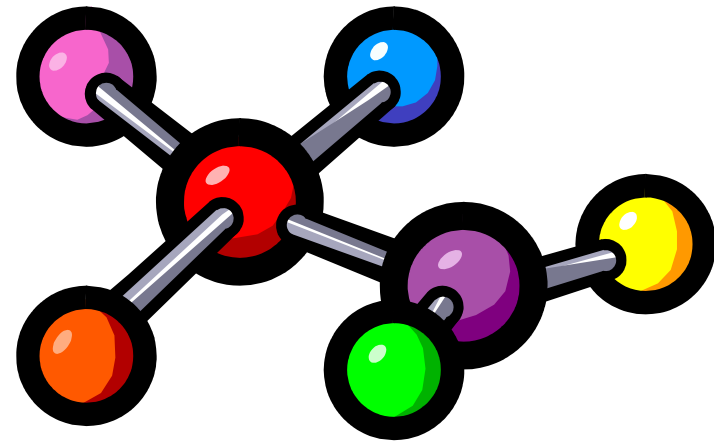
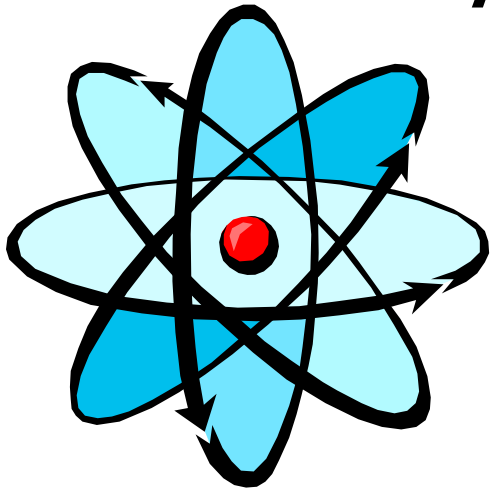


Presentasi Powerpoint Pengajar  
oleh  
Penerbit ERLANGGA  
*Divisi Perguruan Tinggi*

## *Bab 2*

# Atom, Molekul, dan Ion



# Teori Atom Dalton (1808)

1. **Unsur** tersusun atas partikel yang sangat kecil, yang disebut atom. Semua atom unsur tertentu adalah identik, yaitu mempunyai ukuran, masa dan sifat kimia yang sama. Atom satu unsur tertentu berbeda dari atom semua unsur yang lain.
2. **Senyawa** tersusun atas atom-atom dari dua unsur atau lebih. Dalam setiap senyawa perbandingan antara jumlah atom dari setiap dua unsur yang ada bisa merupakan bilangan bulat atau pecahan sederhana.
3. Yang terjadi dalam **reaksi kimia** hanyalah pemisahan, penggabungan, atau penyusunan ulang atom-atom; reaksi kimia tidak mengakibatkan penciptaan atau pemusnahan atom-atom.

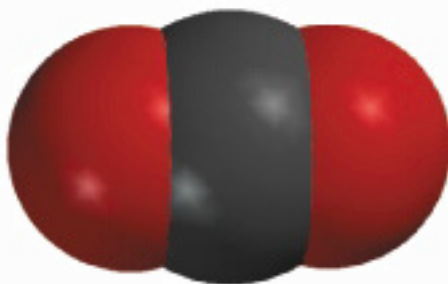
# Oxygen in CO and CO<sub>2</sub>

Carbon monoxide



$$\frac{\text{O}}{\text{C}} = \frac{\text{1 red sphere}}{\text{1 black sphere}} = \frac{1}{1}$$

Carbon dioxide



$$\frac{\text{O}}{\text{C}} = \frac{\text{2 red spheres}}{\text{1 black sphere}} = \frac{2}{1}$$

**Law of Multiple Proportions**

# Dalton's Atomic Theory



Atoms of element X

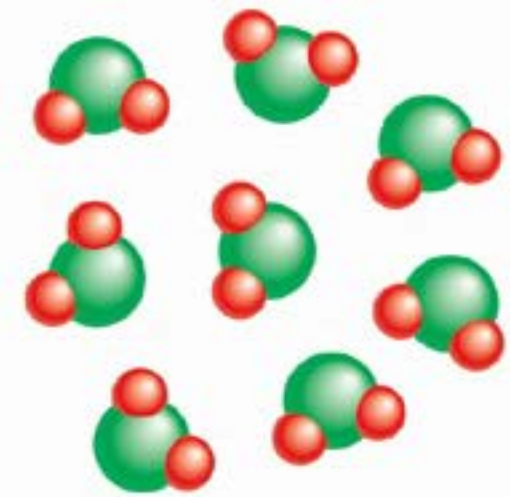
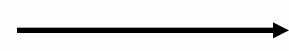
16 X

