Nomenclature of Inorganic Chemical Compounds

Chemical compounds are systems made of two or more different elements/ions. Their composition is presented by chemical formulas

- **Basically, in the Inorganic Chemistry, there are**

FOUR MAJOR TYPES OF CHEMICAL COUPLES

-Oxides

-Hydroxides

-Acids

-Salts

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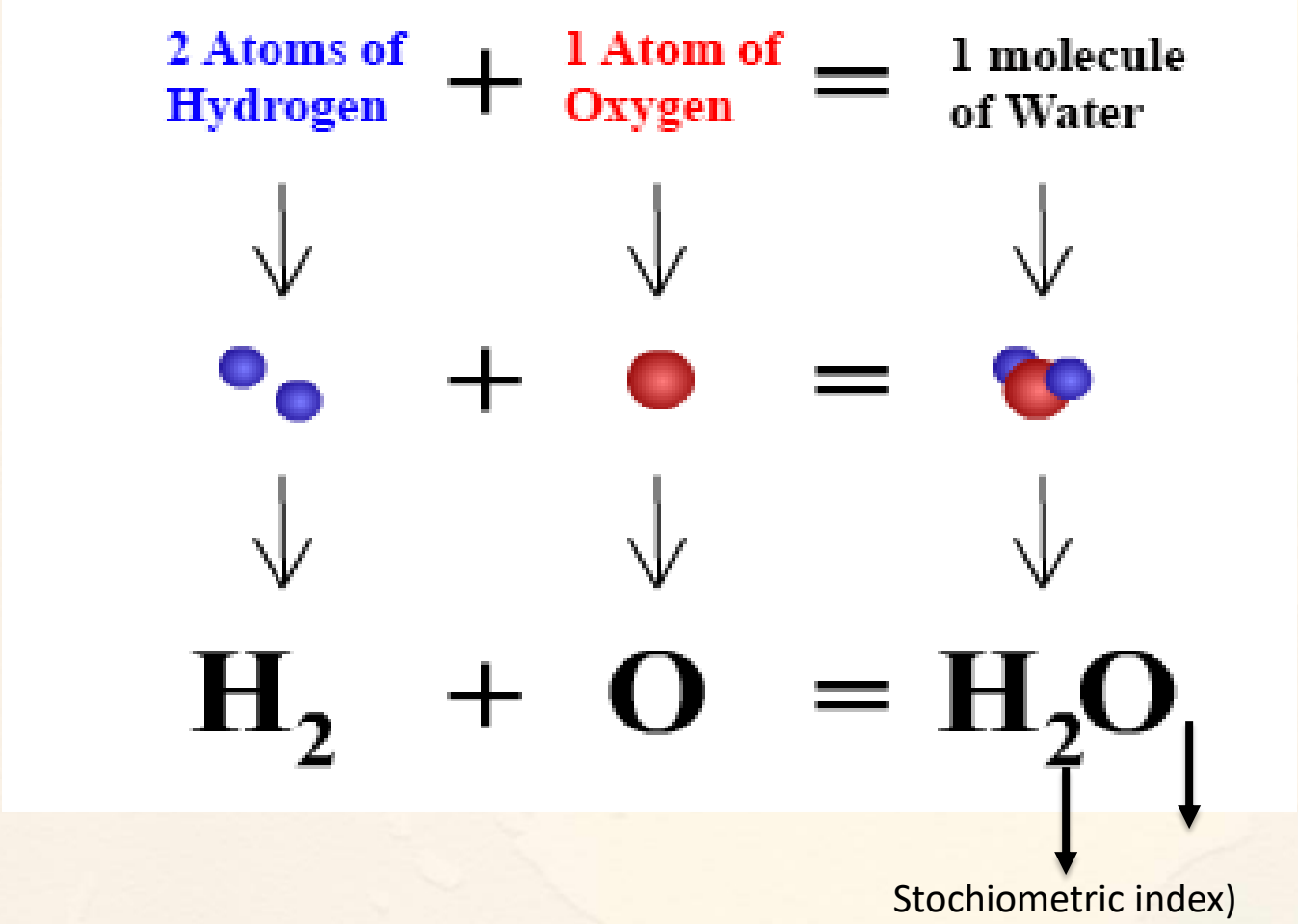
What kind of information we get from the chemical formula?



