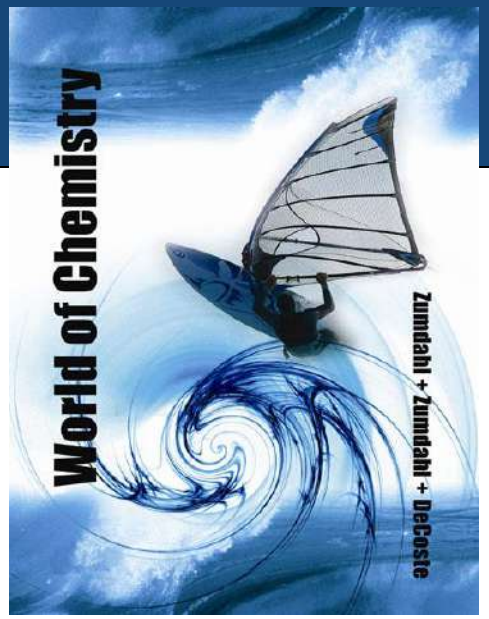

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Chapter 4

Nomenclature

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Naming Binary Compounds

Objectives

1. To learn to name binary compounds of a metal and a nonmetal
2. To learn to name binary compounds containing only nonmetals
3. To summarize the naming of all types of binary compounds

A. Naming Compounds That Contain a Metal and a Nonmetal

- Binary ionic compounds contain positive cations and negative anions.
  - Type I compounds
    - Metal present forms only one cation
  - Type II compounds
    - Metal present can form 2 or more cations with different charges

Type I	Type II
$Na \rightarrow Na^{+}$	$Cr \rightarrow Cr^{2+}$
$Cs \rightarrow Cs^{+}$	$\searrow Cr^{3+}$
$Ca \rightarrow Ca^{2+}$	$Cu \rightarrow Cu^{+}$
$Al \rightarrow Al^{3+}$	$\searrow Cu^{2+}$

A. Naming Compounds That Contain a Metal and a Nonmetal

Table 4.1 Common Simple Cations and Anions

Cation	Name	Anion	Name*
H^+	hydrogen	H^-	hydride
Li^+	lithium	F^-	fluoride
Na^+	sodium	Cl^-	chloride
K^+	potassium	Br^-	bromide
Cs^+	cesium	I^-	iodide
Be^{2+}	beryllium	O^{2-}	oxide
Mg^{2+}	magnesium	S^{2-}	sulfide
Ca^{2+}	calcium		
Ba^{2+}	barium		
Al^{3+}	aluminum		
Ag^+	silver		

*The root is given in color.

Naming Binary Compounds

A. Naming Compounds That Contain a Metal and a Nonmetal

Type I Binary Ionic compounds

Rules for Naming Type I Ionic Compounds

1. The cation is always named first and the anion second.
2. A simple cation (obtained from a single atom) takes its name from the name of the element. For example, Na^+ is called sodium in the names of compounds containing this ion.
3. A simple anion (obtained from a single atom) is named by taking the first part of the element name (the root) and adding *-ide*. Thus the Cl^- ion is called chloride.
4. Write the name for the compound by combining the names of the ions.

A. Naming Compounds That Contain a Metal and a Nonmetal

- For compounds containing both a metal and a nonmetal, the metal is always named first. The nonmetal is named from the root element name.

