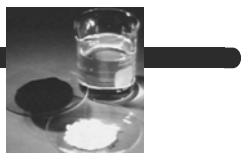


## Chapter 2

### Nomenclature



## Recognizing Bonding Patterns

- Place the following formulas into groups:

- HCl (aq)
- CO<sub>2</sub>
- H<sub>2</sub>SO<sub>4</sub> (aq)
- NiCl<sub>2</sub>
- H<sub>2</sub>O
- KNO<sub>3</sub>
- CH<sub>3</sub>CH<sub>2</sub>CH<sub>3</sub>
- SO<sub>2</sub>
- NaBr
- H<sub>3</sub>PO<sub>4</sub> (aq)
- P<sub>2</sub>O<sub>5</sub>
- BaSO<sub>4</sub>
- CoF<sub>3</sub>
- HI (aq)

## Binary Covalent Compounds: 2 Nonmetals

- Write the most metallic element first
  - Use prefixes to indicate number of atoms (can't use charges to balance formulas)
  - First element name; second element ends in **-ide**
- |                        |              |
|------------------------|--------------|
| • Mono: 1              | <b>mono</b>  |
| • Di: 2                | <b>di</b>    |
| • Tri: 3 (triathlon)   | <b>tri</b>   |
| • Tetra: 4 (tetrakis)  | <b>tetra</b> |
| • Penta: 5 (pentagon)  | <b>penta</b> |
| • Hexa: 6 (hexagon)    | <b>hexa</b>  |
| • Hepta: 7             | <b>hepta</b> |
| • Octa: 8 (octagon)    | <b>octa</b>  |
| • Nona: 9 (nano)       | <b>nona</b>  |
| • Deca: 10 (decathlon) | <b>deca</b>  |

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## Binary Covalent Compounds: 2 Nonmetals

- Use mono to indicate 1 atom unless the first atom has only 1, then it's dropped.
  - ♦ SO<sub>3</sub> is sulfur trioxide
- Group Work: Write the name for NO<sub>2</sub>
- Group Work: Write the formula for dinitrogen pentoxide

## Binary Covalent Compounds: Group Work

- Write formulas for the following names:
  - ♦ silicon tetrachloride
  - ♦ carbon monoxide
  - ♦ tetraphosphorus hexaoxide
- Write names for the following formulas:
  - ♦ N<sub>2</sub>O<sub>4</sub>
  - ♦ Cl<sub>2</sub>O<sub>7</sub>
  - ♦ SF<sub>6</sub>
- Worked Ex. 2.11; Problems 2.19, 2.20; Key Concept 2.21

## Common Charges of Ions

- Figure 2.11

1 1A H <sup>+</sup>	2 2A Hydride	13 3A	14 4A	15 5A N <sup>3-</sup> Nitride	16 6A O <sup>2-</sup> Oxide	17 7A F <sup>-</sup> Fluoride	18 8A
Li <sup>+</sup>	Ba <sup>2+</sup>						
Na <sup>+</sup>	Mg <sup>2+</sup>	Al <sup>3+</sup>			S <sup>2-</sup> Sulfide	Cl <sup>-</sup> Chloride	
K <sup>+</sup>	Cu <sup>2+</sup>	Ga <sup>3+</sup>			Se <sup>2-</sup> Selenide	Br <sup>-</sup> Bromide	
Rb <sup>+</sup>	Sr <sup>2+</sup>	In <sup>3+</sup>	Sn <sup>2+</sup> Sn <sup>4+</sup>		Te <sup>2-</sup> Telluride	I <sup>-</sup> Iodide	
Cs <sup>+</sup>	Ba <sup>2+</sup>	Tl <sup>+</sup> Tl <sup>3+</sup>	Pb <sup>2+</sup> Pb <sup>4+</sup>				

