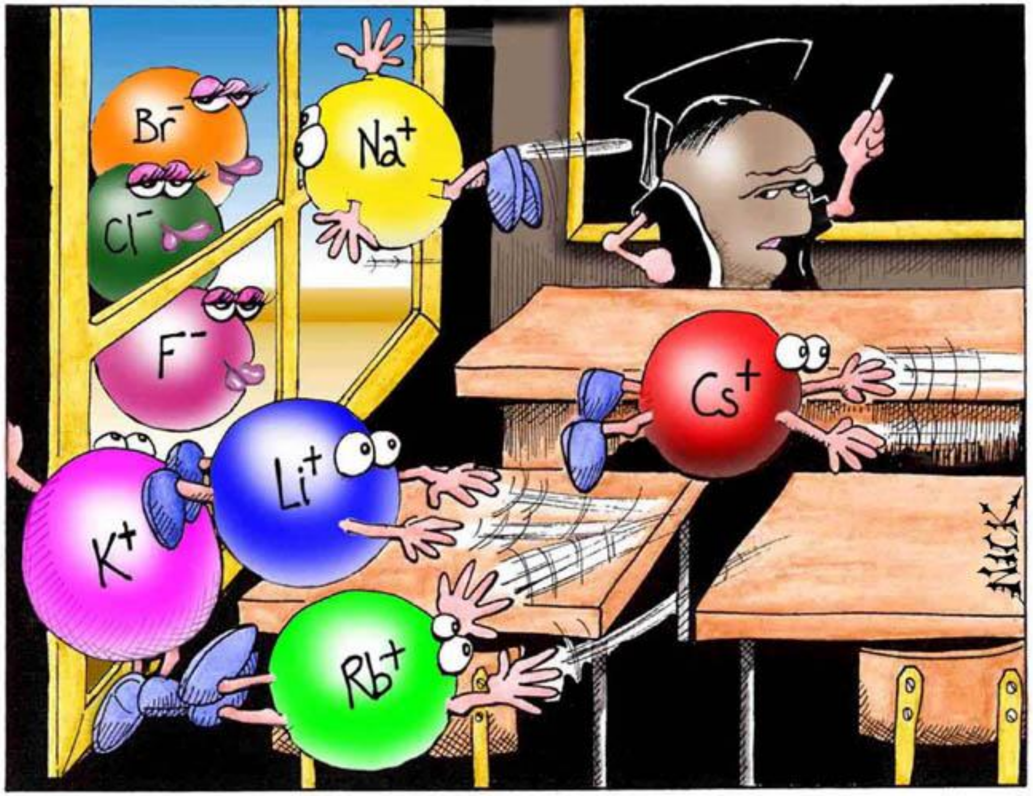
- For elements whose symbols have two letters (or even three), only the first letter is capitalized.
  - For example, Cesium is abbreviated Cs.
  - If you write CS, another person might think it's a compound of Carbon (C) and Sulfur (S).

Review

- What is a cation?
- Which group of elements tend to form cations?
- What is an anion?
- Which group of elements tend to form anions?

Cations and Anions

- And since cations and anions attract one another…
- They form ionic bonds, making ionic compounds.



"Perhaps one of you gentlemen would mind telling me just what it is outside the window that you find so attractive..?"

Need to Know Information

- What kind of elements are involved?
  - Metal, nonmetal, or metalloid.
- How many elements are there?
  - 2 – binary compound
  - 3 – ternary compound (usually has a polyatomic ion)
- What kind of charge does it create?
  - Positive, negative, or neutral.
- Are there <u>polyatomic ions</u>?

Predicting Ionic Charges

Alkali - Group 1A: Lose 1 electron to form 1+ ions

H^+ Li^+ Na^+ K^+

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 18.9984032	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)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (289) (287)		116 (289)		

Predicting Ionic Charges

<u>Alkaline Earth - Group 2A</u>: Loses 2 electrons to form 2+ ions

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

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 18.9984032	10 Ne 20.1797
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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

<u>Group 3A</u>: Loses 3 electrons to form 3+ ions

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

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 18.9984032	10 Ne 20.1797
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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

Neither! Group 4A elements rarely form ions.