Exercise

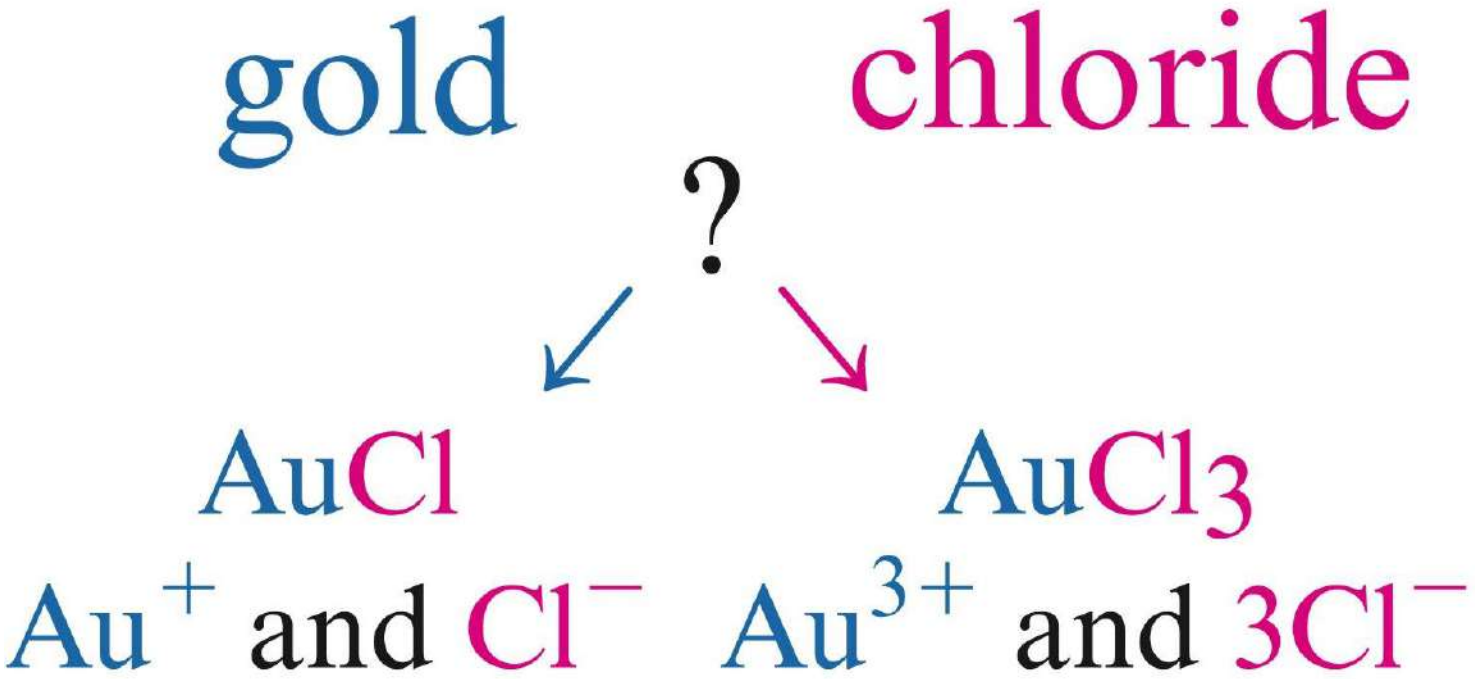
Name the following compounds.

KCl	potassium chloride
$MgBr_2$	magnesium bromide
BaO	barium oxide

A. Naming Compounds That Contain a Metal and a Nonmetal

Type II Binary Ionic compounds

- Since the metal ion can have more than one charge, a Roman numeral is used to specify the charge.



A. Naming Compounds That Contain a Metal and a Nonmetal

Type II Binary Ionic compounds

Table 4.2 Common Type II Cations

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

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

Exercise

Name the following compounds.

CuBr	copper(I) bromide
FeS	iron(II) sulfide
PbO_2	lead(IV) oxide

B. Naming Binary Compounds That Contain Only Nonmetals

Type III Compounds

Rules for Naming Type III Binary Compounds

1. The first element in the formula is named first, and the full element name is used.
2. The second element is named as though it were an anion.
3. Prefixes are used to denote the numbers of atoms present. These prefixes are given in **Table 4.3**.
4. The prefix *mono-* is never used for naming the first element. For example, CO is called carbon monoxide, *not* monocarbon monoxide.

