Chemistry 20

Lesson 3 – Naming compounds

# Common compounds

The following common compounds should be memorized.

O3 ozone

HOH or H2O water

NH3 ammonia

CH4 methane

C12H22O11 sucrose

CH3OH methanol

C2H5OH ethanol

H2O2 hydrogen peroxide

# Molecular elements

The following should be memorized. All metallic elements are written in the singular (Fe, K, Dy, etc.) The inert gases (He, Ne, Ar, Kr, Xe, Rn) are also monatomic. However, some nonmetals naturally occur in groups. The Group 17 elements, the halogens (F2, Cl2, Br2, I2 and As2), occur as diatomic molecules. Other diatomic molecules are H2, O2 and N2. Phosphorous occurs naturally as P4 and sulfur occurs as S8.

# Molecular compounds

A molecular compound is the result of a **sharing of electrons** between a **nonmetal** and another **nonmetal**. Unlike ionic compounds, there is no balancing of charges, therefore a number of A molecular compound is the result of a **sharing of electrons** between a **nonmetal** and another **nonmetal**. Unlike ionic compounds, there is no balancing of charges, therefore a number of compounds are possible when two nonmetals form a compound. Moreover, such compounds exist as separate and distinct **molecules**. For example, at least five compounds of phosphorous and oxygen are found in nature: P2O3, P2O4, P2O5, P4O6, and P4O10. Each of these compounds must have its own, unique name.

For **molecular compounds** we use a **prefix** system to indicate the number of each type of element present:

1 mono 6 hexa

2 di 7 hepta

3 tri 8 octa

4 tetra 9 nona

5 penta 10 deca

The **first** element is named in full, and the **second** element is shortened and given an -***ide*** suffix:

*name* **→**  *formula*

sulphur triiodide **→**  SI3

(note that the single first element often does not require a mono prefix)

nitrogen monoxide **→**  NO

*formula* **→** *name*

CO­­2 **→** carbon dioxide

N2O4 **→** dinitrogen tetraoxide

# Ionic compounds

Ionic compounds form from a **cation** (metallic ion or positive polyatomic ion) and an **anion** (non-metallic ion or a negative polyatomic ion). Since the total negative and positive charges must cancel to form a neutral compound, there is only **one unique way** to write each ionic compound. Therefore, prefixes are not required **and should never be used** for ionic compounds.

**Simple binary ionic compounds**

If the compound consists of a metal and a nonmetal, first **check the metal** to see if it is capable of forming **multiple ions** (e.g. iron (II) [Fe2+] and iron (III) [Fe3+]). On the periodic table the preferred ion is always listed first. For example, the preferred ion for iron is iron (III).

*name* **→**  *formula*

Balance the charges.

copper (II) sulfide **→**  CuS

copper (I) sulfide **→** Cu2S

*formula* **→** *name*

Indicate the ion charge using the **stock** system.

Fe2O3 **→**  iron (III) oxide

FeO **→** iron (II) oxide

If the **metal** is capable of forming only **one ion**, the charge number is not necessary and should never be included:

*name* **→** *formula*

Balance the charges.

zinc sulfide **→** ZnS

calcium chloride **→** CaCl2

*formula* **→** *name*

The **first** element (metal) is named in full and the **second** element (non-metal) is shortened and given an -***ide*** suffix.

Al2Te3 **→** aluminium telluride

GaF3 **→** gallium fluoride

**Compounds involving polyatomic compounds**

Your periodic table includes a **Table of Common Polyatomic Ions**. Note that there are far more polyatomic (complex) ions than are listed.

*formula* **→** *name*

Use full name of cation and the name of the complex ion.

SrSO4 **→** strontium sulfate

Na2SO3 **→** sodium sulfite

*name* **→** *formula*

ammonium hydrogen carbonate **→** NH4HCO3

vanadium (IV) hydroxide **→** V(OH)4

**Hydrated Compounds**

Many ionic compounds are soluble in water. When the water is allowed to evaporate, the ionic compound crystallises as a solid. For a number of ionic solids, water molecules are trapped in the crystal lattice. These ionic compounds are called **hydrates** and they will produce water when they decompose upon heating.

*formula* **→** *name*

The formula appears as an ionic formula with a number of H2O molecules attached to it. Name the ionic compound as usual and include the number of water molecules using the same prefixes as for molecular compounds.

