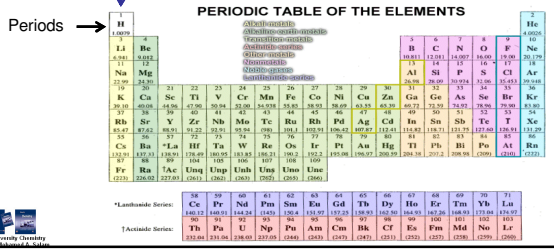
Periodic Table

The periodic table is the most important chemistry reference there is. It arranges all the known elements in an informative array.

Elements are arranged left to right and top to bottom in order of increasing atomic number.

Groups

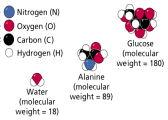
Periods



Molecules

Molecules are compounds in which the elements are in definite, fixed ratios and those atoms are held together usually by chemical bonds.

For example: water, glucose, and alanine.



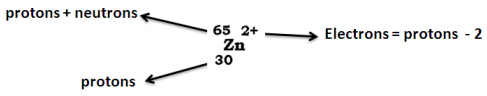
Ions

Ion is an electrically charged particle produced by either removing electrons from a neutral atom to give a positive ion (**Cation**) or adding electrons to a neutral atom to give a negative ion (**anion**).

Note: When an ion is formed, the number of protons does not change.

Example: What is the number of electrons (e), neutrons (n) and protons (p) in the zinc ion ($^{65}_{30}Zn^{2+}$) ?

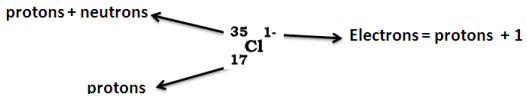
Answer :



number of protons = 30
number of neutrons = 65 – 30 = 35
number of electrons = 30 – 2 = 28

Example: What is the number of electrons (e), neutrons (n) and protons (p) in the chlorine ion ($^{35}_{17}Cl^{-}$)?

Answer :



number of protons = 17
number of neutrons = 35 – 17 = 18
number of electrons = 17+1 = 18

Polyatomic ions

Name	Formula	Name	Formula
Ammonium	**(NH_4^{1+})**		
Chlorate	**(ClO_3^{1-})**	Bicrbonate	**(HCO_3^{1-})**
Cyanide	**(CN^{1-})**	Hydroxide	**(OH^{1-})**
Nitrate	**(NO_3^{1-})**	Nitrite	**(NO_2^{1-})**
Permanganate	**(MnO_4^{1-})**	Thiocyanate	**(SCN^{1-})**
Carbonate	**(CO_3^{2-})**	Chromate	**(CrO_4^{2-})**
Dichromate	**(CrO_4^{2-})**	Sulfate	**(SO_4^{2-})**
Sulfite	**(SO_3^{2-})**		
Phosphate	**(PO_4^{3-})**		

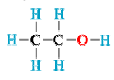
Chemical and structural Formulas

The **chemical formula** tells you how many of each type of atom are in a molecule.

The **structural formula** tells you how many of each type of atoms are in a molecule and also how they are connected.

For example, the chemical formula for ethanol is **C_2H_6O** and

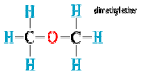
The structural formula of ethanol is



Be carful, the chemical formula could be the same for different molecules, but the structural formula is unique.

The chemical formula for dimethyl ether is **C_2H_6O** and

The structural formula of dimethyl ether is:



Empirical Formulas (simplest formula)

- It shows the simplest whole number ratio of atoms in a molecule.
- For example, hydrogen peroxide's **chemical formula** is H_2O_2, but its **empirical formula** is HO

$$\text{Molecular Formula} = \left(\frac{\text{Molecular weight of unknown (g/mole)}}{\text{mass of Emperical formula}}\right) \text{x Emperical formula}$$

Write the different formulas for the glucose molecule

The chemical formula for glucose is $C_6H_{12}O_6$, but its empirical formula is CH_2O, and its structural formula is

Naming compounds:

The elements inside the periodic table are organized in groups (column), where each group has common characteristics.

One of these common characteristics is the charge (oxidation number), as the whole group tends to lose or gain certain number of electrons and form ion.