+



Atoms of element Y

8 Y

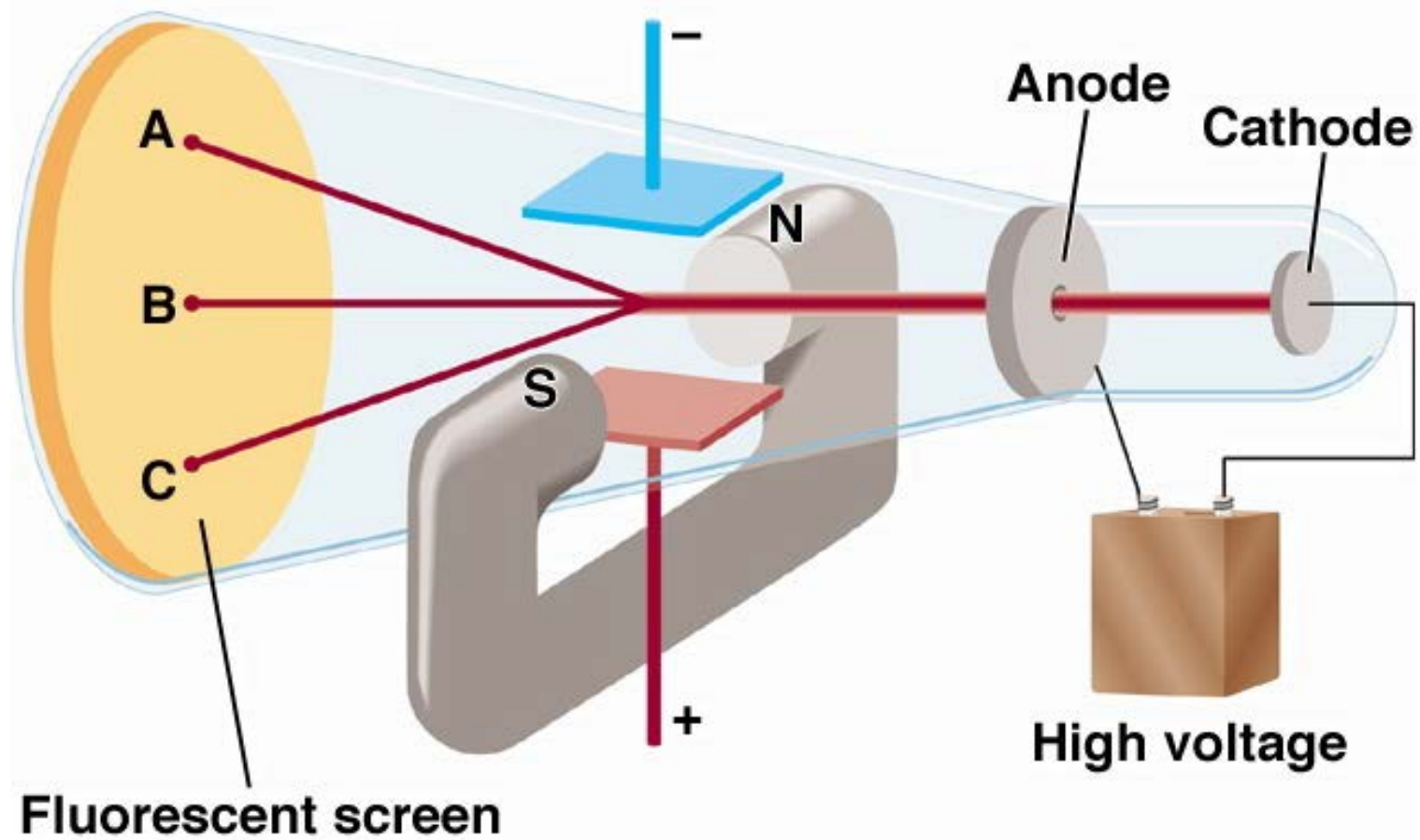


Compound of elements X and Y

8 X<sub>2</sub>Y

## Hukum Kekekalan Massa

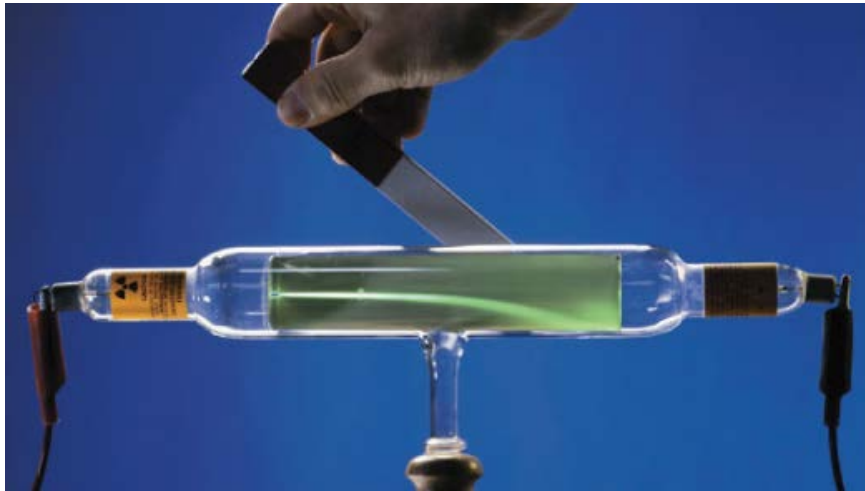
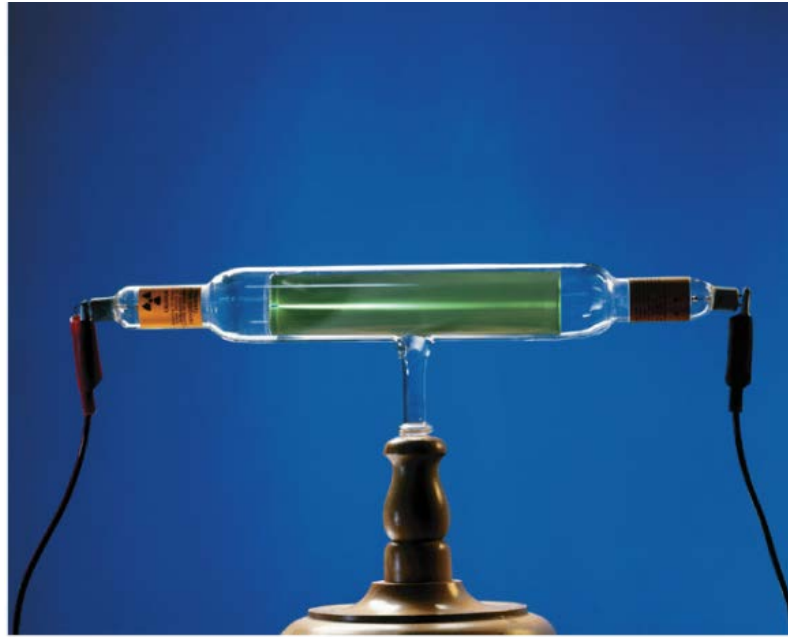
# Cathode Ray Tube



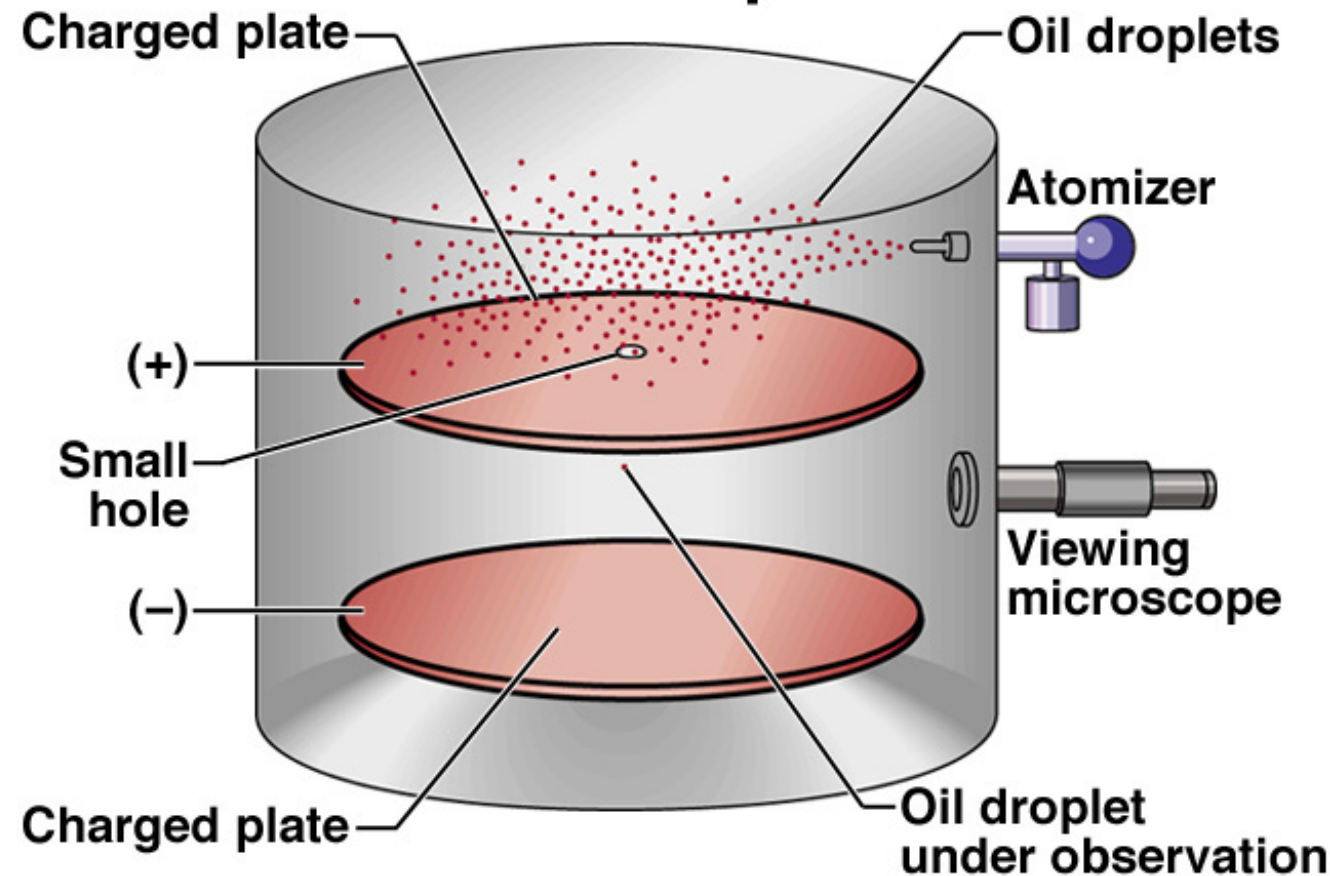
J.J. Thomson, **menentukan perbandingan muatan listrik terhadap massa elektron tunggal  $e^-$**

(Pemenang Hadiah Nobel bidang Fisika tahun 1906) 2.2

# Tabung Sinar Katoda



# Millikan's Experiment



Pengukuran massa  
elektron tunggal ( $e^-$ )