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Types of chemical formulas

-*Empirical formulas*---*they give the smallest ratio of the elements present in given chemical compound*

-***MOLECULAR FORMULA***----*it gives the EXACT ratio of the elements present in given chemical compound*

-***Structural Formula***---*they show the structure of the chemical compound and the bonds formed between them*

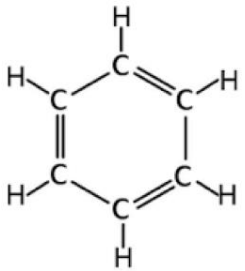
Example:

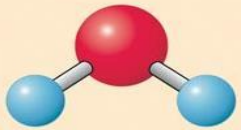
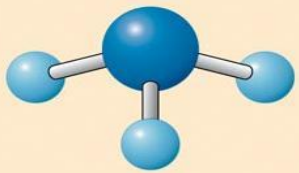
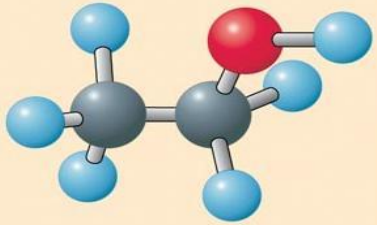
C_6H_6

is **MOLECULAR FORMULA** of BENZENE

Empirical Formula of benzene will be **CH**

Structural formula of benzene is



	Water	Ammonia	Ethanol
Empirical formula	H_2O	NH_3	C_2H_6O
Structural formula	H–O–H	H–N(H)–H	H–C(H)(H)–C(H)(H)–O–H
Molecular model (ball-and-stick type)			
Molecular model (space-filling type)			

In order to know how to write the chemical formulas of so-called INORGANIC COMPOUNDS, WE MUST KNOWN WHAT IS THE **oxidation number=CHARGE** of atoms (or ions) that make given CHEMICAL COMPOUND

- **METALS MAINLY are present as POSITIVE IONS (Cations)**
- **NON-METALS are MAINLY present in a form of negative ions (anions) when present in inorganic chemical compounds**

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Rules about Oxidation numbers of THE METAL CATIONS

Metals of group IA	=>	+1
Metals of Group IIA	=>	+2

MAXIMAL POSITIVE VALENCY (CHARGE) of the metal ions=Group A #

Oxidation numbers of non-metal anions

Monoatomic anions

Grupa VIA (oxygen)	=> -2
Grupa VIIA (Cl, F, Br, I)	=> -1 (mainly, but not always!)

Maximal negative charge of non-metal anions = (8 - Group A #)

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- WE MUST REMEMBER that in MOST OF THE CASES, the chemical compounds we gonna learn have TOTAL CHARGE of ZERO

Example: **+3 + 3(-1) = +3 - 3 = 0**

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Fundamental Chemical Laws

OXIDES

***Oxides** are chemical compounds of metals and non-metals with the OXYGEN*

In all Oxides, the oxidation number (charge) of Oxygen is "2-"

If we known this fact, and if we known that the oxides should have total charge of zero, then we have to find out the charge (=oxidation number) of the second element present in the defined oxide.

We CAN read afterwards the name of the oxide as

Name of the element….(its oxidation number or charge)…Oxide

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Let read the formulas of some oxides

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A. Oxides of non-metal elements C, N, P, S

CO_2

Carbon dioxide

CO

Carbon monoxide

N_2O_4

Dinitrogen tetraoxide

SO_2

Sulphur dioxide

P_2O_5

Di-phosphorous pentoxide

SiO_2 NO

RULE: Name the first element. Since there is only one, no prefix is needed. Only if there is more than one atom, with di, tri-, tetra, penta- …etc we designate the numbers of first elements

The second element always gets a **prefix** of corresponding Greek number before the work "**Oxide**".

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B. **Oxides of metals**—REMEMBER at nomenclature!!!