## Common Charges of Transition Metals

- Figure 2.12



3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 9B	10 10B	11 11B	12 12B
Sc <sup>3+</sup>	Ti <sup>3+</sup>	V <sup>3+</sup>	Cr <sup>2+</sup> Cr <sup>3+</sup>	Mn <sup>2+</sup>	Fe <sup>2+</sup> Fe <sup>3+</sup>	Co <sup>2+</sup>	Ni <sup>2+</sup>	Cu <sup>2+</sup>	Zn <sup>2+</sup>
					Ru <sup>3+</sup>	Rh <sup>3+</sup>	Pd <sup>2+</sup>	Ag <sup>+</sup>	Cd <sup>2+</sup>
									Hg <sup>2+</sup>

Figure 2-12 Chemistry, 5/e  
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## Practice on Ionic Charges: Group Work

- What are the common charges when atoms of the following elements become **ions**:
  - ♦ potassium
  - ♦ sulfur
  - ♦ chlorine
  - ♦ magnesium
  - ♦ nitrogen
  - ♦ cobalt
  - ♦ silver
  - ♦ zinc
  - ♦ cadmium

## Writing Formulas – Ionic Compounds

- The short-cut to writing formulas is similar to cross-multiplying. Cross the charge of one ion to become the number needed for the other ion.
  - ♦ Na<sup>1+</sup> and O<sup>2-</sup> → Na<sub>2</sub>O
- Short-cut doesn't always work.
  - ♦ FeO: iron doesn't have a +1 charge, so we have to know that oxygen is usually a -2. Then we know that iron must have a +2 charge in this compound.

## Writing Ionic Formulas

- Write the formulas of compounds made by the following pairs of ions.
  - Na + F
  - Na + S
  - Na + N
  - Mg + N
  - Ba + Cl
  - Ba + O
  - Al + Cl

## Group Work

- Write neutral ionic formulas using the following pairs of **ions** :
  - ♦ Ba and Cl
  - ♦ Co<sup>+2</sup> and N
  - ♦ Fe<sup>+3</sup> and N
  - ♦ K and P
  - ♦ Zn and O

## Metal vs Nonmetal Ions

- **Metal** atoms and **metal** ions are named the same.
  - ♦ Na: sodium
  - ♦ Na<sup>+</sup>: sodium ion
- **Nonmetal** atoms and **nonmetal** ions differ in the suffix (e.g., -ine becomes -ide)
  - ♦ F: fluorine
  - ♦ F<sup>-</sup>: fluoride ion
  - ♦ N: nitrogen
  - ♦ N<sup>3-</sup>: nitride

## Binary Ionic Compounds (2 elements)

- Metal cation + nonmetal anion
- NaCl
  - ◆ Sodium chloride
- LiF
  - ◆ Lithium fluoride
- CaBr<sub>2</sub>
  - ◆ Calcium bromide
- Transition metals: include charge of metal in the name
  - ◆ FeCl<sub>3</sub>: iron (III) chloride
  - ◆ CuF<sub>2</sub>: copper (II) fluoride



## Binary Ionic Compounds: Group Work

- Write formulas for the following names:
  - ◆ aluminum bromide
  - ◆ titanium(IV) chloride
  - ◆ chromium(III) sulfide
- Write names for the following formulas:
  - ◆ Ba<sub>3</sub>N<sub>2</sub>
  - ◆ K<sub>2</sub>S
  - ◆ MnF<sub>2</sub>
- Worked Ex. 2.10, Problems 2.16, 2.17

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## Polyatomic Ions - Oxoanions

- Most common ions (**KNOW** Tables 2.3 and 2.4, handout on my website):
  - ◆ CO<sub>3</sub><sup>2-</sup> carbonate
  - ◆ NO<sub>3</sub><sup>-</sup> nitrate
  - ◆ PO<sub>4</sub><sup>3-</sup> phosphate
  - ◆ SO<sub>4</sub><sup>2-</sup> sulfate
  - ◆ OH<sup>-</sup> hydroxide
  - ◆ NH<sub>4</sub><sup>+</sup>: ammonium