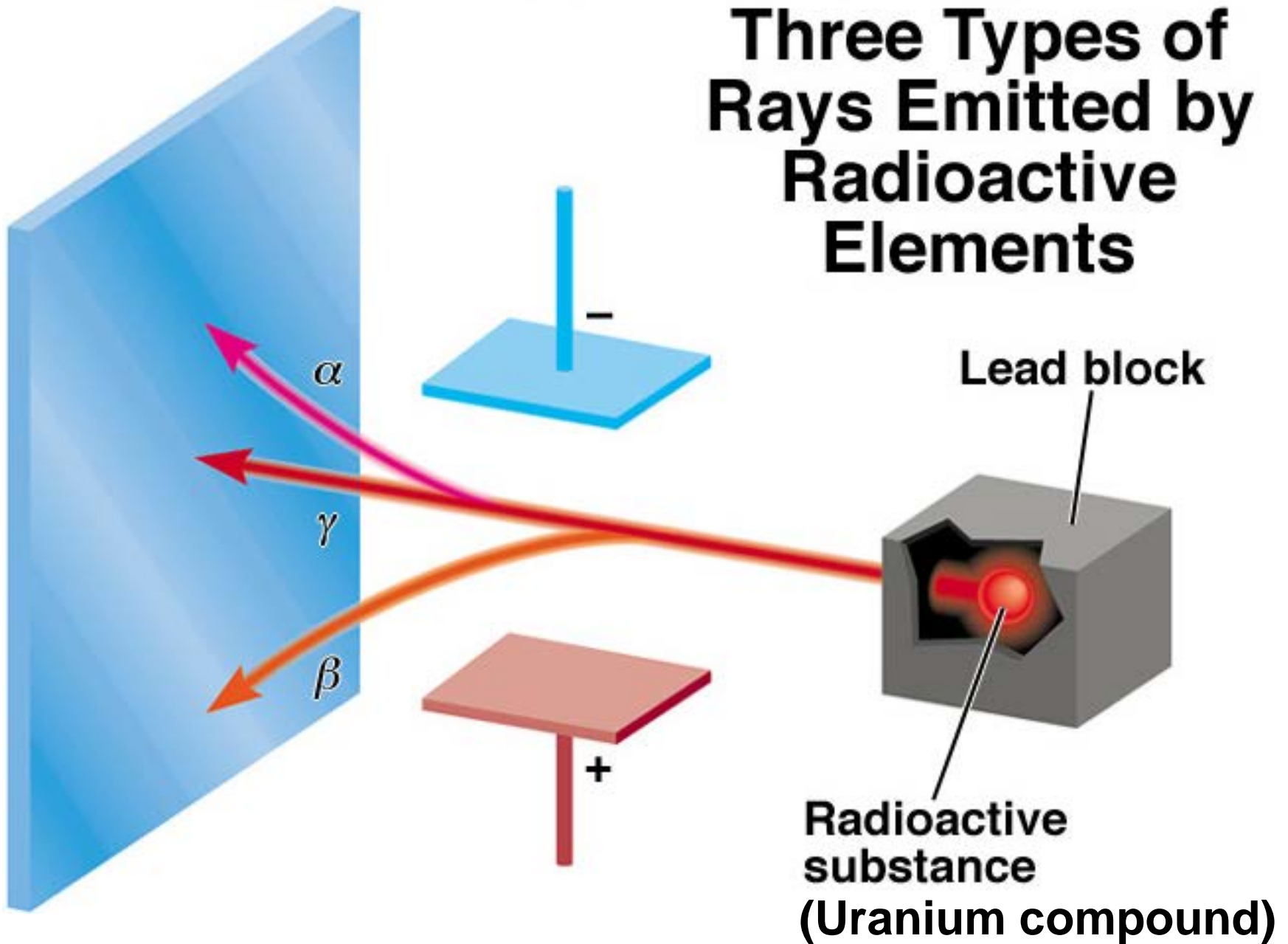
(Pemenang Hadiah Nobel  
bidang Fisika tahun 1923)

$$\text{tegangan } e^- = -1,60 \times 10^{-19} \text{ C}$$

$$\text{tegangan/massa } e^- \text{ Thomson} = -1,76 \times 10^8 \text{ C/g}$$

$$\text{massa } e^- = 9,10 \times 10^{-28} \text{ g}$$

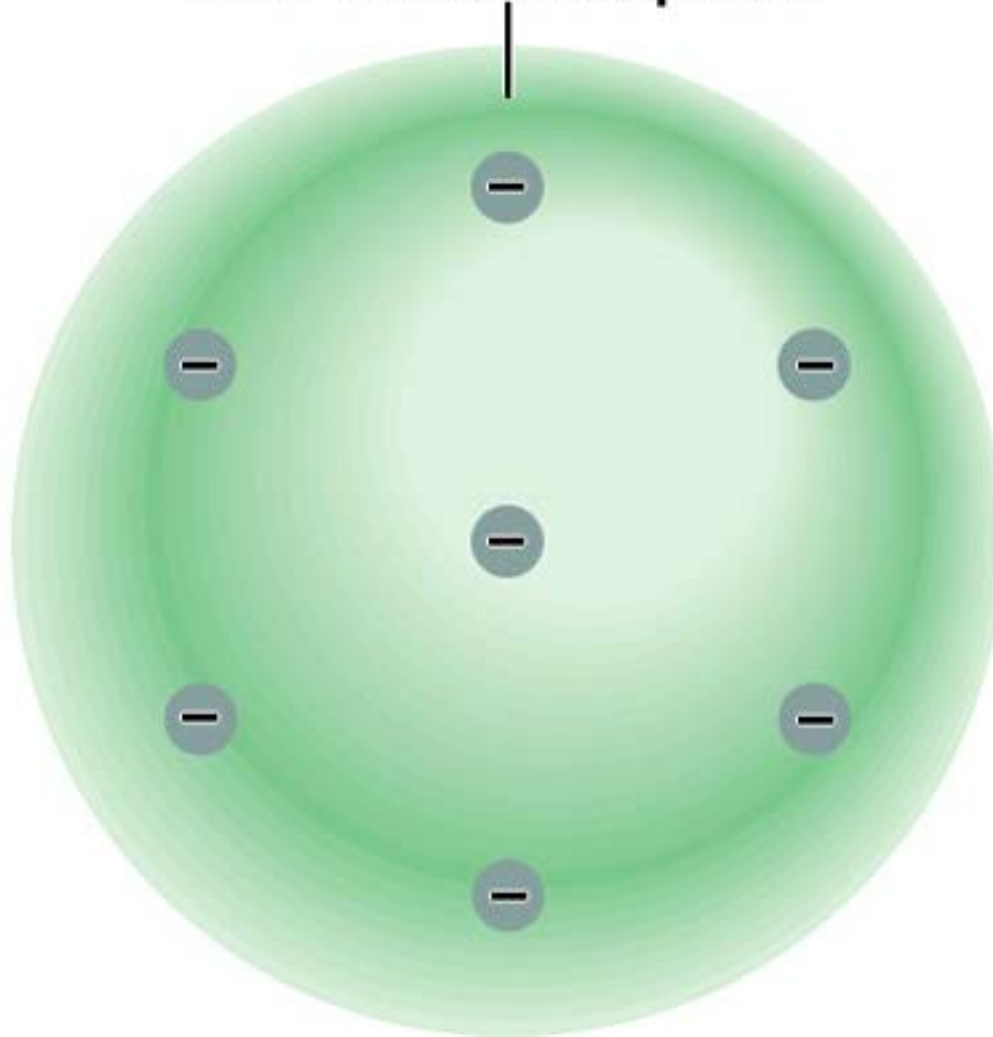
# Three Types of Rays Emitted by Radioactive Elements