Charge of Oxygen is always "2-", while overall charge od oxide should be "0"

$^{2+}Ca^{0}O^{2-}$ Calcium (II) oxide…where roman **(II)** is reported to designated **"2^{+}" charge of Calcium** in the oxide

MgO

Cu_2O

FeO

Fe_2O_3

CrO_3

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Hydroxides –couples that contain $(OH)^-$ **or hydroxide** group in their s

-the charge of overall (OH) group is **1- i.e.** $\mathbf{(OH)^{1-}}$

-names og hydroxides are made in a similar way as the oxides

examlpes:

$NaOH$ sodium (I) hydroxide;

$Mg(OH)_2$ magnesium (II) hydroxide;

$Fe(OH)_2$ iron II hydroxide;

$Fe(OH)_3$ is iron III hydroxide

$U(OH)_6$ uranium VI hydroxide

NH_4OH ---is called ammonium hydroxide

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Naming Simple Compounds

Acids

- Acids can be recognized by the **hydrogen** that appears first in the formula—**HCl** for example
- **Acids are molecules with one or more H^+ ions** attached to an anion that has negative overall charge.

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Naming Simple Compounds

Naming Acids

A. Naming Non-oxygen acids (i.e. Acids that do not have Oxygen in their structures)

Non-oxyacids: Change the "*hydrogen*" to "hydro-" and change the ending "-*ine*" to "-*ic*" of the ROOT of element that appears as anion in that acid.

→Ex. Remember that Root of CHLORine is CHLOR root of BROMine is BROM etc

Ex: Chlorine-----becomes Chloric when it is present in acids that do not contain oxygen

Examples

HCl is hydro*chloric* acid,
HBr is hydro*bromic* acid,
HI is hydroiodic acid
HF is hydrofluoric acid
HCN is hydrocyanic acid. *These are all examples of monoprotic acids.*
and…
H_2S is hydrosulfuric acid

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Naming Simple Compounds

Acid	Anion	Acid Name
HCl	Cl^- is Chloride	Hydro**chlor**ic Acid
HF	F^- is fluor**ide**	Hydro**fluor**ic Acid
HI	I^- is iod**ide**	Hydro**iod**ic Acid
HBr	Br^- is brom**ide**	Hydro**brom**ic Acid

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Naming Simple Compounds

Acids That Do Not Contain Oxygen

Table 5.5 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

CN^- is cyanide

S^{2-} is sulfide

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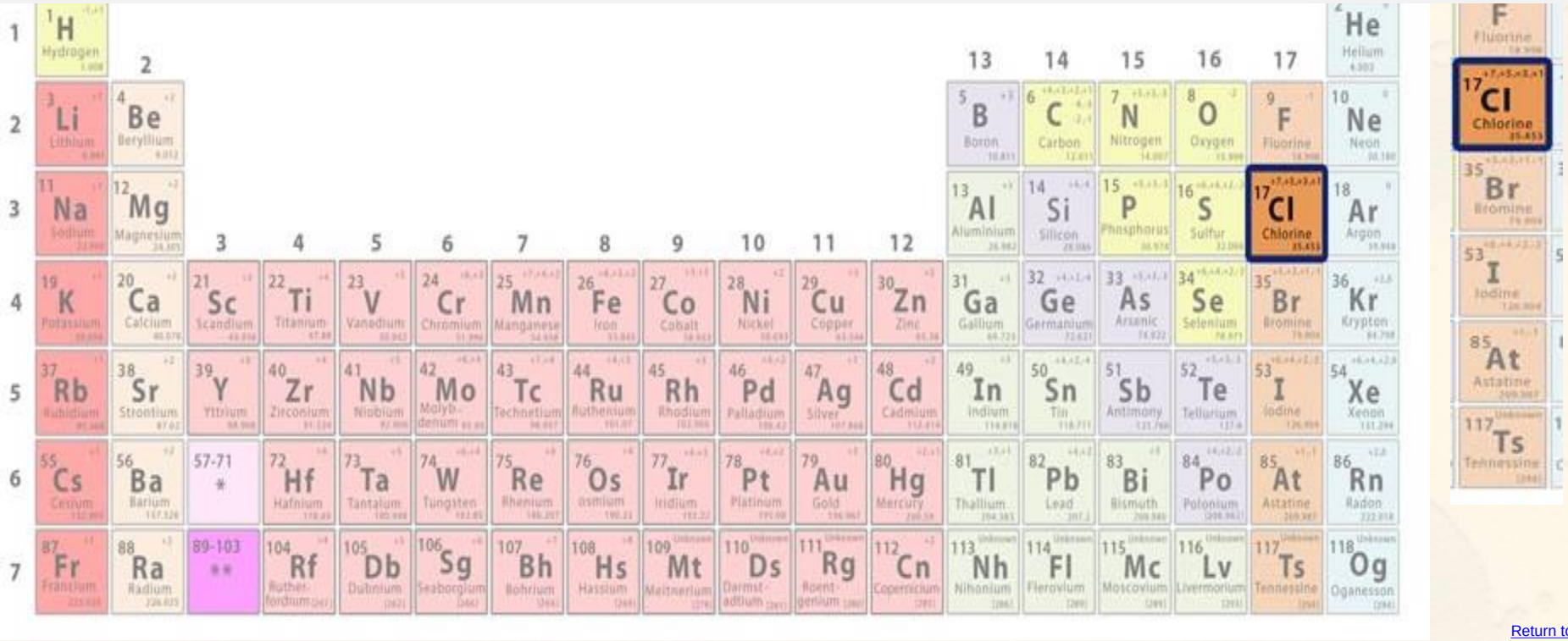
NAMING ACIDS THAT CONTAIN OXYGEN