B. Naming Binary Compounds That Contain Only Nonmetals

Type III Compounds

Table 4.3 Prefixes Used to Indicate Numbers in Chemical Names

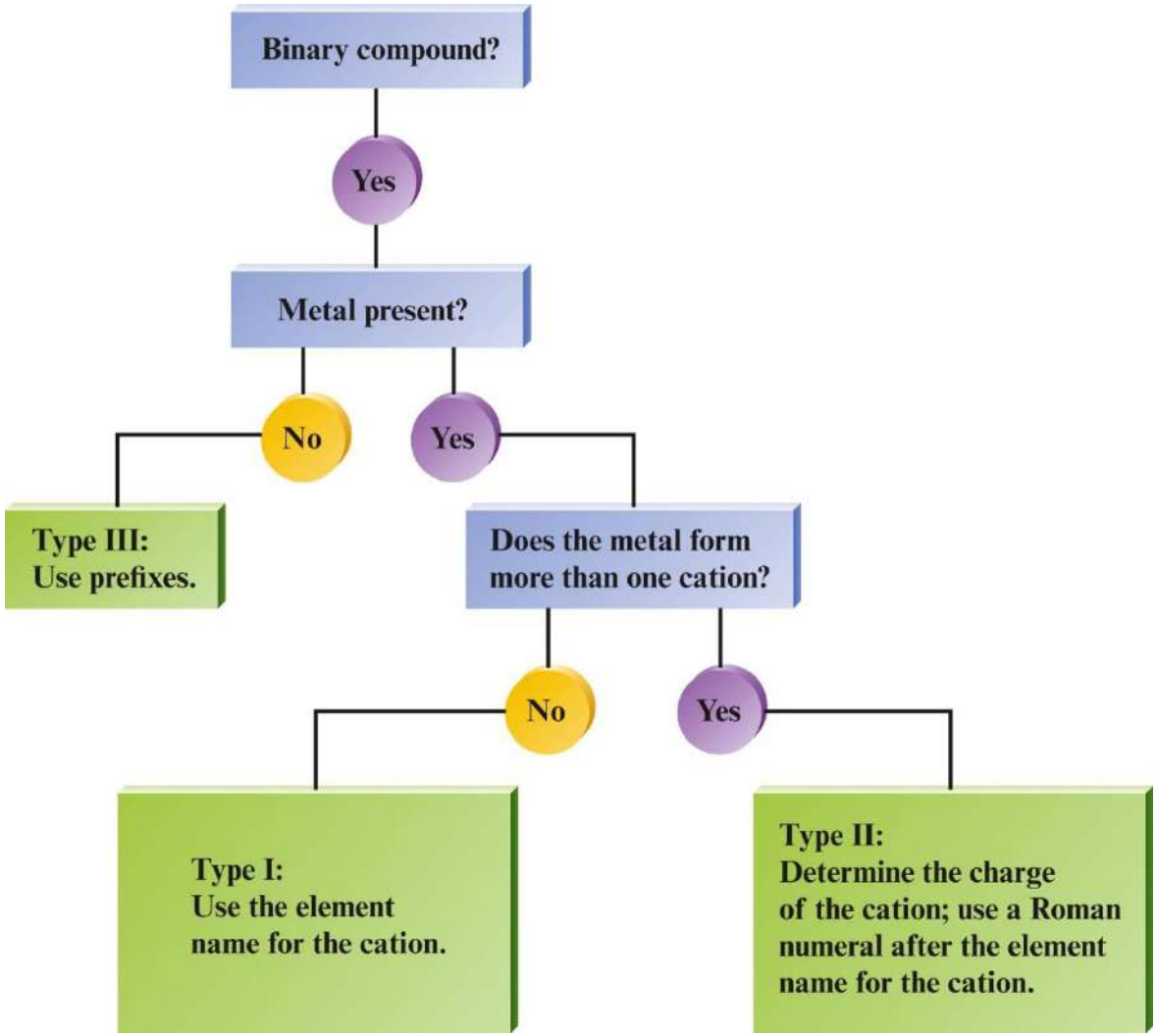
Prefix	Number Indicated
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8

Exercise

Name the following compounds.