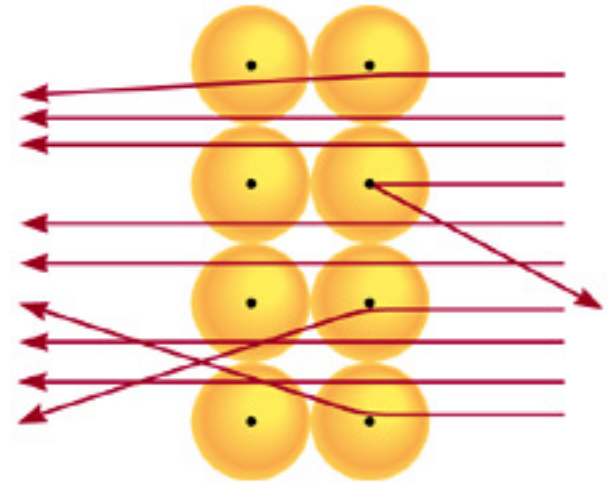
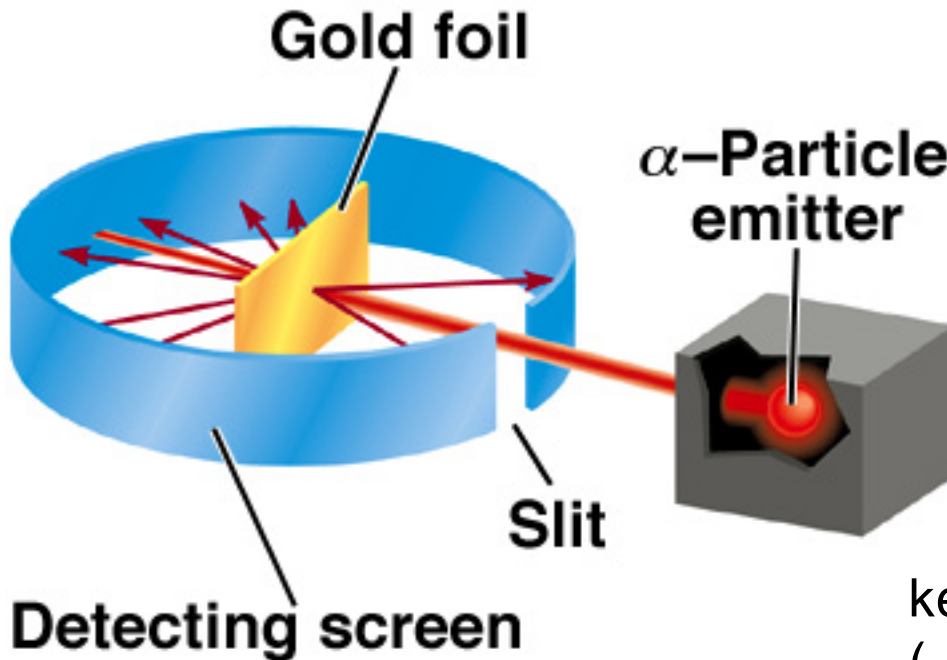
# Thomson's Model of the Atom

Positive charge spread  
over the entire sphere



# Rutherford's Experimental Design

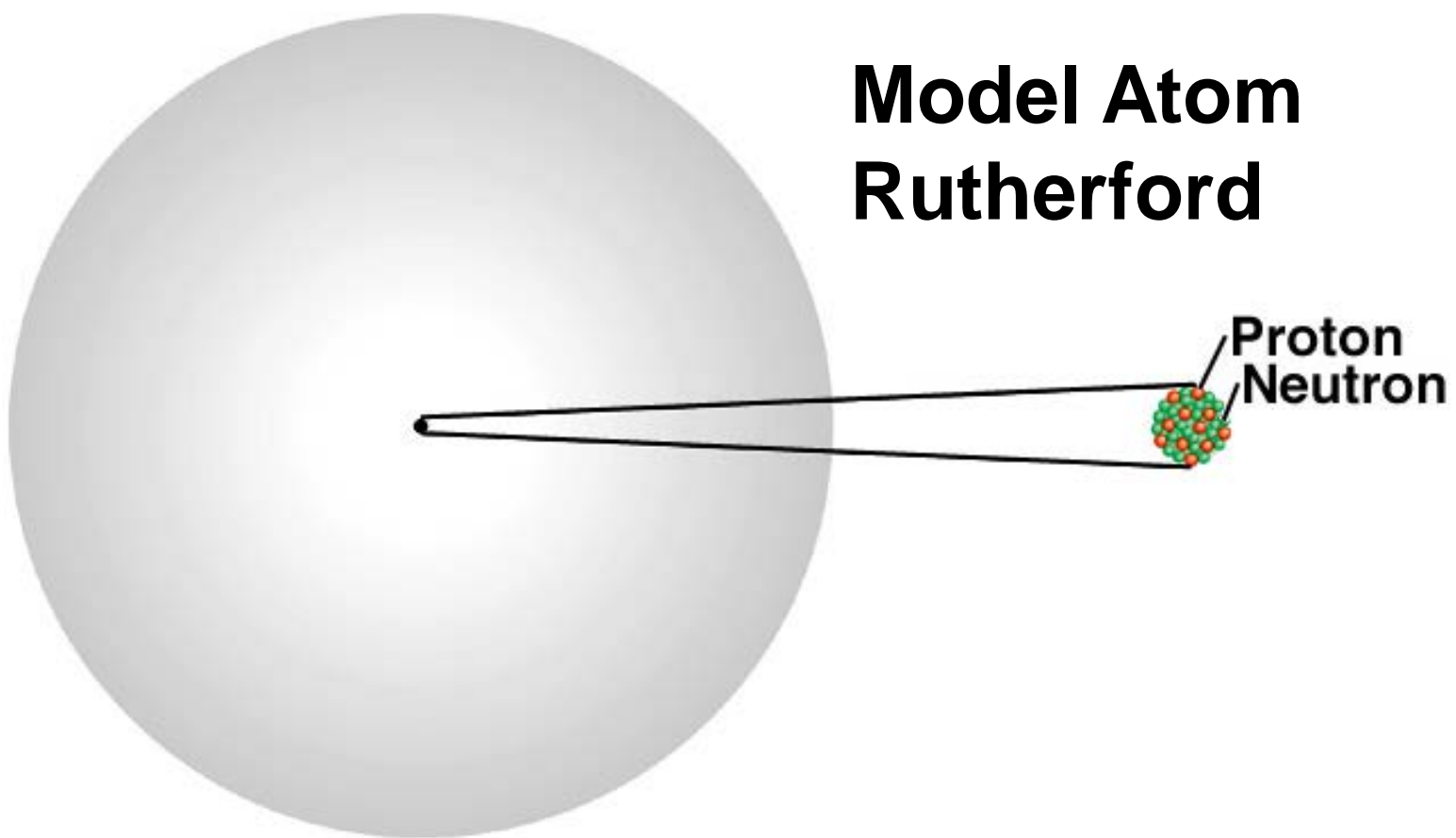
(Pemenang Hadiah Nobel di bidang Kimia tahun 1908)



kecepatan partikel  $\alpha \sim 1,4 \times 10^7$  m/dt  
(~5% dari kecepatan cahaya)

1. muatan positif atom seluruhnya terkumpul dalam ***inti***.
2. proton (p) memiliki muatan yang berlawanan (+) dari muatan elektron (-).
3. massa proton  $1.840 \times$  massa elektron ( $1,67 \times 10^{-24}$  g). 2.2

# Model Atom Rutherford

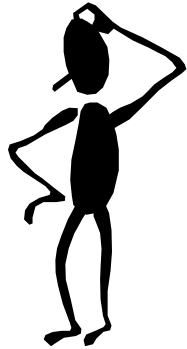


jari-jari atom  $\sim 100 \text{ pm} = 1 \times 10^{-10} \text{ m}$

Jari-jari inti atom  $\sim 5 \times 10^{-3} \text{ pm} = 5 \times 10^{-15} \text{ m}$

“Jika suatu atom seukuran Gelora Senayan, maka volume intinya akan sebanding dengan ukuran kelereng.”