## Polyatomic Ions

TABLE 2.3 Some Common Polyatomic Ions

Formula	Name	Formula	Name
<b>Cation</b>		<b>Singly charged anions (continued)</b>	
NH <sub>4</sub> <sup>+</sup>	Ammonium	NO <sub>2</sub> <sup>-</sup>	Nitrite
		NO <sub>3</sub> <sup>-</sup>	Nitrate
<b>Singly charged anions</b>		<b>Doubly charged anions</b>	
CH <sub>3</sub> CO <sub>2</sub> <sup>-</sup>	Acetate	CO <sub>3</sub> <sup>2-</sup>	Carbonate
CN <sup>-</sup>	Cyanide	CrO <sub>4</sub> <sup>2-</sup>	Chromate
ClO <sup>-</sup>	Hypochlorite	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	Dichromate
ClO <sub>2</sub> <sup>-</sup>	Chlorite	O <sub>2</sub> <sup>2-</sup>	Peroxide
ClO <sub>3</sub> <sup>-</sup>	Chlorate	HPO <sub>4</sub> <sup>2-</sup>	Hydrogen phosphate
ClO <sub>4</sub> <sup>-</sup>	Perchlorate	SO <sub>3</sub> <sup>2-</sup>	Sulfite
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	Dihydrogen phosphate	SO <sub>4</sub> <sup>2-</sup>	Sulfate
HCO <sub>3</sub> <sup>-</sup>	Hydrogen carbonate (or bicarbonate)	S <sub>2</sub> O <sub>3</sub> <sup>2-</sup>	Thiosulfate
HSO <sub>4</sub> <sup>-</sup>	Hydrogen sulfate (or bisulfate)	<b>Triply charged anion</b>	
OH <sup>-</sup>	Hydroxide	PO <sub>4</sub> <sup>3-</sup>	Phosphate
MnO <sub>4</sub> <sup>-</sup>	Permanganate		

## Oxoanion Nomenclature

- 1 More oxygen: per-\_\_ -ate
- **Most common:** \_\_ -ate
- 1 Less oxygen: \_\_ -ite
- Still fewer: hypo-\_\_ -ite



- What is the name of NaClO?
- What is the formula for sodium chlorate?
- What is the name of FePO<sub>4</sub>?

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## Nomenclature with Polyatomic Ions

- Name compounds with polyatomic ions just like binary ionic, but use the name of the polyatomic ion.
- NaNO<sub>3</sub>
  - ◆ sodium nitrate
- K<sub>3</sub>PO<sub>4</sub>
  - ◆ potassium phosphate
- Cu(OH)<sub>2</sub>
  - ◆ copper (II) hydroxide
- You must be able to recognize when the formula contains a polyatomic ion!

## Ionic Nomenclature

- **Write formulas:**
- Iron (III) phosphate
- Nickel (II) fluoride
- Calcium sulfide
- Cadmium phosphite
- Vanadium (IV) sulfate
- Potassium chromate
- Worked Ex. 2.12, 2.13
- **Write names:**
- ScS
- $Zn_3N_2$
- $AgNO_3$
- LiOH
- $SrSO_3$
- $Cu(CH_3COO)_2$
- Problems 2.22, 2.23; Key Concept 2.24

## Acids and Bases

- Hydrogen cation ( $H^+$ ), also called the proton
- Hydroxide anion ( $OH^-$ )
- Acid: substance that produces  $H^+$  in water
  - ♦  $HCl, HNO_3, H_2SO_4, H_3PO_4$
  - ♦  $HCl$  dissolves in water  $\rightarrow H^+(aq) + Cl^-(aq)$
  - ♦  $HNO_3$  in water  $\rightarrow H^+(aq) + NO_3^-(aq)$
- Base: substance that produces  $OH^-$  in water
  - ♦  $NaOH, KOH, Ba(OH)_2$
  - ♦  $NaOH$  dissolves in water  $\rightarrow Na^+(aq) + OH^-(aq)$

## Binary Acids ( $H^+$ + halogen anion)

- Acids produce  $H^+$  when dissolved in water
- **hydro-\_\_-ic acid**
- Name the following acids:
  - $HBr(aq)$
  - $HCl(aq)$
  - $HI(aq)$
  - $HF(aq)$