<u>Group 4A</u>: Lose 4 electrons or gain 4 electrons?

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 18.9984032	10 Ne 20.1797
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Predicting Ionic Charges

N^{3-} Nitride

P^{3-} Phosphide

As^{3-} Arsenide

<u>Group 5A</u>: Gains 3 electrons to form $3-$ ions

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 18.9984032	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
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Predicting Ionic Charges

O^{2-} Oxide

S^{2-} Sulfide

Se^{2-} Selenide

<u>Group 6A</u>: Gains 2 electrons to form 2- ions

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 18.9984032	10 Ne 20.1797
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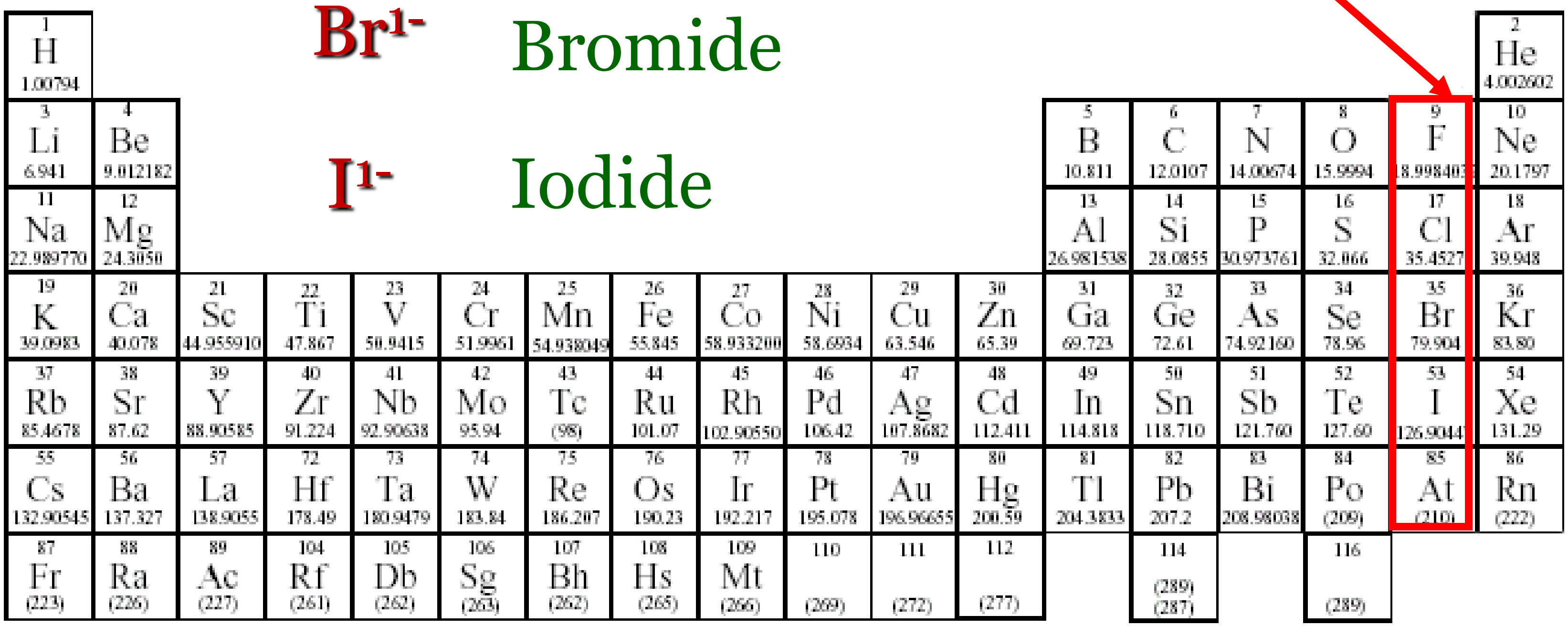
Predicting Ionic Charges