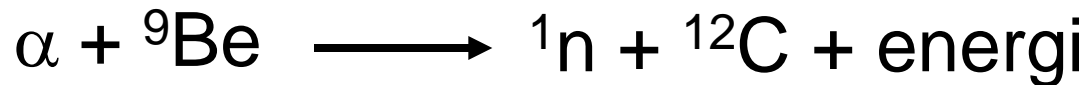
# Eksperimen Chadwick (1932)



atom H - 1 p; atom He - 2 p

massa He/massa H seharusnya = 2

perbandingan massa He/massa H = 4



neutron (n) adalah netral (bermuatan = 0)

massa n ~ massa p =  $1,67 \times 10^{-24}$  g

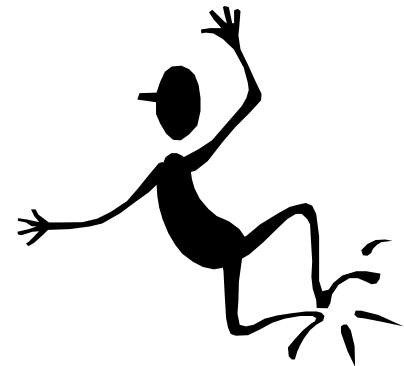


TABLE 2.1

## Mass and Charge of Subatomic Particles

Particle	Mass (g)	Charge	
		Coulomb	Charge Unit
Electron*	$9.10939 \times 10^{-28}$	$-1.6022 \times 10^{-19}$	-1
Proton	$1.67262 \times 10^{-24}$	$+1.6022 \times 10^{-19}$	+1
Neutron	$1.67493 \times 10^{-24}$	0	0

\* More refined measurements have given us a more accurate value of an electron's mass than Millikan's.

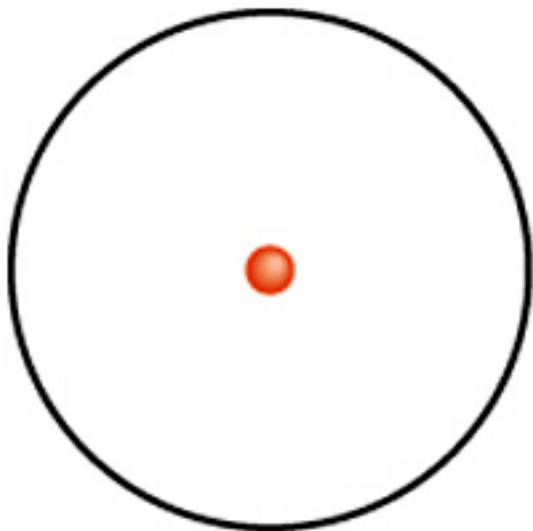
$$\text{massa p} = \text{massa n} = 1.840 \times \text{massa e}^-$$

**Nomor Atom** (Z) = jumlah proton dalam inti setiap atom  
suatu unsur.

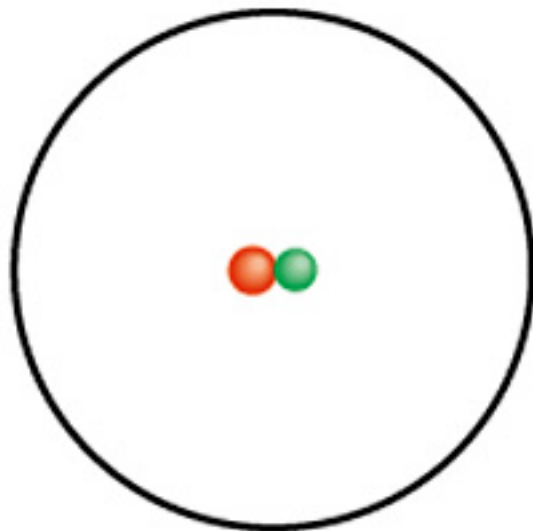
**Nomor Massa** (A) = jumlah total proton + neutron dalam inti  
atom suatu unsur.  
= nomor atom (Z) + jumlah neutron.

**Isotop** adalah atom-atom yang memiliki nomor atom yang sama  
tetapi berbeda nomornya.

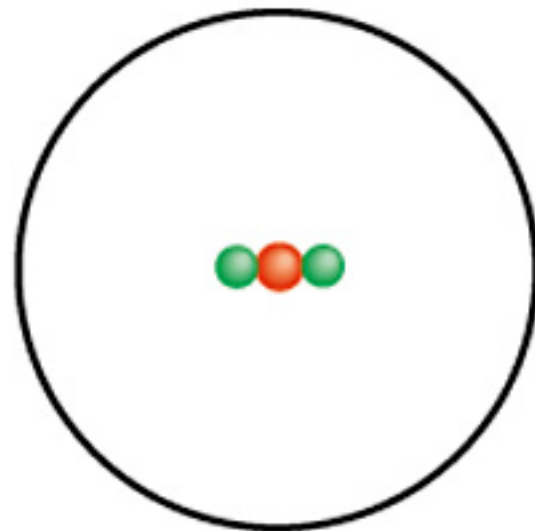




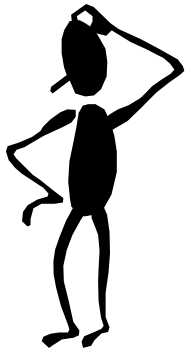
${}^1_1\text{H}$



${}^2_1\text{H}$



${}^3_1\text{H}$



Apakah Anda sudah Mengerti Isotop?

Berapa jumlah proton, neutron, dan elektron pada  $^{14}_6\text{C}$  ?

6 proton, 8 (14 - 6) neutron, 6 elektron

Berapa jumlah proton, neutron, dan elektron pada  $^{11}_6\text{C}$  ?

6 proton, 5 (11 - 6) neutron, 6 elektron



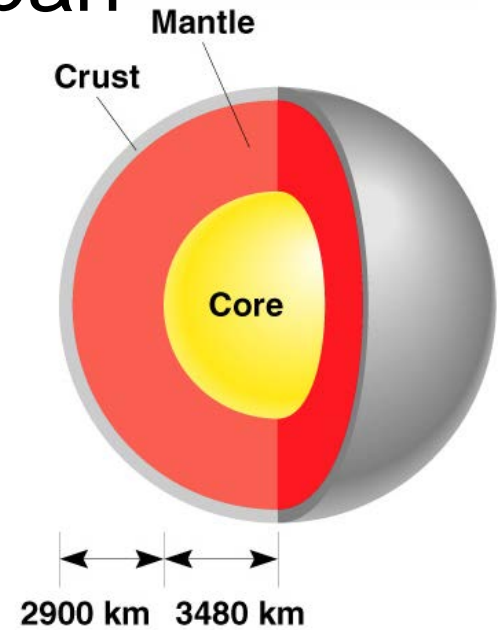
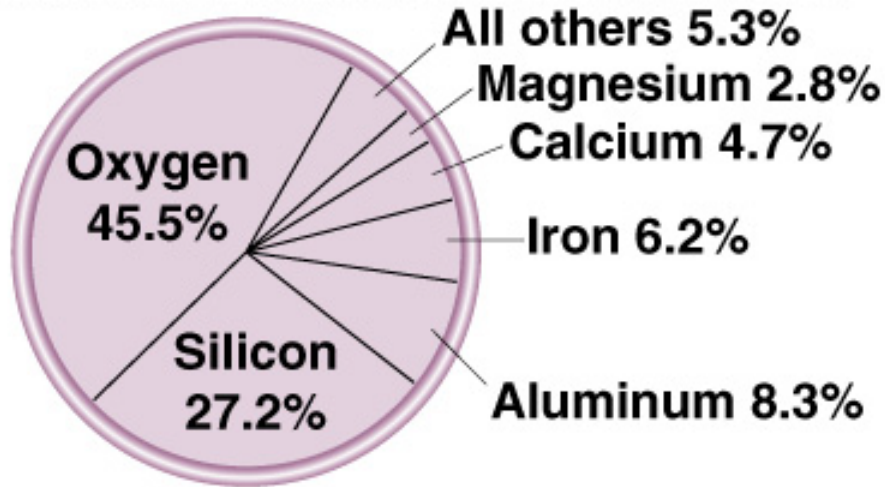
# Modern Periodic Table