CO_2	carbon dioxide
SF_6	sulfur hexafluoride
N_2O_4	dinitrogen tetroxide

C. Naming Binary Compounds: A Review



Exercise

Which of the following compounds is named incorrectly?

a) K_3N	potassium nitride
b) TiO_2	titanium(II) oxide
c) $SnBr_4$	tin(IV) bromide
d) PBr_5	phosphorus pentabromide
e) CaS	calcium sulfide

Objectives

1. To learn the names of common polyatomic ions
2. To learn to name compounds containing polyatomic ions
3. To learn how the anion composition determines an acid's name
4. To learn the names for common acids
5. To learn to write the formula for a compound, given its name

A. Naming Compounds That Contain Polyatomic Ions

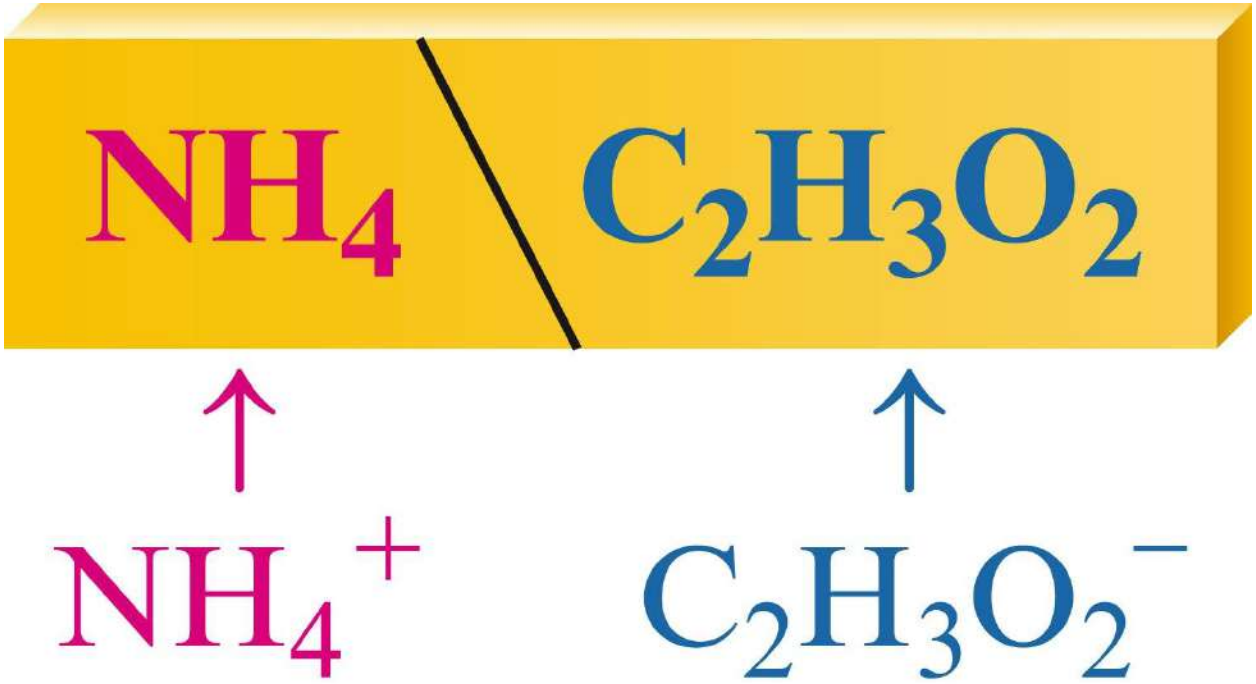
- Polyatomic ions are charged entities composed of several atoms bound together.
- They have special names and must be memorized.