Best way is to start with the Oxygen-containing acids of Chlorine Cl

***(*what holds for Chlorine, it will be in analogic way for F, Br and I)*

-In each of the Oxygen-containing acids, there is one acid which is named "*BASIC OXYGEN CONTAINING ACID*" of that element, *and we MUST KNOW what is the formula of that acid*



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Lets name the Oxygen-containing acids of Chlorine Cl

B. Rules for Naming Acids – if the anion contains oxygen

- **Rule**: ***The suffix "–ic"*** is added to the root name of so-called ***BASIC Oxygen Acid of given element***, while **the corresponding anion name** ends in ***–ate***.
- Example: BASIC OXYGEN ACID of Chlor**ine** has a formula **$HClO_3$** …it is named → **Chloric** acid
- Anion of this acid gets name when"***ic***" from Chlor**ic is replaced by –ate …**
- **so $(ClO_3)^{-1}$ is named Chlor*ate***

Home work Task: In the group with Chlorine (Cl) in periodic system are F; Br; I. Write down formula and names of BASIC OXYGEN ACIDS of these elements, and write down the names of the corresponding anions

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Lets name the Oxygen-containing acids of Chlorine Cl

B. Rules for Naming Acids – if the anion contains oxygen

- Rule: The PREFIX –***"per"*** is added to the root name of ***BASIC Oxygen Acid of given element***, if there is ONE OXYGEN MORE than in the basic oxygen acid of that element
- To remember: BASIC OXYGEN ACID of Chlorine has a formula **$HClO_3$** …and it is named → Chlor**ic** acid
- **Oxygen acid of Chlorine (Cl) that has ONE OXYGEN more than the basic acid** will have a formula **$HClO_4$ and it will be named *PER*chloric acid**
- **By analogy, ClO_4^- anion is named PERchlor*ate***

Task: In the group with Chlorine (Cl) in periodic system are F; Br; I. Write down formula and names of OXYGEN ACIDS of these elements that have ONE OXYGEN MORE than their basic oxygen acids, and write down the names of the corresponding anions

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Lets name the Oxygen-containing acids of Chlorine Cl

TO REMEMBER: BASIC OXYGEN ACID of Chlorine has a formula **$HClO_3$** …it is named → Chlor**ic** acid

It the acid contains *ONE OXYGEN LESS* than the basic acid, than the suffix "***ic***" from the basic acid is replaced by suffix "***ous***" …
So **$HClO_2$ will be named "*Chlorous Acid*"**

- Anion of this acid gets name when suffix"***ate***" **is replaced by the suffix"ite" …**
- **so ClO_2^- is named Chlor*ite***

TASK: In the group with Chlorine (Cl) in periodic system are F; Br; I. Write down formula and names of OXYGEN ACIDS containing ONE OXYGEN LESS than the basic oxygen containing acids of of these elements, and write down the names of the corresponding anions

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TO REMEMBER:**It the acid contains *ONE OXYGEN LESS* than the basic acid**, than the suffix "***ic***" from the basic acid is replaced by suffix "***ous***" …So **$HClO_2$ is named "*Chlorous Acid*"**

It the acid contains *TWO OXYGENs LESS* than the basic oxygen of Chlorine (Cl) acid, than it gets prefix ***"hypo"*** and suffix "***ous***" …
-→So **HClO will be named "Hypo*Chlorous Acid*"**