1 1A													13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
H													B	C	N	O	F	Ne
Li													Al	Si	P	S	Cl	Ar
21 3B	22 4B	23 5B	24 6B	25 7B	26-28 8B		29 1B	30 2B	31 3A	32 4A	33 5A	34 6A	35 7A	36 8A				
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr			
39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe			
57 Cs	72 Ba	73 La	74 Hf	75 Ta	76 W	77 Re	78 Os	79 Ir	80 Pt	81 Au	82 Hg	83 Tl	84 Pb	85 Bi	86 Po	87 At	88 Rn	
87 Fr	89 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112	(113)	114	(115)	116	(117)	118	

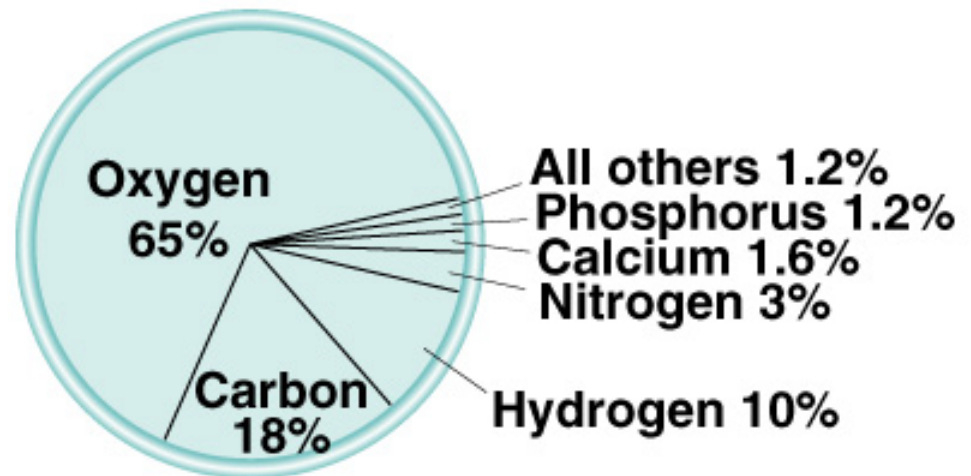
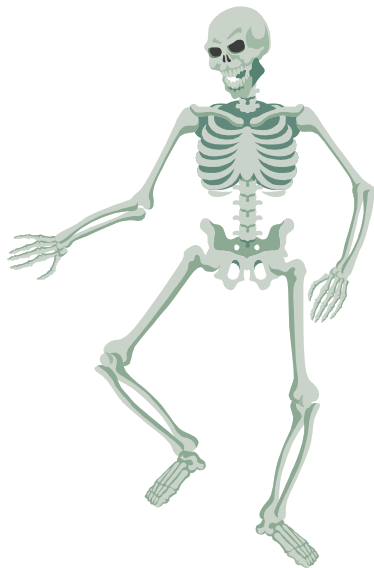
Metals	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Metalloids	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
Nonmetals														

# Kimia Dalam Kehidupan

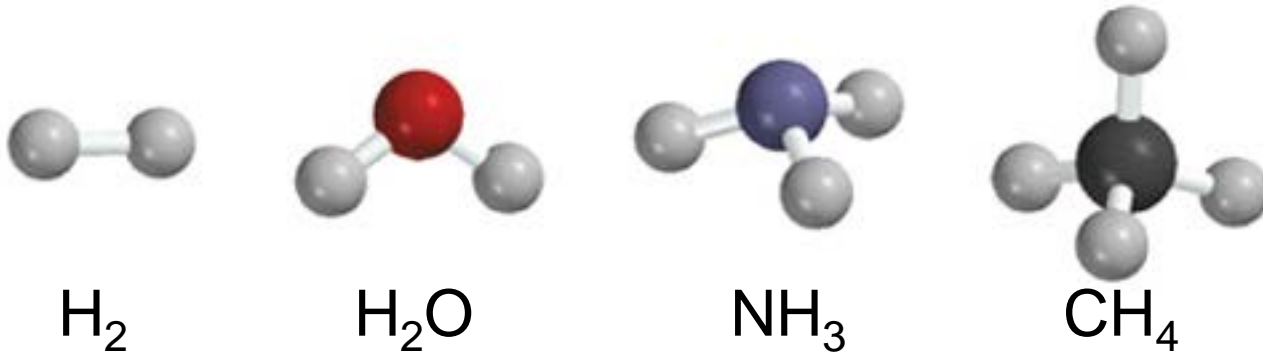
Unsur mineral alam dalam perut Bumi



Unsur mineral alam pada tubuh manusia



**Molekul** adalah suatu agregat (kumpulan) yang terdiri dari sedikitnya dua atom dalam susunan tertentu yang terikat bersama oleh gaya-gaya kimia (disebut juga ikatan kimia).



**Molekul diatomik** mengandung hanya dua atom



**Molekul poliatomik** mengandung lebih dari dua atom



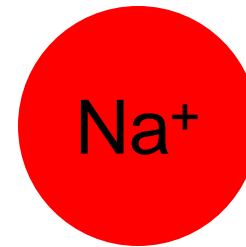
**Ion** adalah sebuah atom atau sekelompok atom yang mempunyai muatan total positif atau negatif.

**kation** – ion dengan muatan total positif.

Atom netral yang **kehilangan** satu atau lebih elektronnya akan menghasilkan kation.



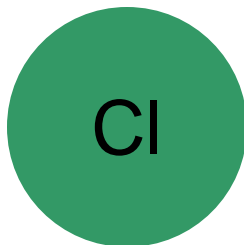
11 proton  
11 elektron



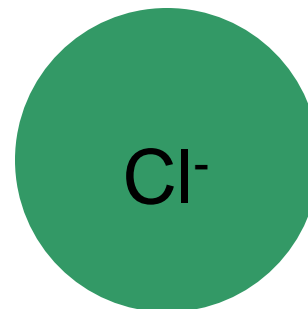
11 proton  
10 elektron

**anion** – ion dengan muatan total negatif.

Atom netral yang **bertambah** satu atau lebih elektronnya akan menghasilkan anion.

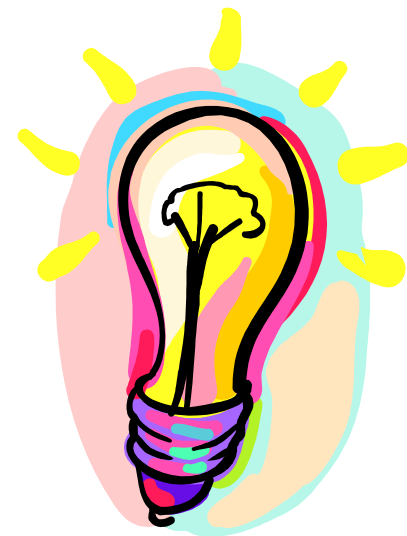
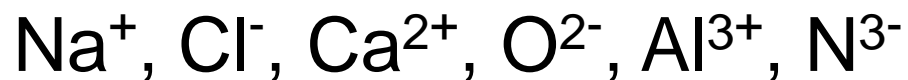


17 proton  
17 elektron

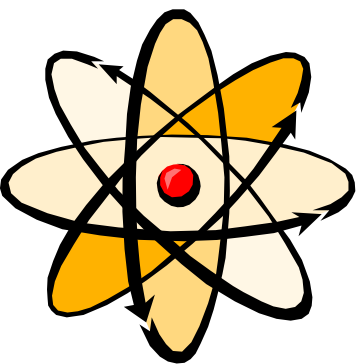


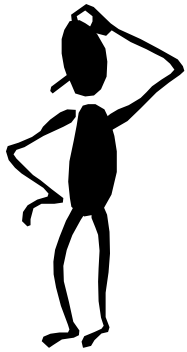
17 proton  
18 elektron

***Ion monatomik*** mengandung hanya satu atom



***Ion poliatomik*** mengandung lebih dari satu atom





Apakah Anda sudah Mengerti Ion?

