

Chapter 2 – part B

Acids & Bases
Nomenclature

Acids & Bases
H = hydrogen atom

H⁺ = hydrogen ion (*proton*)
 A substance that *donates* H⁺ ions in water = acid

OH⁻ = hydroxide ion
 A substance that *donates* OH⁻ ions in water = base

More realistic definition is
"Any substance that accepts an H⁺ ion".

Strong Acids vs. Weak acids

Strong acids *completely* ionize in water to form H⁺ ion and the corresponding anion.

HCl (g) $\xrightarrow{\text{H}_2\text{O}}$

HNO₃ (l) $\xrightarrow{\text{H}_2\text{O}}$

H₂SO₄ (l) $\xrightarrow{\text{H}_2\text{O}}$

H₃PO₄ (l) $\xrightarrow{\text{H}_2\text{O}}$

Weak acids *slightly* ionize in water and remain in the molecular form.

HC₂H₃O₂ (l) \rightleftharpoons H⁺ (aq) + C₂H₃O₂⁻ (aq)

Strong Bases vs. Weak Bases

Strong bases *completely* ionize in water to form OH⁻ ion and the corresponding cation.

NaOH (s) $\xrightarrow{\text{H}_2\text{O}}$

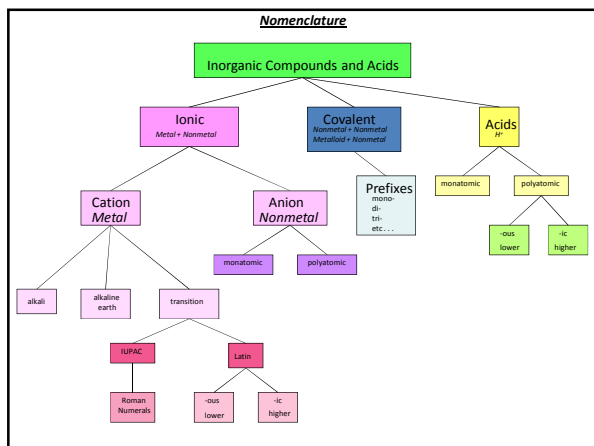
KOH (s) $\xrightarrow{\text{H}_2\text{O}}$

Ba(OH)₂ (s) $\xrightarrow{\text{H}_2\text{O}}$

NH₃ (l) $\xrightarrow{\text{H}_2\text{O}}$

Weak bases *slightly* ionize in water and remain in the molecular form.

You'll learn more acid/base chemistry in CHM152 (chapter 15).



A. Metal Cation From a Representative Metal Plus a Monatomic Anion

The metal cation is *always* first.
 The nonmetal monatomic anion gets a new ending *-ide*.

Name the metal then name the nonmetal with -ide ending

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

A. Metal Cation From a Representative Metal Plus a Monatomic Anion

When writing a formula from a name, cross down the number NOT the charge.



- | | |
|-----------------------------------|-----------------------|
| 1. NaCl | 7. strontium oxide |
| 2. BaBr ₂ | 8. gallium fluoride |
| 3. MgO | 9. lithium nitride |
| 4. Al ₂ S ₃ | 10. barium phosphide |
| 5. Ca ₃ N ₂ | 11. beryllium sulfide |
| 6. BeF ₂ | 12. aluminum iodide |

B. Transition Metal Cation plus Monatomic Anion

Use Roman Numerals to Indicate the Charge of the Transition Metal

| | | | |
|------------------|--------------------|--------------------|-------------|
| Cu ⁺ | copper (I) ion | Exceptions: | |
| Cu ²⁺ | copper (II) ion | Ag ⁺ | silver ion |
| Fe ²⁺ | iron (II) ion | Zn ²⁺ | zinc ion |
| Fe ³⁺ | iron (III) ion | Cd ²⁺ | cadmium ion |
| Mn ²⁺ | manganese (II) ion | | |
| Mn ⁴⁺ | manganese (IV) ion | | |

- | | |
|-----------------------------------|--------------------------|
| 1. Fe ₃ | 1. nickel (II) fluoride |
| 2. CuO | 2. tin (IV) sulfide |
| 3. MnO ₂ | 3. titanium (II) nitride |
| 4. Cr ₃ P ₂ | 4. mercury (II) oxide |
| 5. AgCl | 5. zinc bromide |

C. Metal Cation Plus Polyatomic Anion

Name the metal cation first, use Roman Numerals for transition metal, then name the polyatomic anion.

TABLE 2.3 Some Common Polyatomic Ions

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

The Oxoanions

NO₃⁻ ← Higher number of O = -ate ending

NO₂⁻ ← Lower number of O = -ite ending

SO₄²⁻ sulfate ion PO₄³⁻ phosphate ion
SO₃²⁻ sulfite ion PO₃³⁻ phosphite ion

ClO₄⁻ perchlorate ion
ClO₃⁻ chlorate ion
ClO₂⁻ chlorite ion
ClO⁻ hypochlorite ion

Same for F, I, and Br

D. Naming Acids

I. Monatomic acids

hydro - (name of anion) -ide acid

HI (aq) = hydroiodic acid HF (aq) = hydrofluoric acid

H₂S (aq) = hydrosulfuric acid H₂O = ????

II. Polyatomic acids

-ate endings become -ic acids

-ite endings become -ous acids

HNO₃ (aq) = nitric acid HNO₂ (aq) = nitrous acid

H₂SO₄ (aq) = sulfuric acid H₂SO₃ (aq) = sulfurous acid

HIO₄ (aq) periodic acid
HIO₃ (aq) iodic acid
HIO₂ (aq) iodous acid
HIO (aq) hypoiodous acid

TABLE 2.4 Some Common Oxoacids and Their Anions

| Oxoacid | | Oxoanion | |
|--------------------------------|-------------------|-------------------------------|------------------|
| HNO ₂ | Nitrous acid | NO ₂ ⁻ | Nitrite ion |
| HNO ₃ | Nitric acid | NO ₃ ⁻ | Nitrate ion |
| H ₃ PO ₄ | Phosphoric acid | PO ₄ ³⁻ | Phosphate ion |
| H ₂ SO ₃ | Sulfurous acid | SO ₃ ²⁻ | Sulfite ion |
| H ₂ SO ₄ | Sulfuric acid | SO ₄ ²⁻ | Sulfate ion |
| HClO | Hypochlorous acid | ClO ⁻ | Hypochlorite ion |
| HClO ₂ | Chlorous acid | ClO ₂ ⁻ | Chlorite ion |
| HClO ₃ | Chloric acid | ClO ₃ ⁻ | Chlorate ion |
| HClO ₄ | Perchloric acid | ClO ₄ ⁻ | Perchlorate ion |

E. Molecular Compounds

covalent bonds
nonmetal-nonmetal or metalloid-nonmetal

Use prefixes to indicate the number of atoms for each nonmetal.

1. Don't use mono- for the first nonmetal.
2. Add *-ide* to the ending of the second nonmetal.

Prefixes:

1 mono-
2 di-
3 tri-
4 tetra-
5 penta-
6 hexa-
7 hepta-
8 octa-
9 nona-
10 deca-

- | | |
|-------------|-------------------------------|
| 1. S_2F_2 | 1. phosphorous dichloride |
| 2. P_4O_6 | 2. dinitrogen trioxide |
| 3. NCl_3 | 3. iodine monochloride |
| 4. N_2O_3 | 4. disulfur dichloride |
| 5. BrF_3 | 5. tetraphosphorous heptoxide |
| 6. P_4O_7 | 6. silicon dioxide |