Group	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIII A
# electrons	1	2	3	4	3	2	1	0
Action	lose	lose	lose	Lose/gain	gain	gain	gain	no
Example	Na^+	Ca^{2+}	Al^{3+}	C^{4-} or C^{4+}	N^{3-}	O^{2-}	Cl^{1-}	Ne

Common ions and their names

Element	Name	ion	Type	Name
Li	Lithium	Li^{1+}	Cation	Lithium ion
Na	Sodium	Na^{1+}	Cation	Sodium ion
Mg	Magnesium	Mg^{2+}	Cation	Magnesium ion
Ca	Calcium	Ca^{2+}	Cation	Calcium ion
Al	Aluminum	Al^{3+}	Cation	Aluminum ion
K	Potassium	K^{1+}	Cation	Potassium ion
Cl	Chlorine	Cl^{1-}	Anion	Chlor**ide**
Br	Bromine	Br^{1-}	Anion	Brom**ide**
S	Sulfur	S^{2-}	Anion	Sulf**ide**
O	Oxygen	O^{2-}	Anion	Ox**ide**
N	Nitrogen	N^{3-}	Anion	Nitr**ide**
P	phosphors	P^{3-}	Anion	Phosph**ide**
C	Carbon	C^{4-}	Anion	Carb**ide**
Si	Silicon	Si^{4-}	Anion	Silic**ide**

Rules for naming compounds:

Ionic compounds (compounds contain cations and anions)

- The cation is named first and the anion is named second
- Be sure the net charge is **ZERO**
- **P.S. For** Ionic compounds that contain transition metals cations (more than one possible oxidation state), write the oxidation state between two bracket.

Example: Write the names for the following molecules: $AlCl_3$, Na_2S, K_2O, MgH_2, FeO, Fe_2O_3, $CaCO_3$, $AlPO_4$, $Zn(OH)_2$, $KMnO_4$, $CuSO_4$, $AgNO_3$.

Answer:

Compound	Name	Compound	Name
$AlCl_3$	Aluminum Chlor***ide***	Na_2S	Sodium Sulf***ide***
K_2O	Potassium Ox**ide**	MgH_2	Magnesium Hydr**ide**
FeO	Iron (II) Ox**ide**	Fe_2O_3	Iron (III) Ox**ide**
$CaCO_3$	Calcium Carbonate	$AlPO_4$	Aluminum Phosphate
$Zn(OH)_2$	Zinc Hydroxide	$KMnO_4$	Potassium Permanganate
$CuSO_4$	Copper (II) Sulfate	$AgNO_3$	Silver Nitrate

How to write the formula:

1- Identify the symbol for both cation and anion.

2- Write them and the charge underneath them.

3- Remove the charge (+ or -), and leave the number.

4- Exchange the numbers

5- Make the numbers as simple as possible (exact number and no fractions).

6- Write the formula using the final numbers from step 5.

Example: Write the chemical formula for Calcium sulfate, Aluminum oxide, Iron(II) nitrate.

Answer:

Calcium sulfate

Using the above mentioned method:

1- Calcium is Ca^{2+}, and sulfate is (SO_4^{2-})

2- Write them and the charge underneath them

	Ca	(SO_4)
	2+	2-
3- Remove the charge	Ca	(SO_4)
	2	2
4- Exchange the numbers	Ca	(SO_4)
	2	2
5- Divide both numbers by 2:	Ca	(SO_4)
	1	1

6- Write the formula:

$Ca_1(SO_4)_1$ **or** $CaSO_4$

Naming Covalent compounds

Covalent compounds contain no charge and they are formed from non-metals located at the right hand side of the periodic table. *The number of the atoms must be written* before the name of the element *using the following prefix* (Drop a prefix is if the *mono* is to appear at the beginning of the name).

Number of atoms	Prefix	Number of atoms	Prefix
one	Mono-	**Two**	Di-
Three	Tri-	**Four**	Tetra-
Five	Penta-	**Six**	Hexa-

Example: Write the names for the following molecules: CO, N_2O_4, NO, SO_2, PCl_5

Answer:

Compound	Name	Compound	Name
CO	Carbon **mono**xide	N_2O_4	**Di**nitrogen **tetra**oxide
NO	Nitrogen **mono**xide	SO_2	Sulfur **di**oxide
PCl_5	Phosphorus **penta**chloride	HBr	Hydrogen **mono**chloride

Example: Write the Chemical formula for: Carbon dioxide, sulfur trioxide, dihydrogen monoxide, phosphorous trichloride, nitrogen dioxide.

Answer:

Name	Formula	Name	Formula
Carbon dioxide	**CO_2**	**sulfur trioxide**	**SO_3**
dihydrogen monoxide	**H_2O**	**dihydrogen monoxide**	**H_2O**
phosphorous trichloride	**PCl_3**	**nitrogen dioxide**	**NO_2**

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University Chemistry
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