CuSO4 · 5H2O (s) **→** copper (II) sulfate pentahydrate

AlCl3 · 6H2O(s) **→** aluminum chloride hexahydrate

*name* **→** *formula*

Write the regular ionic formula followed by the indicated number of water molecules.

lithium chloride tetrahydrate **→** LiCl · 4H2O(s)

barium hydroxide octahydrate **→** Ba(OH)2 · 8H2O(s)

# Assignment

1. If the following pairs of elements were mixed and heated, they would combine into solid ionic compounds. (Note: **All ionic compounds are solids at room temperature**.) Write the name and formula of each compound formed.

**Name Formula**

e.g. strontium and arsenic strontium arsenide Sr3As2 (s)

a) silver and iodine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

b) magnesium and oxygen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

c) magnesium and bromine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

d) calcium and nitrogen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

e) zinc and selenium \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

f) sodium and sulfur \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

g) barium and phosphorus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

h) aluminium and fluorine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

i) potassium and chlorine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

j) silver and oxygen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

2. If the following pairs of elements were mixed and heated, they would combine into ionic compounds. In this worksheet, use the most common ionic form of the multivalent metal ion. The most common form is listed first in the periodic table. For example, niobium exists as both 5+ and 3+ ions, with niobium (V) being the most common.

**Name** **Formula**

e.g. niobium and oxygen niobium (V) oxide Nb2O5 (s)

a) iron and sulfur \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

b) copper and oxygen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

c) manganese and fluorine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

d) gold and nitrogen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

e) chromium and chlorine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

f) platinum and phosphorus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

g) nickel and oxygen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

h) cobalt and bromine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

i) tungsten and iodine \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

j) manganese and sulfur \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

3. Complete the following table.

|  |  |  |
| --- | --- | --- |
| **COMBINE** | **FORMULA** | **NAME** |
| iron (II) & nitrate | Fe(NO3)2 (s) | iron (II) nitrate |
| aluminium & nitrate |  |  |
| sodium & sulfate |  |  |
| lead (IV) & sulfate |  |  |
| magnesium &  carbonate |  |  |
| gold (III) & sulfite |  |  |
| zinc &  hydrogen carbonate |  |  |
| ammonium & nitrate |  |  |
| copper (I) & phosphate |  |  |
| silver & hydroxide |  |  |
| aluminium &  hydroxide |  |  |
| lead (II) & phosphate |  |  |
| potassium & acetate |  |  |
| manganese (V) &  sulfate |  |  |

4. Complete the following table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Formula** | **Description or Use**  **[*for interest only*]** | | | **Name of Compound** |
|  | e.g., CCl4 | toxic cleaning fluid and solvent | | | carbon tetrachloride |
| 1. |  | composition of air | | 78.03% | nitrogen |
| 2. |  | 20.99% | oxygen |
| 3. |  | 0.94% | argon |
| 4. | CO2 | 0.035% |  |
| 5. |  | 0.0016% | other noble gases |
| 6. | NO | air pollutants | in automobile exhaust | |  |
| 7. | NO2 | ­Los Angeles-type smog | |  |
| 8. |  | ­London-type smog | | sulfur dioxide |
| 9. | SO3 | ­becomes sulfuric acid | |  |
| 10. |  | colorless, oderless poison | | carbon monoxide |
| 11. |  | good in upper atmosphere | | ozone |
| 12. |  | grain alcohol, ethyl alcohol | | | ethanol |
| 13. |  | table sugar | | | sucrose |
| 14. |  | yellow solid in Group 16 | | | sulfur |
| 15. | P4O10 | oxides formed by burning | | |  |
| 16. | P4O6 | white phosphorus in air | | |  |
| 17. |  | chlorination of water | | | chlorine dioxide |
| 18. |  | methyl alcohol, methyl hydrate | | | methanol |
| 19. |  | a white solid | | | phosphorus |
| 20. |  | a cleaner when dissolved in water | | | ammonia |
| 21. | CH4 | 85 - 95% of natural gas | | |  |
| 22. | HCl | a gas; in water is hydrochloric acid | | |  |
| 23. |  | laughing gas, anaesthetic | | | dinitrogen oxide |
| 24. |  | tincture of iodine in alcohol | | | iodine |
| 25. | H2O | the most common solvent | | |  |