→**ClO^- anion is named *hypochlorite***

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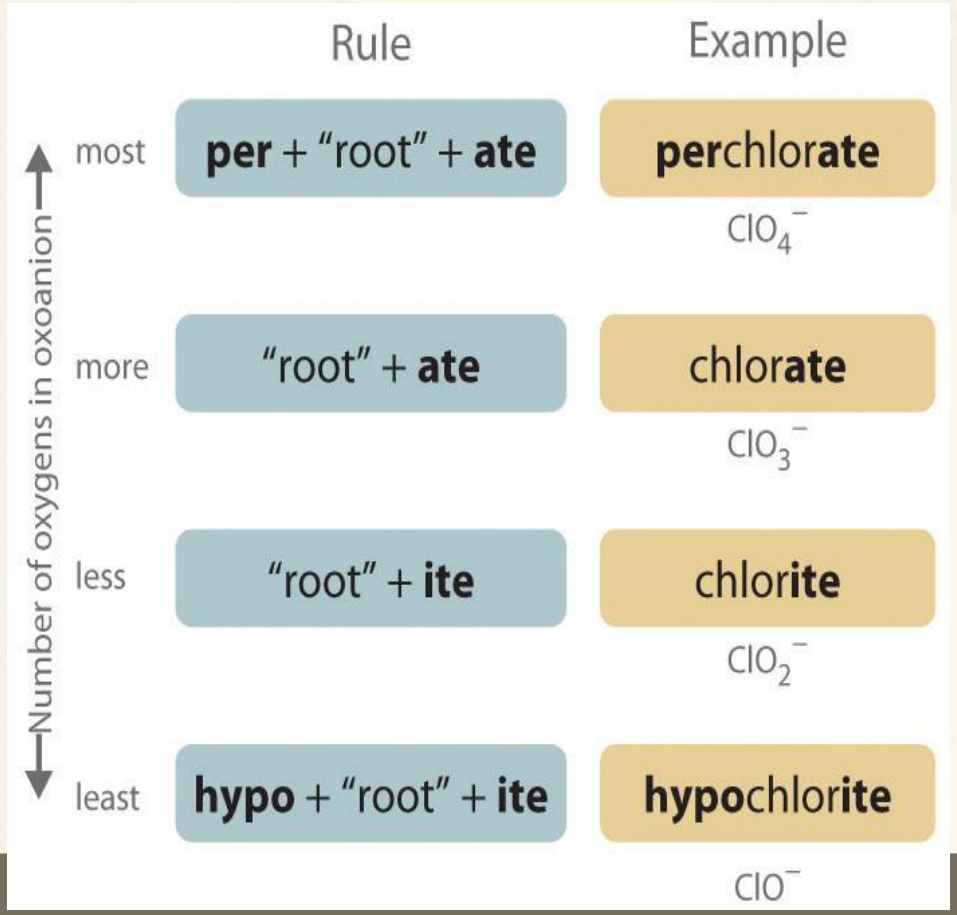
HOME TASK: In the group with Chlorine (Cl) in periodic system are F; Br; I. Write down formula and names of OXYGEN ACIDS containing TWO OXYGENs LESS than the basic oxygen containing acids of of these elements, and write down the names of the corresponding anions//

Here are the rules, and in the next slide you have formulas and names of all oxygen-containing acids of Chlorine Cl



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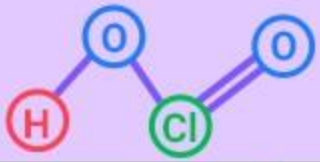
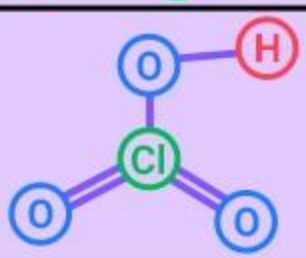
Names and formulas of all Oxygen-containing acids of Chlorine Cl

COMPOUD	STRUCTURE	FORMULA
Hypochlorous acid		HClO
Chlorous acid		$HClO_2$
Chloric acid		$HClO_3$
Perchloric acir		$HClO_4$

Basic Oxygen-containing acid of Cl

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Oxygen-containing acids of N, P, S , C and B

Names of Common Ions and Their Acids

of N, P, and S , C and B

HNO_3	Nitric acid	NO_3^-	Nitrate
HNO_2	Nitrous acid	NO_2^-	Nitrite
H_3PO_4	Phosphoric acid	PO_4^{3-}	Phosphate
H_2SO_4	Sulfuric acid	SO_4^{2-}	Sulfate
H_2SO_3	Sulfurous acid	SO_3^{2-}	Sulfite
H_2CO_3	Carbonic acid	CO_3^{2-}	Carbonate
H_3BO_3	Boric acid	BO_3^{3-}	Borate

