

PERIODIC TABLE OF THE ELEMENTS

Periodic Table: - an arrangement of elements in horizontal rows (Periods) and vertical columns (Groups)
- exhibits periodic repetition of properties

First Periodic Table: - discovered by Mendeleev (1869) & Meyer (1869)
- elements were arranged in increasing order of their Atomic Weights
- there were many discrepancies in the ordering of the elements

Modern Periodic Table: - elements arranged in increasing order of their Atomic Numbers
- elements are classified as metals, non-metals and metalloids.

Metals | Nonmetals

Metals	Metalloids (Semi-metals)	Nonmetals
<ul style="list-style-type: none"> • Mostly solid • Have shiny appearance • Good conductors of heat and electricity • Are malleable and ductile • Lose electrons in a chemical reaction 	<ul style="list-style-type: none"> • Have both metallic and non-metallic properties • semiconductors 	<ul style="list-style-type: none"> • Can be solid, liquid or gas • Have dull appearance • Poor conductors of heat and electricity • Are brittle (if solid) • Gain or share electrons in a chemical reaction

PERIODIC TABLE OF THE ELEMENTS

- The periodic table is composed of **periods** (rows) and **groups or families** (columns).
- Elements in the same family have similar properties, and are commonly referred to by their traditional names.
- Elements in groups **1-2** and **13-18** are referred to as **main-group** or **representative elements**.
- The group of metals in between the main group elements are called the **transition metals**.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
Alkali Metals	Alkali-Earth Metals	Transition Metals										C	Si	Ge	Sn	Pb	O	S	Se	Te	Po	Halogens	Noble Gases

No common names

ELEMENTS & COMPOUNDS

Pure substances may be classified according to the particles they contain into:

I. MOLECULAR SUBSTANCES

- are made up of molecules

MOLECULE: a group of atoms (identical or different) chemically bonded together

- contain nonmetallic atoms only

Elements:

Diatomic molecules:
H₂, N₂, O₂, F₂, Cl₂, Br₂, I₂

Polyatomic:

P₄, S₈

Compounds:

H₂O, NH₃, CO₂

II. IONIC SUBSTANCES

- are made up of ions

ION: electrically charged particle obtained from an atom by adding or removing electrons

- contain metals and nonmetals

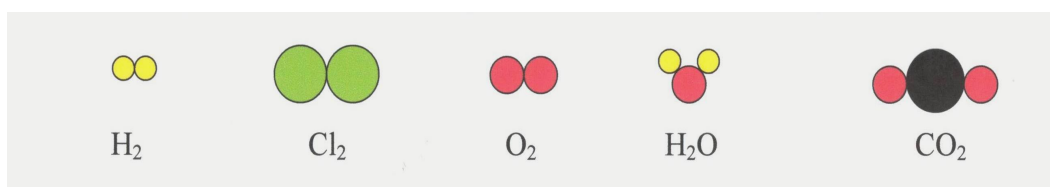
Cations:

- Positive ions
- Formed by losing electrons

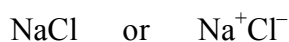
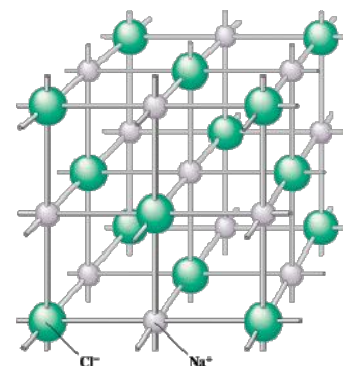
Anions:

- Negative ions
- Formed by gaining electrons

- Molecular Substances are represented by **molecular formulas**
- Molecular formulas give the exact number and type of atoms in a molecule



- Ionic Substances are represented by **ionic formulas**
- Ionic formulas give the smallest whole number ratio of the ions.



(There is a 1:1 ratio between the Sodium Ions and the Chloride Ions)

FORMULA OF IONIC COMPOUNDS

- An ionic compound is composed of **cations** and **anions** arranged in a crystalline structure.

CATIONS are positive ions formed by removal of electrons from metallic atoms.

Examples:

Na^+
11 protons
10 electrons
sodium ion

Ca^{2+}
20 protons
18 electrons
calcium ion

Al^{3+}
13 protons
10 electrons
aluminum ion

ANIONS are negative ions formed by gaining of electrons by nonmetallic atoms.

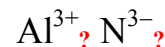
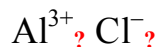
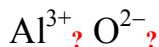
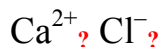
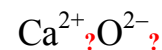
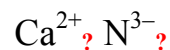
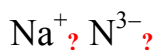
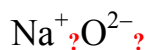
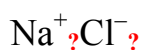
Examples:

N^{3-}
7 protons
10 electrons
nitride ion

O^{2-}
8 protons
10 electrons
oxide ion

Cl^-
17 protons
10 electrons
chloride ion

- In an ionic compound, the cations and the anions combine in the smallest whole-number ratio which mutually neutralizes the overall charge.
- All ionic compounds are **electrically neutral** as a whole.



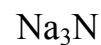
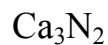
NOMENCLATURE OF IONIC COMPOUNDS
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- Chemical nomenclature is based on rules set forth by the **International Union of Pure and Applied Chemists (IUPAC)**.