Halogens

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

F^{1-}	Fluoride
Cl^{1-}	Chloride
Br^{1-}	Bromide
I^{1-}	Iodide



Predicting Ionic Charges

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

1 H 1.00794																	2 He 4.002602
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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
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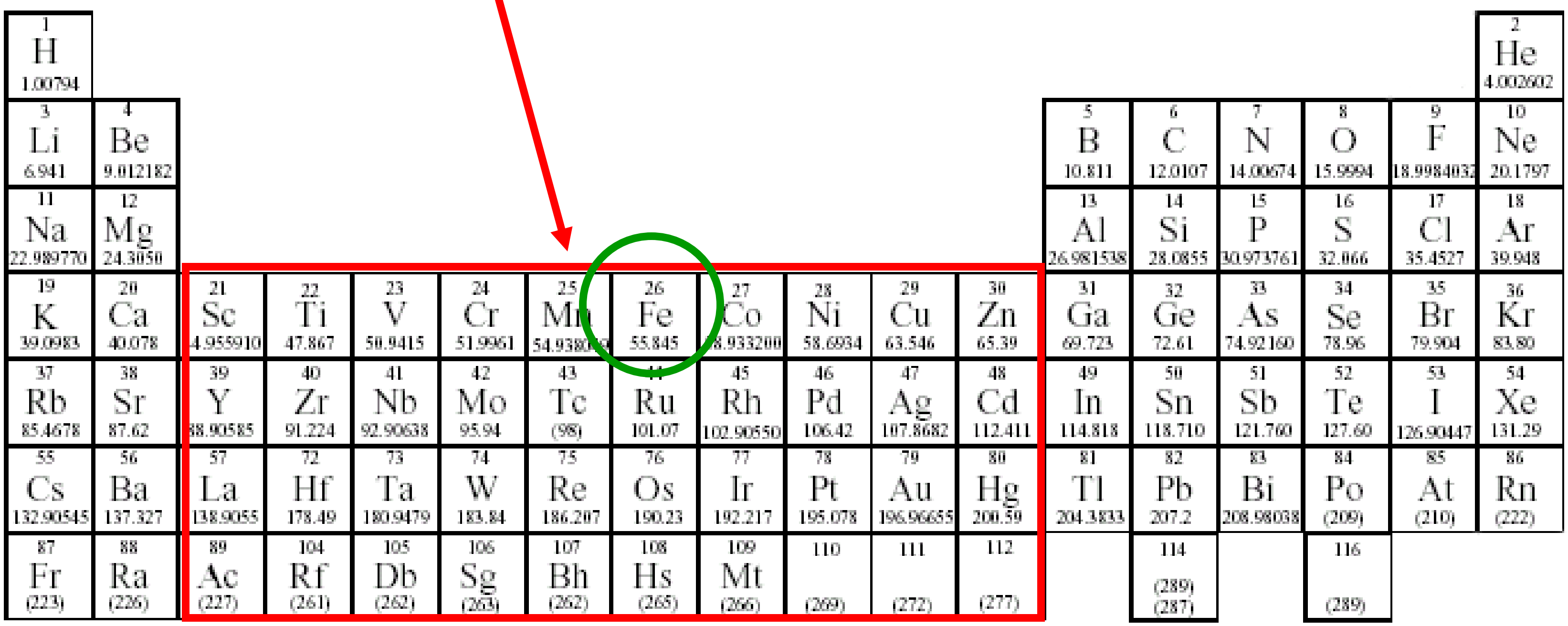
Predicting Ionic Charges

<u>Groups 1B-8B</u>: Many transition elements have more than one possible oxidation state.

Iron(II) = Fe^{2+}

Iron(III) = Fe^{3+}



Common Multivalent Elements

- Copper (Cu) – either 1 or 2 valence electrons.
  - Copper (I) or Copper (II) – 1^+ or 2^+
- Nickel (Ni) – either 2 or 3 valence electrons.
  - Nickel (II) or Nickel (III) – 2^+ or 3^+
- Iron (Fe) – either 2 or 3 valence electrons.
  - Iron (II) or Iron (III) – 2^+ or 3^+
- Lead (Pb) – either 2 or 4 valence electrons.
  - Lead (II) or Lead (IV) – 2^+ or 4^+
- Tin (Sn) – either 2 or 4 valence electrons.
  - Tin (II) or Tin (IV) – 2^+ or 4^+
- Mercury (Hg) – either 1 or 2 valence electrons.
  - Mercury (I) or Mercury (II) – 1^+ or 2^+