Berapa jumlah proton dan elektron pada  ${}_{13}^{27}\text{X}^{3+}$  ?

13 proton, 10 (13 – 3) elektron

Berapa jumlah proton dan elektron pada  ${}_{34}^{78}\text{X}^{2-}$  ?


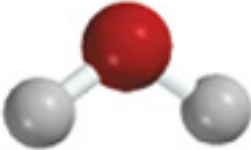
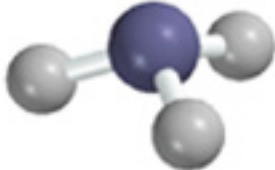
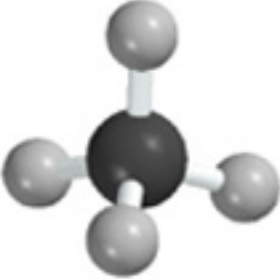




34 proton, 36 (34 + 2) elektron

# Monatomic Ions

The image shows a periodic table with monatomic ions for elements 1 through 18. The table is color-coded: green for cations and red for anions. The ions are as follows:

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
$\text{Li}^+$																	
$\text{Na}^+$	$\text{Mg}^{2+}$																
$\text{K}^+$	$\text{Ca}^{2+}$				$\text{Cr}^{3+}$	$\text{Mn}^{2+}$	$\text{Fe}^{2+}$ $\text{Fe}^{3+}$	$\text{Co}^{2+}$ $\text{Co}^{3+}$	$\text{Ni}^{2+}$	$\text{Cu}^+$ $\text{Cu}^{2+}$	$\text{Zn}^{2+}$						
$\text{Rb}^+$	$\text{Sr}^{2+}$									$\text{Ag}^+$	$\text{Cd}^{2+}$						
$\text{Cs}^+$	$\text{Ba}^{2+}$										$\text{Hg}_2^{2+}$ $\text{Hg}^{2+}$		$\text{Sn}^{2+}$				
													$\text{Pb}^{2+}$				

# Standard Types of Formulas and Models

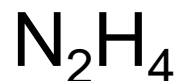
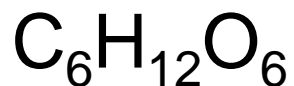
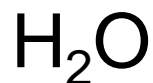
	Hydrogen	Water	Ammonia	Methane
Molecular formula	$H_2$	$H_2O$	$NH_3$	$CH_4$
Structural formula	$H-H$	$H-O-H$	$\begin{array}{c} H-N-H \\   \\ H \end{array}$	$\begin{array}{c} H \\   \\ H-C-H \\   \\ H \end{array}$
Ball-and-stick model				
Space-filling model				



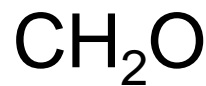
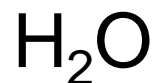
***Rumus molekul*** menunjukkan jumlah eksak atom-atom dari setiap unsur di dalam unit terkecil suatu zat.

***Rumus empiris*** menunjukkan unsur-unsur yang ada dan perbandingan bilangan bulat paling sederhana pada atom-atomnya.

**molekular**



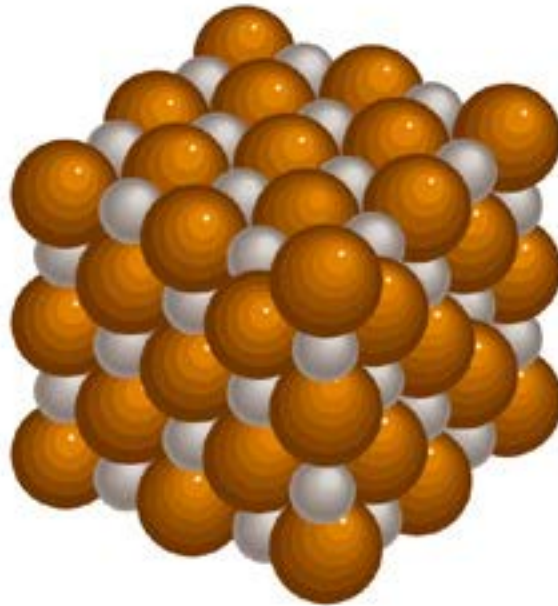
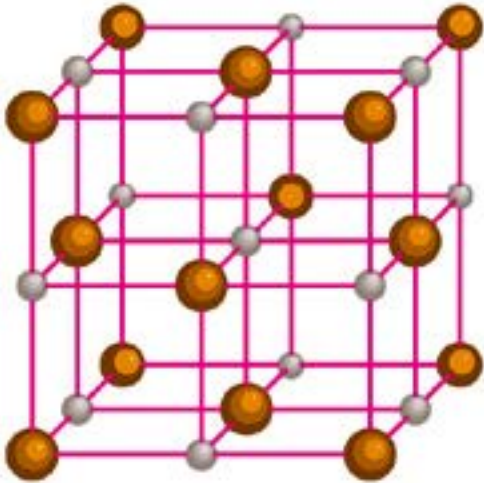
**empirikal**



***Rumus senyawa ionik*** terdiri atas kombinasi dari kation dan anion.

- biasanya sama dengan rumus empirisnya.
- perbandingan muatan (+) dan (-) di setiap senyawa = 1:1 sehingga senyawa tersebut bermuatan listrik netral.

rumus senyawa ionik senyawa NaCl



# Rumus Senyawa Ionik

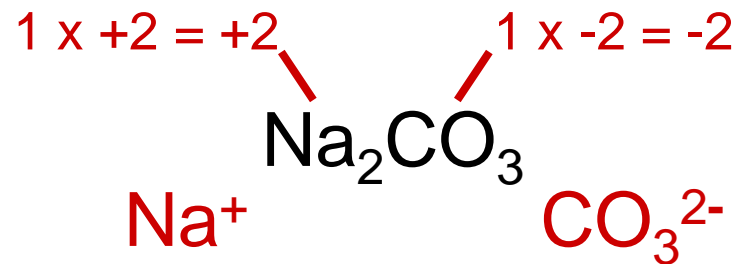
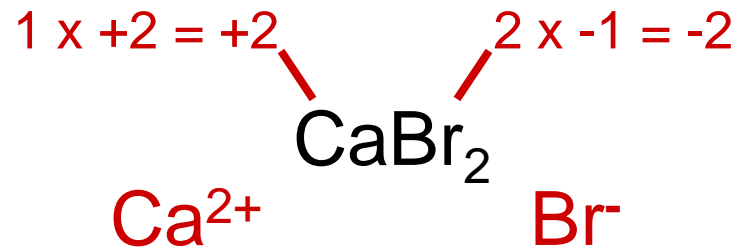
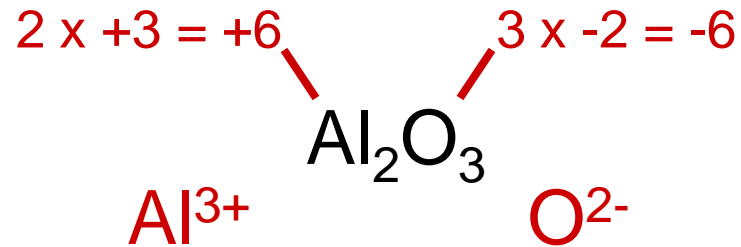


TABLE 2.2

**The “-ide” Nomenclature of Some Common Monatomic Anions According to Their Positions in the Periodic Table**

<b>Group 4A</b>	<b>Group 5A</b>	<b>Group 6A</b>	<b>Group 7A</b>
C Carbide ( $\text{C}^{4-}$ )*	N Nitride ( $\text{N}^{3-}$ )	O Oxide ( $\text{O}^{2-}$ )	F Fluoride ( $\text{F}^-$ )
Si Silicide ( $\text{Si}^{4-}$ )	P Phosphide ( $\text{P}^{3-}$ )	S Sulfide ( $\text{S}^{2-}$ )	Cl Chloride ( $\text{Cl}^-$ )
		Se Selenide ( $\text{Se}^{2-}$ )	Br Bromide ( $\text{Br}^-$ )
		Te Telluride ( $\text{Te}^{2-}$ )	I Iodide ( $\text{I}^-$ )

\* The word “carbide” is also used for the anion  $\text{C}_2^{2-}$ .

