

Multivalent Compounds

Compounds with metals that can have more than one charge

Multivalent Compounds

Four circles are arranged horizontally at the top of the slide. From left to right, they are: a solid light purple circle, an empty light purple circle with a thin outline, a solid light purple circle, an empty light purple circle with a thin outline, and a solid light purple circle.

Metal (variable valence) + Nonmetal

Metal (variable valence) + radical

Nonmetal (variable valence) + nonmetal

What is a Multivalence?

- Many elements we have studied only have ONE valence
 - They always form the same number of bonds
 - e.g. Group 2 elements always form 2 bonds, so the valence is always +2
- Some elements can form different numbers of bonds depending on the conditions they are in. These are listed in the **VALENCE TABLE** and must be **MEMORIZED.**

What is a Multivalence?

- Let's look at Group 5/15 elements (N, P, As, etc)
- Recall that all group 5 elements have an electron configuration that ends in s^2p^3
 - Usually gains 3 electrons - valence is -3
 - Sometimes loses 3 electrons - valence is +3
 - Sometimes loses 5 electrons - valence is +5
- Note: this doesn't always mean that the non-metal is forming an ion; the valence refers to how many bonds the atom can make.
 - Ca_2P_3 - valence of P is -3
 - PCl_3 - valence of P is +3
 - PCl_5 - valence of P is +5

What is a Multivalence?

- Let's look at Group 6/16 elements (S, Se, etc)
- Recall: Sulphur's electron configuration ends in $3s^23p^4$
 - Usually gains 2 electrons - valence is -2 e.g Na_2S
 - Sometimes loses 4 electrons - valence is +4 e.g. SO_2
 - Sometimes loses 6 electrons - valence is +6 e.g SO_3
- How do you determine the valence of Sulphur?
 - Use the known valence of oxygen (which is -2) to help you determine the valence of sulphur
 - Valences of oxygen and sulphur must add to ZERO!

Binary Ionic Compounds

Containing a Metal that is Multivalent

To name these compounds:

- ✓ give the name of the metal followed by Roman numerals in parentheses to indicate the **valence** of the metal
- ✓ followed by the name of the nonmetal, with its ending replaced by the suffix **-ide**.

Examples	Stock System	Traditional System
FeCl_2	Iron (II) chloride	Ferrou s chloride
FeCl_3	Iron (III) chloride	Ferric chloride
SnO	Tin (II) oxide	Stannou s oxide
SnO_2	Tin (IV) oxide	Stannic oxide

NOTE: "ic" ending = higher valence
"ous" ending is lower valence

Multivalent Cations

Common Multivalent Cations

Ion	Stock System	Traditional System
Fe^{3+}	iron (III)	ferric
Fe^{2+}	iron (II)	ferrous
Cu^{2+}	copper (II)	cupric
Cu^{1+}	copper (I)	cuprous
Co^{3+}	cobalt (III)	cobaltic
Co^{2+}	cobalt (II)	cobaltous
Sn^{4+}	tin (IV)	stannic
Sn^{2+}	tin (II)	stannous
Pb^{4+}	lead (IV)	plumbic
Pb^{2+}	lead (II)	plumbous
Hg^{2+}	mercury (II)	mercuric
Hg_2^{2+}	mercury (I)	mercurous

*Mercury (I) ions are always bound together in pairs to form Hg_2^{2+}

Example 1 - $\text{Fe}(\text{NO}_3)_2$

- Since the positive ion is multivalent, its valence must be determined.
- This is done by figuring out the charge on the negative particle.
 - There are two NO_3^{1-} □ a charge of -2
 - Since we only have one Fe we know it must be the atom with the a +2 valence so that a net charge of zero is achieved.

ferrous nitrate OR iron (II) nitrate

Ionic Compounds with Radicals

Containing a Metal that is Multivalent

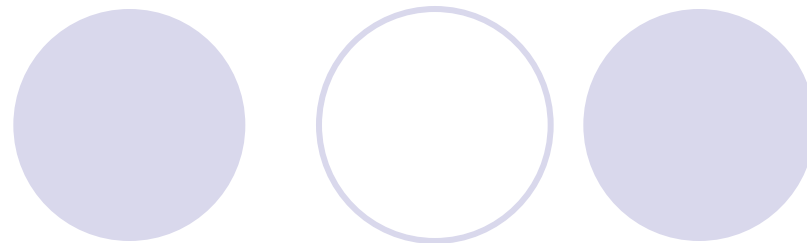
To name these compounds:

- ✓ give the name of the metal followed by Roman numerals in parentheses to indicate the **valence** of the metal
- ✓ followed by the name of the **Radical**.

Examples	Stock System	Traditional System
FeSO_4	Iron (II) sulfate	Fer rous sulfate
$\text{Fe}(\text{HSO}_4)_3$	Iron (III) hydrogen sulfate	Ferr ic hydrogen sulfate
$\text{Pb}_3(\text{PO}_5)_2$	lead (II) perphosphate	plumb ous perphosphate
$\text{Pb}(\text{CO}_2)_2$	lead (IV) carbonite	plumb ic carbonite

Note: “ic” ending = higher valence
“ous” ending = lower valence

Your Turn!!



Formula

Name

1 NiO nickel (II) oxide

2 $\text{Hg}(\text{NO}_3)_2$ mercury (II) nitrate

3 CuF_2 cupric fluoride

4 Cu_3PO_3 cuprous phosphite

5 $\text{Cr}_2(\text{SO}_4)_3$ chromium (III) sulfate

6 $\text{Pb}(\text{ClO})_4$ plumbic hypochlorite

Molecular Compounds

Containing a **Nonmetal** that is Multivalent

To name these compounds, give the name of the nonmetal followed by Roman numerals in parentheses to indicate the **valence** of the nonmetal, followed by the name of the nonmetal, with its ending replaced by the suffix **-ide**.

Examples	Stock System	Prefix Method (traditional)
PCl_3	phosphorus (III) chloride	Phosphorus trichloride (phosphorous chloride)
PCl_5	phosphorus (V) chloride	Phosphorus pentachloride (Phosphoric chloride)
SO_2	sulfur (IV) oxide	Sulfur dioxide (sulfurous oxide)
SO_3	sulfur (VI) oxide	Sulfur trioxide (sulfuric oxide)



Your Turn!!

Formula

Name

- | | | |
|---|---|------------------------------|
| 1 | UF_6 | <u>Uranium (VI) fluoride</u> |
| 2 | NO_2 | <u>Nitrogen dioxide</u> |
| 3 | <u>As_2S_3</u> | arsenic (III) sulfide |
| 4 | <u>PBr_3</u> | phosphorus (III) bromide |
| 5 | CS_2 | <u>Carbon disulfide</u> |
| 6 | <u>SF_4</u> | sulfur tetrafluoride |