5. Complete the following table.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Chemical**  **Formula** | **Description or Use**  **[*for Interest only*]** | **Name of Compound** |
| e.g. | CaCl2 (s) | white solid; wetting agent | calcium chloride |
| 1. |  | dietary supplement for iodine | potassium iodide |
| 2. | MgO (s) | white powder; magnesium ore |  |
| 3. |  | antiperspirant | aluminum chloride |
| 4. | NaBr (s) | in Epsom Salts |  |
| 5. | Al2O3 (s) | whiting; aluminum ore |  |
| 6. |  | black; lithium reacts with air | lithium nitride |
| 7. | CaO (s) | white powder; quicklime |  |
| 8. |  | white solid like CaCl2 | barium chloride |
| 9. |  | white solid; table salt | sodium chloride |
| 10. | ZnO (s) | protective oxide on zinc metal |  |
| 11. |  | photographic emulsion | silver bromide |
| 12. |  | magnesium reacts with hydrogen | magnesium hydride |
| 13. |  | 11 % of minerals in sea water | magnesium chloride |
| 14. |  | in soldering paste | zinc chloride |
| 15. | Ag2S (s) | argentite (silver ore) |  |
| 16. |  | potash (fertilizer) | potassium chloride |
| 17. | CaF2 (s) | fluorite (pretty mauve crystals) |  |
| 18. |  | for toning pictures brown | sodium sulfide |
| 19. | CaH2 (s) | preparation of hydrogen |  |
| 20. |  | zinc blende (zinc ore) | zinc sulfide |

6. Complete the following table.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Chemical**  **Formula** | **Description or Use**  [*for interest only*] | **Name of Compound** |
| e.g., | Cu2S | copper ore (chalcocite) | copper(I) sulfide |
| 1. |  | uranium ore (uraninite) | uranium(IV) oxide |
| 2. |  | lead ore (galena) | lead(IV) sulfide |
| 3. | SnO2 | tin ore (cassiterite) |  |
| 4. |  | manganese ore (pyrolusite) | manganese(IV) oxide |
| 5. | Sb2S3 | antimony ore (stibnite) |  |
| 6. | FeO | iron ore (hematite) |  |
| 7. | HgS | mercury ore (cinnabar) |  |
| 8. | MoS2 | molybdenum ore (molybdenite) |  |
| 9. |  | copper ore (chalcopyrite) | copper (II) sulfide |
| 10. | FeS | also in chalcopyrite |  |
| 11. |  | electrode In car battery | lead (IV) oxide |
| 12. | HgO | laboratory preparation of oxygen |  |
| 13. | V2O5 | a common catalyst |  |
| 14. |  | toothpaste additive | tin (II) fluoride­ |
| 15. |  | a green paint pigment | chromium (III) oxide |
| 16. | TiO2 | a white paint pigment |  |
| 17. | AuCl3 | gold tinting of pictures |  |
| 18. |  | separating types of U atoms | uranium (VI) fluoride |
| 19. | NiBr2 | forms a green solution |  |
| 20. |  | forms a pink solution | cobalt (II) chloride |

7. Complete the following table.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **i or m** | **Chemical Formula** | **Name of Compound** |
| 1. |  | K2CO3 |  |
| 2. |  | (NH4)2S |  |
| 3. |  |  | calcium hydroxide |
| 4. |  |  | magnesium silicate |
| 5. |  |  | iron (II) chlorite |
| 6. |  | Cr(NO3)3 |  |
| 7. |  |  | potassium dichromate |
| 8. |  | SO3 |  |
| 9. |  | NaNO2 |  |
| 10. |  |  | ammonium sulfate |
| 11. |  |  | sodium hydrogen carbonate |
| 12. |  | K3PO4 |  |
| 13. |  |  | potassium oxalate |
| 14. |  | NH3 |  |
| 15. |  |  | sodium nitrate |
| 16. |  | KMnO4 |  |
| 17. |  |  | sodium thlosulfate |
| 18. |  | CO2 |  |
| 19. |  |  | barium perchlorate |
| 20. |  |  | rubidium hydrogen sulfide |
| 21. |  |  | potassium cyanide |
| 22. |  | NH4H2PO4 |  |
| 23. |  |  | sodium hydrogen sulfite |
| 24. |  | Na2SO4 |  |
| 25. |  |  | potassium thiocyanate |