Binary Compounds:

- Binary compounds are those that contain only two elements.
- All binary compounds names end in **"ide"**.
- Binary ionic compounds contain:

Metallic cation	Nonmetallic Anion								
Cation (+) is always written first	Anion (-) is always written second								
Name of cation = name of metallic atom	Name of anion \neq name of nonmetallic atom								
<table style="width: 100%; border: none;"> <tr> <td style="text-align: center; padding: 5px;">Na</td> <td style="text-align: center; padding: 5px;">Na⁺</td> </tr> <tr> <td style="text-align: center; padding: 5px;">sodium atom</td> <td style="text-align: center; padding: 5px;">sodium ion</td> </tr> </table>	Na	Na ⁺	sodium atom	sodium ion	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center; padding: 5px;">Cl</td> <td style="text-align: center; padding: 5px;">Cl⁻</td> </tr> <tr> <td style="text-align: center; padding: 5px;">chlorine atom</td> <td style="text-align: center; padding: 5px;">chloride ion</td> </tr> </table>	Cl	Cl ⁻	chlorine atom	chloride ion
Na	Na ⁺								
sodium atom	sodium ion								
Cl	Cl ⁻								
chlorine atom	chloride ion								

Examples:sodium chlor**ide**sodium ox**ide**sodium nitr**ide**









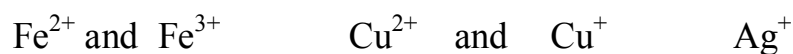


IONIC CHARGES

- In order to write correct formulas for Binary Ionic Compounds, the charges of ions (both cations and anions) must be known.
- Many of these charges are readily obtained by the use of a periodic table.
- For the main-group elements, the charges depend on the group numbers as outlined below:

CHARGES OF CATIONS			CHARGES OF ANIONS			
Charge of cation = Group No.			Charge of anion = 8 – Group No.			
I A	II A	III A	IV A	V A	VI A	VII A
Li ⁺	Be ²⁺		C ⁴⁻	N ³⁻	O ²⁻	F ⁻
Na ⁺	Mg ²⁺	Al ³⁺		P ³⁻	S ²⁻	Cl ⁻
K ⁺	Ca ²⁺	Ga ³⁺		As ³⁻	Se ²⁻	Br ⁻
Rb ⁺	Sr ²⁺	In ³⁺			Te ²⁻	I ⁻
Cs ⁺	Ba ²⁺	Tl ³⁺				
Exceptions:			Sn ²⁺ , Sn ⁴⁺			
Exceptions:			Tl ⁺ Pb ²⁺ , Pb ⁴⁺			

- For cations from Transition Metals the most common ionic charge is 2+
- There are many other charges and exceptions. Some of these charges must be memorized.



IONIC CHARGES

- Writing formulas of ionic compounds is based on the knowledge of the ionic charges. (Recall that the charges must balance).

Examples:

Write correct ionic charges and formulas for the following binary ionic compounds shown below:

aluminum fluoride



Ionic charges

Formulas:

potassium sulfide



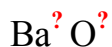
magnesium bromide





Ionic charges

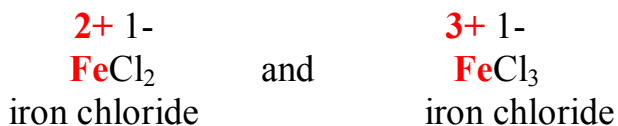
Formulas:





IONIC NOMENCLATURE

- Some metallic atoms may form more than one cation and therefore more than one compound with the same anion.



- Note that the usual nomenclature rules do not distinguish between the two different compounds.
- To distinguish between such compounds, two common nomenclature systems are presently in use:

	2+ FeCl ₂	3+ FeCl ₃
Old System	<ul style="list-style-type: none"> “ous” ending for the lower charge <p style="text-align: center;">ferrous chloride</p>	<ul style="list-style-type: none"> “ic” ending for the higher charge <p style="text-align: center;">ferric chloride</p>
Stock System Roman numeral indicates the cation's charge	iron (II) chloride	iron (III) chloride

Examples:

- Name the compounds listed below, using the old system and the stock system:



Old system: _____

Stock system: _____

- Write formulas for the following compounds:

ferric oxide

chromium (VI) oxide

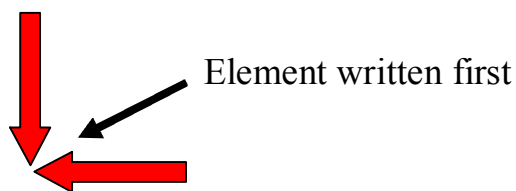
lead (II) sulfide

NOMENCLATURE OF MOLECULAR COMPOUNDS
Binary Molecular Compounds

Contain:	2 nonmetals	
Examples:	CO	CO ₂
	carbon monoxide	carbon dioxide

IUPAC RULES:

1. The element written first is the one more to the left and lower down on the Periodic Table.



Exception: NH₃

2. Prefixes are used to indicate the number of atoms of each kind in the molecule.

1	mono:	CO	mono carbon monoxide)						often omitted
2	di	CO ₂	(carbon dioxide)						
3	tri	SO ₃	(sulfur trioxide)						
4	tetra	CCl ₄	(carbon tetrachloride)						
5	penta	PCl ₅	(phosphorus pentachloride)						
6	hexa	SF ₆	(sulfur hexafluoride)						
7	hepta	ICl ₇	(iodine heptachloride)						
8	octa								
9	nona								
10	deca	P ₄ O ₁₀	(tetraphosphorus decaoxide)						

Examples:

1. Name the following compounds:

HCl _____ H₂O _____ H₂O₂ _____

N₂O₅ _____ AsBr₃ _____ HF _____

2. Give the formula for the following compounds:

dihydrogen sulfide _____ carbon disulfide _____ dinitrogen tetroxide _____