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## Binary Acids

**TABLE 2.5** Some Simple Acids

Anion	Corresponding Acid
$F^-$ (fluoride)	$HF$ (hydrofluoric acid)
$Cl^-$ (chloride)	$HCl$ (hydrochloric acid)
$Br^-$ (bromide)	$HBr$ (hydrobromic acid)
$I^-$ (iodide)	$HI$ (hydroiodic acid)

## Oxoacids

- Oxoacids
- Name is based on the name of the oxoanion:
  - ♦ per- -ate per- -ic acid
  - ♦ -ate -ic acid
  - ♦ -ite -ous acid
  - ♦ hypo- -ite hypo- -ous acid
- Name  $HNO_3(aq)$
- Name  $H_2SO_4(aq)$
- Write the formula for phosphoric acid
- Write the formula for phosphorous acid
- Worked Ex. 2.14; Problem 2.25

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## Oxoacid Nomenclature

**TABLE 2.4** Some Common Oxoacids and Their Anions

Oxoacid	Oxoanion
$HNO_2$	Nitrous acid
$HNO_3$	Nitric acid
$H_3PO_4$	Phosphoric acid
$H_2SO_3$	Sulfurous acid
$H_2SO_4$	Sulfuric acid
$HClO$	Hypochlorous acid
$HClO_2$	Chlorous acid
$HClO_3$	Chloric acid
$HClO_4$	Perchloric acid
$NO_2^-$	Nitrite ion
$NO_3^-$	Nitrate ion
$PO_4^{3-}$	Phosphate ion
$SO_3^{2-}$	Sulfite ion
$SO_4^{2-}$	Sulfate ion
$ClO^-$	Hypochlorite ion
$ClO_2^-$	Chlorite ion
$ClO_3^-$	Chlorate ion
$ClO_4^-$	Perchlorate ion

Table 2-4 Chemistry, 5/e  
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## Nomenclature Summary

- Is the compound covalent, ionic, or acid?
- If covalent, use prefixes to describe numbers of atoms.
- If ionic, name metal + nonmetal-ide
  - ◆ Is the metal a transition metal, lead, or tin? If so, use roman numerals.
  - ◆ Is the nonmetal a polyatomic ion? If so, use the special name for the ion rather than the -ide ending.
- If acid, is it binary or oxoacid?
  - ◆ If binary, use hydro-\_\_\_\_-ic acid
  - ◆ If oxoacid, use oxoanion name (-ate → -ic, etc.)

## Nomenclature

- diphosphorus tetroxide
- XeF<sub>4</sub>
- carbon tetrachloride
- aluminum oxide
- SnO<sub>2</sub>
- PbF<sub>2</sub>
- copper (II) nitrate
- chromium (VI) oxide
- H<sub>2</sub>SO<sub>3</sub> (aq)
- calcium carbonate
- Cr<sub>2</sub>O<sub>3</sub>
- H<sub>2</sub>CO<sub>3</sub> (aq)
- iron (III) oxide
- SiO<sub>2</sub>
- TiCl<sub>3</sub>
- sulfurous acid
- P<sub>4</sub>O<sub>10</sub>
- lead (II) chromate
- HBr (aq)
- hydrofluoric acid

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## Nomenclature Answers

- P<sub>2</sub>O<sub>4</sub>
- xenon tetrafluoride
- CCl<sub>4</sub>
- Al<sub>2</sub>O<sub>3</sub>
- tin (IV) oxide
- lead (II) fluoride
- Cu(NO<sub>3</sub>)<sub>2</sub>
- CrO<sub>3</sub>
- sulfurous acid
- CaCO<sub>3</sub>
- chromium (III) oxide
- carbonic acid
- Fe<sub>2</sub>O<sub>3</sub>
- silicon dioxide
- titanium (III) chloride
- H<sub>2</sub>SO<sub>3</sub> (aq)
- tetraphosphorus decoxide
- PbCrO<sub>4</sub>
- hydrobromic acid
- HF (aq)