Table 4.4 Names of Common Polyatomic Ions

Ion	Name	Ion	Name
NH_4^+	ammonium	ClO^-	hypochlorite
NO_2^-	nitrite	ClO_2^-	chlorite
NO_3^-	nitrate	ClO_3^-	chlorate
SO_3^{2-}	sulfite	ClO_4^-	perchlorate
SO_4^{2-}	sulfate	CO_3^{2-}	carbonate
HSO_4^-	hydrogen sulfate (bisulfate is a widely used common name)	HCO_3^-	hydrogen carbonate (bicarbonate is a widely used common name)
OH^-	hydroxide	$C_2H_3O_2^-$	acetate
CN^-	cyanide	MnO_4^-	permanganate
PO_4^{3-}	phosphate	$Cr_2O_7^{2-}$	dichromate
HPO_4^{2-}	hydrogen phosphate	CrO_4^{2-}	chromate
$H_2PO_4^-$	dihydrogen phosphate	O_2^{2-}	peroxide

A. Naming Compounds That Contain Polyatomic Ions

- Naming ionic compounds containing polyatomic ions follows rules similar to those for binary compounds.
  - Example: ammonium acetate



Exercise

Name the following compounds.

K_2CO_3	potassium carbonate
$Mg(OH)_2$	magnesium hydroxide
$(NH_4)_3PO_4$	ammonium phosphate

B. Naming Acids

- An acid is a molecule with one or more H^+ ions attached to an anion.

Rules for Naming Acids

1. If the *anion does not contain oxygen*, the acid is named with the prefix *hydro-* and the suffix *-ic* attached to the root name for the element.

   For example, when gaseous HCl, HCN, and H_2S are dissolved in water, they form the following acids:

Acid	*Anion*	*Name*
HCl	Cl^-	hydrochloric acid
HCN	CN^-	hydrocyanic acid
H_2S	S^{2-}	hydrosulfuric acid

B. Naming Acids

Table 4.5 Names of Acids That Do Not Contain Oxygen

Acid	Name
HF	hydrofluoric acid
HCl	hydrochloric acid
HBr	hydrobromic acid
HI	hydroiodic acid
HCN	hydrocyanic acid
H_2S	hydrosulfuric acid

B. Naming Acids

2. When the *anion contains oxygen*, the acid name is formed from the root name of the central element of the anion or the anion name with a suffix of *-ic* or *-ous*. When the anion name ends in *-ate*, the suffix *-ic* is used. For example,

Acid	***Anion***	***Name***
H_2SO_4	SO_4^{2-} (sulfate)	sulfuric acid
H_3PO_4	PO_4^{3-} (phosphate)	phosphoric acid
$HC_2H_3O_2$	$C_2H_3O_2^-$ (acetate)	acetic acid

When the anion name ends in *-ite*, the suffix *-ous* is used in the acid name. For example,