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Naming Simple Compounds

Naming Acids

There are three major rules to remember

Anion Name suffix		Acid Name
- ide	Hydro-	-ic Acid
-ate		-ic Acid
-ite		-ous Acid

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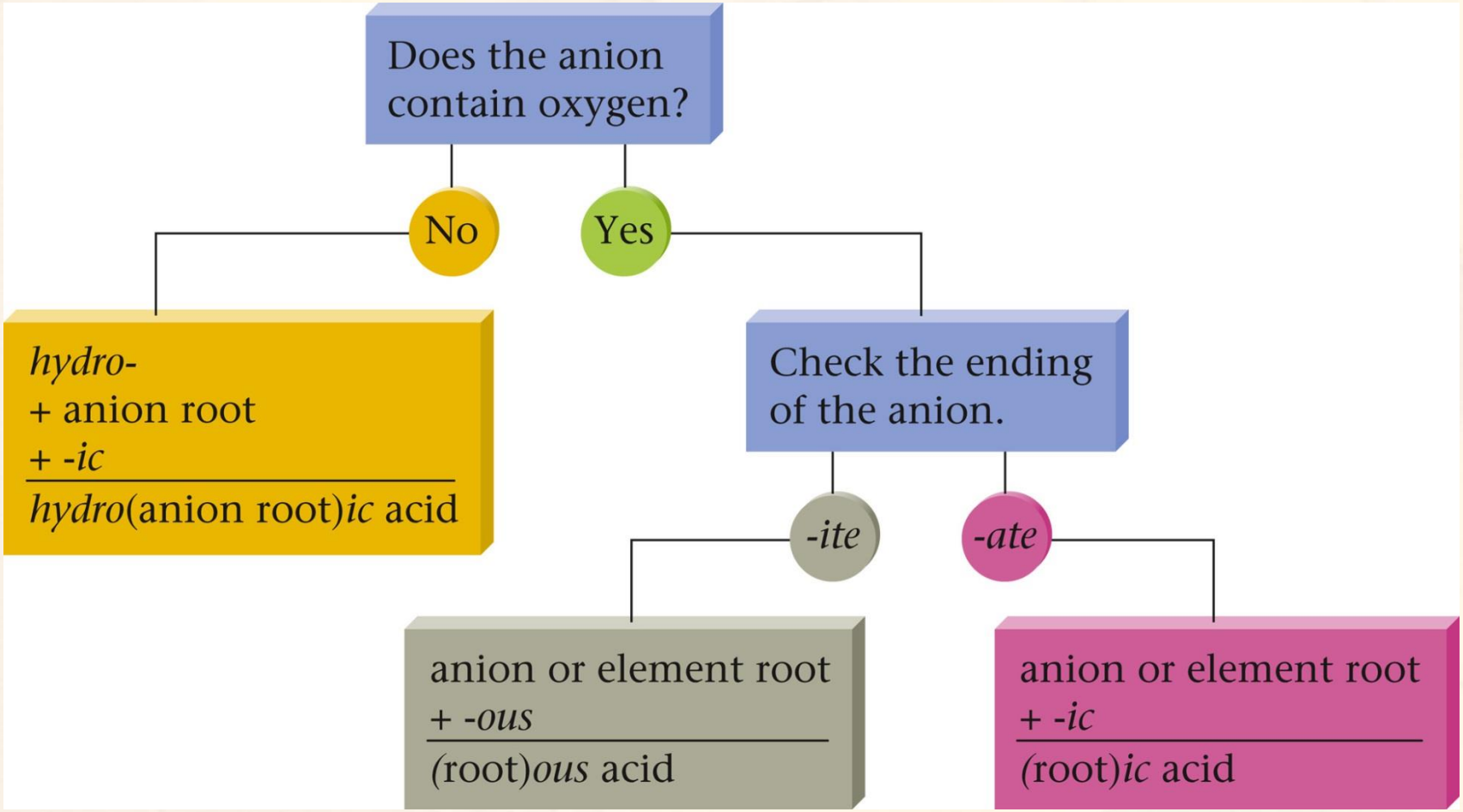
Naming Simple Compounds