8. Complete the following table.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Name of Hydrate** | **Common Name, Use or Description** | **Formula** |
| e.g., | copper(II) sulfate pentahydrate | blue vitriol, bluestone, copper plating,  blue solid | CuSO4 •5H2O |
| 1. |  | Epsom salts, white solid explosives, matches | MgSO4•7H2O |
| 2. | sodium carbonate decahydrate | washing soda, soda ash, water softener, white solid |  |
| 3. |  | white solid, fireproofing wood, disinfectants, parchment paper | MgCl2 •6H2O |
| 4. | barium chloride dihydrate | white solid, pigments, dyeing fabrics, tanning leather |  |
| 5. |  | white solid, photographic emulsions | Cd(NO3)2 •4H2O |
| 6. |  | white solid, embalming material, fireproofing lumber, vulcanizing | ZnCl2•6H2O |
| 7. | zinc sulfate heptahydrate | white solid, clarifying glue, preserving wood and skins |  |
| 8. | lithium chloride tetrahydrate | white solid, soldering aluminum, in fireworks |  |
| 9. |  | photographic hypo, antichlor, white solid | Na2S2O3•5H2O |
| 10. | cobalt(II) chloride hexahydrate | pink solid, humidity and water indicator, foam stabilizer in beer |  |
| 11. |  | white solid, antiperspirant | AlCl3•6H2O |
| 12. |  | de-icer used on icy highways, added to cement mixtures to prevent freezing | CaCl2 •2H2O |
| 13. | barium hydroxide octahydrate | white solid, manufacture of glass, water softener |  |
| 14. | nickel(II) chloride hexahydrate | green solid, absorbent for ammonia in gas masks |  |
| 15. |  | Glauber's salt (a medicine), white solid, drying agent | Na2SO4 •10H2O |

9. Complete the following table. Classify the substance as ionic or molecular (i or m) in the first column. Use a subscript to indicate the state of matter of each substance (s, l, or g at room temperature).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **i or m** | **Chemical Formula** | **Name of Compound** |  | **i or m** | **Chemical Formula** | **Name of Compound** |
| 1. |  | Al(OH)3 |  | 26. |  |  | magnesium sulfate  heptahydrate |
| 2. |  |  | sodium sulfate decahydrate | 27. |  | Ca(OH)2 |  |
| 3. |  |  | sodium nitrate hexahydrate | 28. |  |  | sodium thiosulfate |
| 4. |  | Al3(SO4)3 |  | 29. |  | CaO |  |
| 5. |  |  | calcium chloride hexahydrate | 30. |  |  | copper (II) sulfate  pentahydrate |
| 6. |  | NH4NO3 |  | 31. |  |  | sulfur |
| 7. |  |  | phosphorus trihydride | 32. |  | BrH6 (g) |  |
| 8. |  | N2O4 (g) |  | 33. |  |  | potassium dichromate |
| 9. |  |  | methane | 34. |  |  | phosphorus |
| 10. |  | K2SO4 |  | 35. |  | SO3 |  |
| 11. |  | Fr3PO4 |  | 36. |  |  | sodium chlorate |
| 12. |  |  | bismuth (V) borate | 37. |  | Na2SiO3 |  |
| 13. |  | (NH4)2SO4 |  | 38. |  |  | methanol |
| 14. |  | SnF4 |  | 39. |  |  | chlorine |
| 15. |  |  | xenon hexabromide | 40. |  |  | lead (II) sulfate |
| 16. |  | PbO2 |  | 41. |  | Ca(HCO3)2 |  |
| 17. |  |  | silicon dioxide | 42. |  |  | nitrogen trichloride |
| 18. |  | NaClO |  | 43. |  |  | sodium hydrogen sulfite |
| 19. |  |  | potassium permanganate | 44. |  | CO |  |
| 20. |  | KNO3 |  | 45. |  | H2Se |  |
| 21. |  | K2CO3•2H2O |  | 46. |  |  | silicon carbide |
| 22. |  |  | hydrogen fluoride | 47. |  |  | aluminum phosphate |
| 23. |  | H2S(g ) |  | 48. |  |  | lithium nitrate |
| 24. |  |  | sodium hydroxide | 49. |  | SF2 |  |
| 25. |  | NaHSO4 |  | 50. |  | H2O2 (aq) |  |