Predicting Ionic Charges

<u>Groups 1B-8B</u>: **Some transition elements have only one possible oxidation state.**

Zinc = Zn^{2+}

Silver = Ag^{+}

Nickel= Ni^{2+}

Gold= Au^{3+}

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 18.9984032	10 Ne 20.1797
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Binary Ionic Compounds

- What does binary mean?
  - Two
  - Contains 2 elements
- What is an ionic compound?
  - Formed between a metal and a nonmetal

Binary Ionic Compou

Example

Potassium and Fluorine

- **Elements to Formulas**
  - Identify cation/anion (**with charges)**
  - ***Roman numerals for transition & other multivalent metals!***

Cation – K^+

Anion– F^-

  - Put the cation symbol first, then the anion

$K^+ F^-$

  - Drop & Cross to balance charges

KF

Binary Ionic Compounds Practice

- Calcium and Bromine
- Copper(II) and Oxygen
- Lithium and Sulfur
- Mercury(I) and Oxygen
- Aluminum and Chlorine
- Lead(IV) and Sulfur
- Potassium and Sulfur
- Beryllium and Bromine
- Cobalt(II) and Phosphorus
- Tin(IV) and Chlorine

Binary Ionic Compounds

Example
KF

- **Formulas to Names**
  - Write the name of the cation (*Roman numerals with multivalent transition metals*)

K^+– Potassium

  - Write the name of the anion
    - Drop the ending
    - Add **–ide**

F^-– Fluorine becomes Fluoride

  - Combine cation then anion

Potassium fluoride

Binary Ionic Compounds Practice

- $CaBr_2$
- Hg_2O
- $NaCl$
- $CoCl_2$
- $AlCl_3$
- K_2S
- $CrCl_2$
- Na_3P

Binary Ionic Compounds *with Transition Metals*

Example
Iron(III) and Chlorine

- **Elements to Formulas**
  - Identify cation/anion (**with charges**)

Cation – Fe^{3+}

Anion– Cl^{-}

  - Put the cation symbol first, then the anion

Fe^{3+} Cl^{-}

  - Drop & Cross to balance charges

$FeCl_3$

Binary Ionic Compounds Practice

- Copper(II) and Oxygen
- Mercury(I) and Oxygen
- Lead(IV) and Sulfur
- Cobalt(II) and Chlorine
- Tin(IV) and Chlorine
- Cobalt(III) and Iodine
- Silver and Bromine
- Chromium(II) and Chlorine

Binary Ionic Compounds *with Transition Metals*

Example
$FeCl_3$

- **Formulas to Names**
  - "**Uncross**" to find charge
  - Write the name of the cation **with roman numeral**

Fe^{3+}– Iron(III)

  - Write the name of the anion
    - Drop the ending
    - Add **–ide**

Cl^{-}– Chlorine becomes Chloride

  - Combine cation then anion

Iron(III) Chloride

Binary Ionic Compounds Practice

- Hg_2O
- CuO
- Pb_2S_4
- $CoCl_2$
- $SnCl_4$
- CoI_3
- $AgBr$
- $CrCl_2$

Compounds *with* Pol

Example

Sodium and Carbonate

- **Elements/Polyatomics**
  - Identify cation/anion (**with charges**)
  - Identify the polyatomic ion (**with charges**)

Cation – Na^{1+}

Negative Polyatomic – CO_3^{2-}

  - Put the cation/positive polyatomic symbol first, then the anion/negative polyatomic

Na^{1+} CO_3^{2-}

  - Drop & Cross to balance charges. Put polyatomics in ( ) if more than one.

Na_2CO_3

Compounds with Polyatomics Practice

- Ammonium and Oxygen
- Potassium and Nitrate
- Lead(IV) and Dichromate
- Calcium and Hydroxide
- Lithium and Sulfate
- Calcium and Permanganate
- Sodium and Chlorate
- Magnesium and Phosphate

Compounds *with Polyato*

Example
Na_2CO_3

- **Formulas to Names**
  - Look for the polyatomic – ***it can be 1st or 2nd***
  - "**Uncross**" to find charge

Na^{1+}– Sodium

CO_3^{2-}– Carbonate

  - Write the name
    - If the polyatomic is 1st, end the anion with **–ide**
    - If the polyatomic is 2nd, cation is written as normal and polyatomic is normal