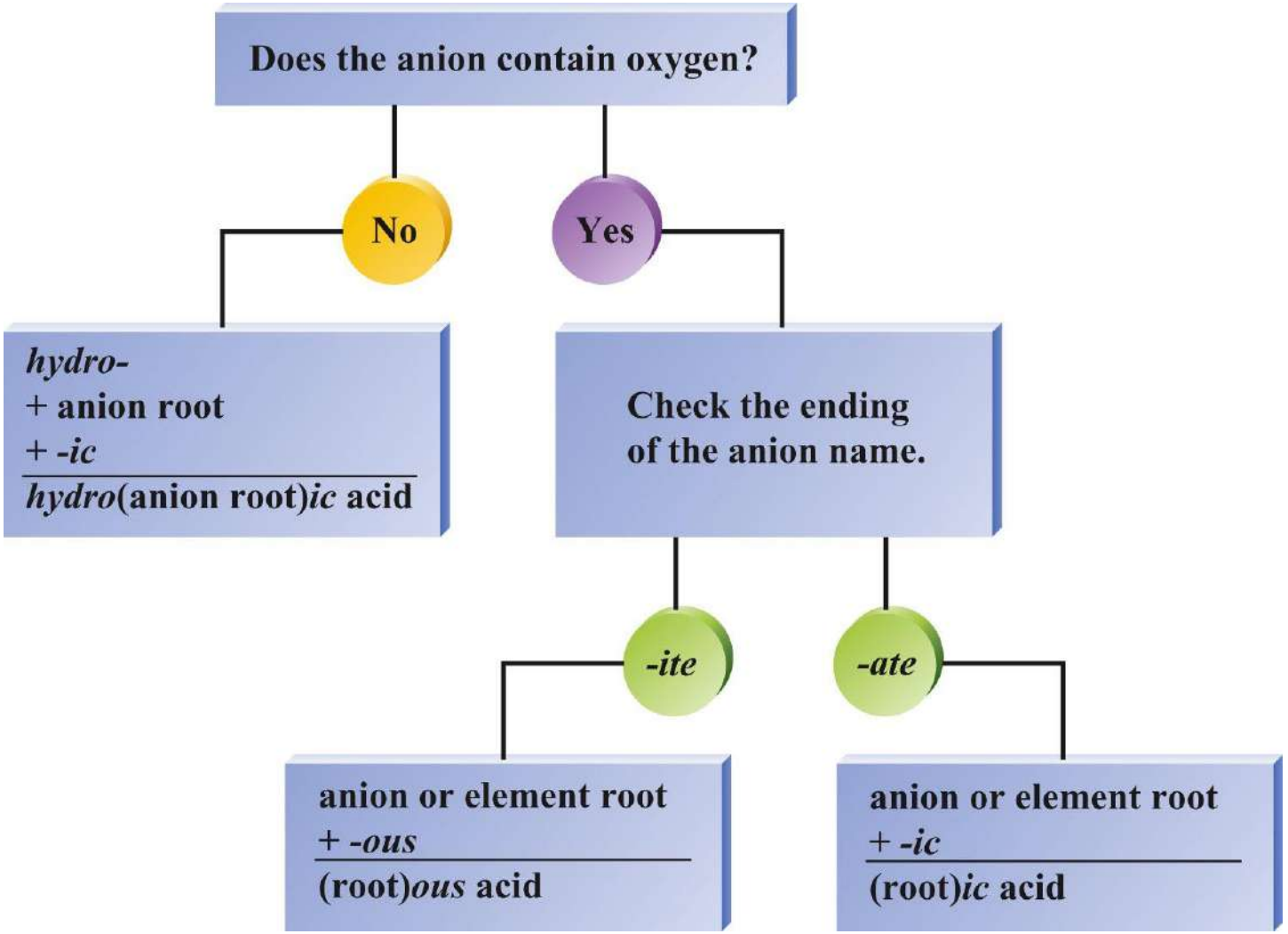
Acid	***Anion***	***Name***
H_2SO_3	SO_3^{2-} (sulfite)	sulfurous acid
HNO_2	NO_2^- (nitrite)	nitrous acid

B. Naming Acids

Table 4.6 Names of Some Oxygen-Containing Acids

Acid	Name
HNO_3	nitric acid
HNO_2	nitrous acid
H_2SO_4	sulfuric acid
H_2SO_3	sulfurous acid
H_3PO_4	phosphoric acid
$HC_2H_3O_2$	acetic acid

B. Naming Acids



Exercise

Name the following acids.

HNO_3	nitric acid
HBr	hydrobromic acid
H_3PO_4	phosphoric acid

C. Writing Formulas from Names

- Sodium hydroxide
  - NaOH
- Potassium carbonate
  - K_2CO_3
- Sulfuric acid
  - H_2SO_4
- Dinitrogen pentoxide
  - N_2O_5
- Cobalt(III) nitrate
  - $Co(NO_3)_3$

Exercise

What is the formula for each of the following compounds?

barium chloride $BaCl_2$

copper(I) nitrate $CuNO_3$

iron(III) sulfate $Fe_2(SO_4)_3$

phosphorus pentabromide PBr_5