Flowchart for Naming Acids



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Naming Simple Compounds

Writing Acids

Name	Anion	Acid Formula
Hydrobromic acid	Br^-	HBr
Sulfuric acid	SO_4^{2-}	H_2SO_4
Periodic acid	IO_4^-	HIO_4
Phosphorous acid	PO_3^{3-}	H_3PO_3

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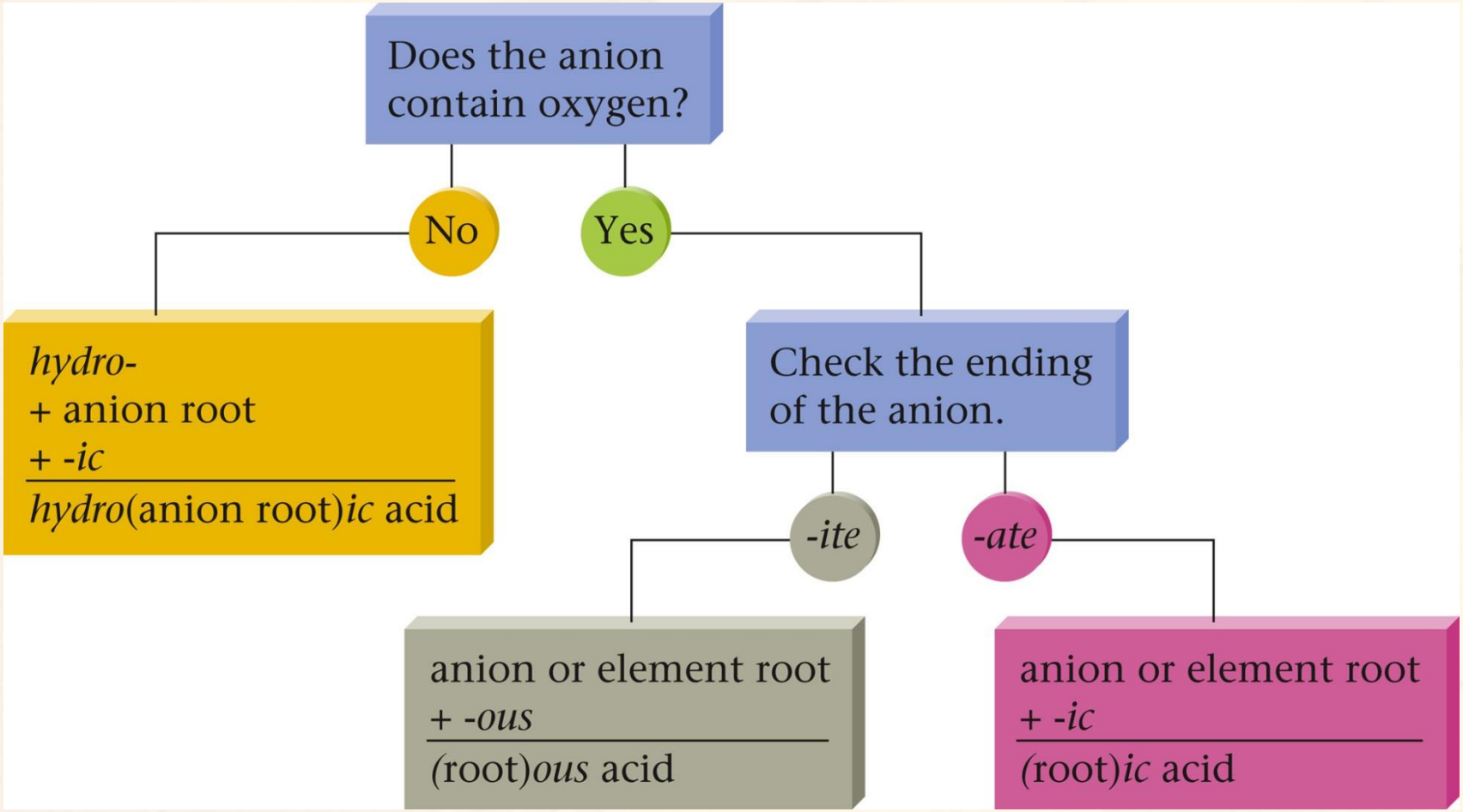
Naming Simple Compounds

Flowchart for Naming Acids



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