Sodium Carbonate

Compounds with Polyatomics Practice

- NH_4Cl
- KNO_3
- $Ca(OH)_2$
- $Pb(Cr_2O_7)_2$
- Li_2SO_4
- $Ca(MnO_4)_2$
- $NaClO_3$
- $Mg_3(PO_4)_2$

Name or Write a Formula for the following examples…

- NaOH
- Beryllium Sulfate
- Tin(II) Iodide
- Aluminum Cyanide
- Zinc Hydroxide
- Co_3N_2
- Ag_2SO_3
- Mg_3P_2
- Beryllium Acetate
- Fe_3N_2
- $Ga(NO_2)_3$
- Silver Sulfide

Naming Acids

- Acids contain 1 or more H atoms
  - H is the first element listed!
- If anion ends with **–ide** (halogens)…
  - Acid name begins with **hydro–**
  - Stem of anion ends with **–ic**
  - End the name by writing **acid**
- For polyatomics…
  - **–ite** endings become **–ous**, followed by **acid**
  - **–ate** endings become **–ic**, followed by **acid**

Example
HCl

hydrochloric acid

Example
H_2SO_4

SO_4^{2-} - Sulfate

sulfuric acid

Naming Acids Practice

- HCl
  - Cl^- would be chlor<u>ide</u>, so it's <u>hydro</u>chlor<u>ic</u> <u>acid</u>.
- H_2SO_4
  - SO_4^{2-} would be sulf<u>ate</u>, so it's sulfur<u>ic</u> <u>acid</u>.
- $HClO_2$
  - ClO_2^- would be chlor<u>ite</u>, so it's chlor<u>ous</u> <u>acid</u>.

Writing Acid Formulas

- Hydrogen forms a 1+ charge in acids.
  - *first element listed!*

<u>Example</u>
Nitric acid

- Identify the anion (halogen or polyatomic)
  - Write the formula with charge

$\mathbf{H^+ \, NO_3^{\,-}}$
– ic means an –ate polyatomic

- Drop & Cross

$\mathbf{HNO_3}$

Writing Acid Formulas

- Bromic Acid
  - $HBrO_3$
- Hydroiodic Acid
  - HI
- Carbonous Acid
  - H_2CO_2
- Nitrous Acid
  - HNO_2

Overall Acid Practice

- H_2CO_3
- Hydroiodic acid
- $HC_2H_3O_2$
- HBr
- Chloric acid
- H_2CO_3
- Hydrofluoric acid
- H_3PO_3

Binary Molecular Compounds

- Review
  - Binary = 2 elements

- What is an molecular compound?
  - Composed of 2 nonmetals
  - Composed of molecules, not ions…no charges!

Binary Molecular Compounds

- **Prefixes** are used to indicate how many atoms of an element are present in the compound.

Prefix	Meaning
Mono –	1
Di –	2
Tri –	3
Tetra –	4
Penta –	5
Hexa –	6
Hepta –	7
Octa –	8
Nona –	9
Deca –	10

Naming Binary Molecular Compounds

- Confirm that the two elements are nonmetals
- Name the 1st element
  - If only 1 of the 1st element omit prefix
  - If more than 1 of the 1st element use prefix
- Name the 2nd element (the more EN element)
  - Always use a prefix
  - Add **-ide** ending

<u>Example</u>
CO

C – carbon

O – *mono*xide

carbon monoxide

Molecular Naming Practice

Compound Formula	Compound Name
N_2O_4	
SO_3	
NO	
NO_2	
As_2O_5	
PCl_3	
CCl_4	
SeF_6	

Molecular Formula Practice

Compound Formula	Compound Name
	Dinitrogen Triiodide
	Diphosphorus pentoxide
	Dinitrogen monoxide
	Silicon dioxide
	Carbon tetrabromide
	Sulfur dioxide
	Phosphorus pentabromide
	Iodine trichloride

Overall Molecular Compounds Practice

- PCl_3
- Diphosphorus trioxide
- SF_6
- Carbon dioxide
- C_2H_6
- CCl_4
- Dichlorine octoxide
- N_2O