TABLE 2.3

## Names and Formulas of Some Common Inorganic Cations and Anions

Cation	Anion
Aluminum ( $\text{Al}^{3+}$ )	Bromide ( $\text{Br}^-$ )
Ammonium ( $\text{NH}_4^+$ )	Carbonate ( $\text{CO}_3^{2-}$ )
Barium ( $\text{Ba}^{2+}$ )	Chlorate ( $\text{ClO}_3^-$ )
Cadmium ( $\text{Cd}^{2+}$ )	Chloride ( $\text{Cl}^-$ )
Calcium ( $\text{Ca}^{2+}$ )	Chromate ( $\text{CrO}_4^{2-}$ )
Cesium ( $\text{Cs}^+$ )	Cyanide ( $\text{CN}^-$ )
Chromium(III) or chromic ( $\text{Cr}^{3+}$ )	Dichromate ( $\text{Cr}_2\text{O}_7^{2-}$ )
Cobalt(II) or cobaltous ( $\text{Co}^{2+}$ )	Dihydrogen phosphate ( $\text{H}_2\text{PO}_4^-$ )
Copper(I) or cuprous ( $\text{Cu}^+$ )	Fluoride ( $\text{F}^-$ )
Copper(II) or cupric ( $\text{Cu}^{2+}$ )	Hydride ( $\text{H}^-$ )
Hydrogen ( $\text{H}^+$ )	Hydrogen carbonate or bicarbonate ( $\text{HCO}_3^-$ )
Iron(II) or ferrous ( $\text{Fe}^{2+}$ )	Hydrogen phosphate ( $\text{HPO}_4^{2-}$ )
Iron(III) or ferric ( $\text{Fe}^{3+}$ )	Hydrogen sulfate or bisulfate ( $\text{HSO}_4^-$ )
Lead(II) or plumbous ( $\text{Pb}^{2+}$ )	Hydroxide ( $\text{OH}^-$ )
Lithium ( $\text{Li}^+$ )	Iodide ( $\text{I}^-$ )
Magnesium ( $\text{Mg}^{2+}$ )	Nitrate ( $\text{NO}_3^-$ )
Manganese(II) or manganous ( $\text{Mn}^{2+}$ )	Nitride ( $\text{N}^{3-}$ )
Mercury(I) or mercurous ( $\text{Hg}_2^{2+}$ )*	Nitrite ( $\text{NO}_2^-$ )
Mercury(II) or mercuric ( $\text{Hg}^{2+}$ )	Oxide ( $\text{O}^{2-}$ )
Potassium ( $\text{K}^+$ )	Permanganate ( $\text{MnO}_4^-$ )
Silver ( $\text{Ag}^+$ )	Peroxide ( $\text{O}_2^{2-}$ )

# Penamaan Senyawa

- **Senyawa Ionik**

- biasanya logam + non-logam.
- anion (non-logam), menambahkan “ida” pada nama senyawa.



barium klorida



potassium oksida



magnesium hidroksida



potassium nitrat

- Senyawa Ionik logam transisi
  - Menunjukkan kation-kation berbeda dari unsur yang sama dengan menggunakan angka Romawi.

$\text{FeCl}_2$     2  $\text{Cl}^-$   $-2$  so Fe adalah  $+2$     besi(II) klorida

$\text{FeCl}_3$     3  $\text{Cl}^-$   $-3$  so Fe adalah  $+3$     besi(III) klorida

$\text{Cr}_2\text{S}_3$     3  $\text{S}^{2-}$   $-6$  so Cr adalah  $+3$  ( $6/2$ )

kromium(III) sulfida

## • Senyawa molekular

- non-logam atau non-logam + metaloid
- istilah umum
  - $\text{H}_2\text{O}$ ,  $\text{NH}_3$ ,  $\text{CH}_4$ ,  $\text{C}_{60}$
- unsur di tabel periodik yang berada lebih ke kiri ditempatkan di depan.
- unsur terdekat dengan golongan terbawah ditempatkan didepan.
- Jika lebih dari satu senyawa dapat dibentuk dari unsur yang sama, gunakan awalan untuk mengindikasikan nomor dari masing-masing atom.
- unsur terakhir diakhiri dengan “ida”.

**Greek Prefixes Used  
in Naming Molecular  
Compounds**

<b>Prefix</b>	<b>Meaning</b>
Mono-	1
Di-	2
Tri-	3
Tetra-	4
Penta-	5
Hexa-	6
Hepta-	7
Octa-	8
Nona-	9
Deca-	10

**TABLE 2.4**



# Senyawa Molekular

HI hidrogen iodida

NF<sub>3</sub> nitrogen trifluorida

SO<sub>2</sub> sulfur dioksida

N<sub>2</sub>Cl<sub>4</sub> dinitrogen tetraklorida

NO<sub>2</sub> nitrogen dioksida RACUN!



N<sub>2</sub>O dinitrogen monoksida Gas Tawa



# Compound

## Ionic

Cation: metal or  $\text{NH}_4^+$  Anion: monatomic or polyatomic

### Cation has only one charge

- Alkali metal cations
- Alkaline earth metal cations
- $\text{Ag}^+$ ,  $\text{Al}^{3+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Zn}^{2+}$

### Naming

- Name metal first
- If monatomic anion, add “-ide” to the root of the element name
- If polyatomic anion, use name of anion (see Table 2.3)

### Cation has more than one charge

- Other metal cations

### Naming

- Name metal first
- Specify charge of metal cation with Roman numeral in parentheses
- If monatomic anion, add “-ide” to the root of the element name
- If polyatomic anion, use name of anion (see Table 2.3)

## Molecular

- Binary compounds of nonmetals

### Naming

- Use prefixes for both elements present (Prefix “mono-” usually omitted for the first element)
- Add “-ide” to the root of the second element

**Asam** dapat digambarkan sebagai zat yang menghasilkan ion hidrogen ( $H^+$ ) ketika dilarutkan ke air.

HCl

- Cairan murni (gas), hidrogen klorida
- Ketika dilarutkan ke air ( $H^+ Cl^-$ ), asam klorida

**Asam okso** merupakan asam yang mengandung hidrogen, oksigen, dan unsur lain (unsur pusat).

$HNO_3$

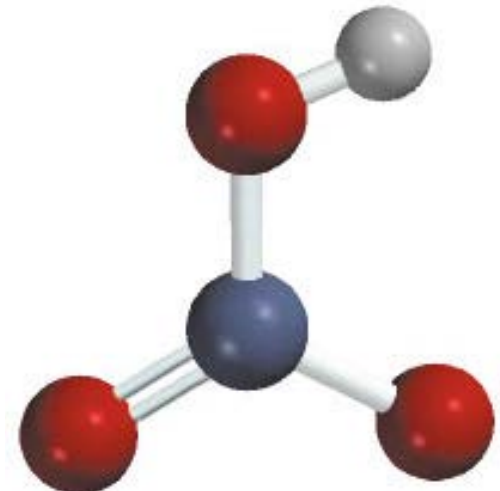
Asam nitrat

$H_2CO_3$

Asam karbonat

$H_2SO_4$

Asam sulfat

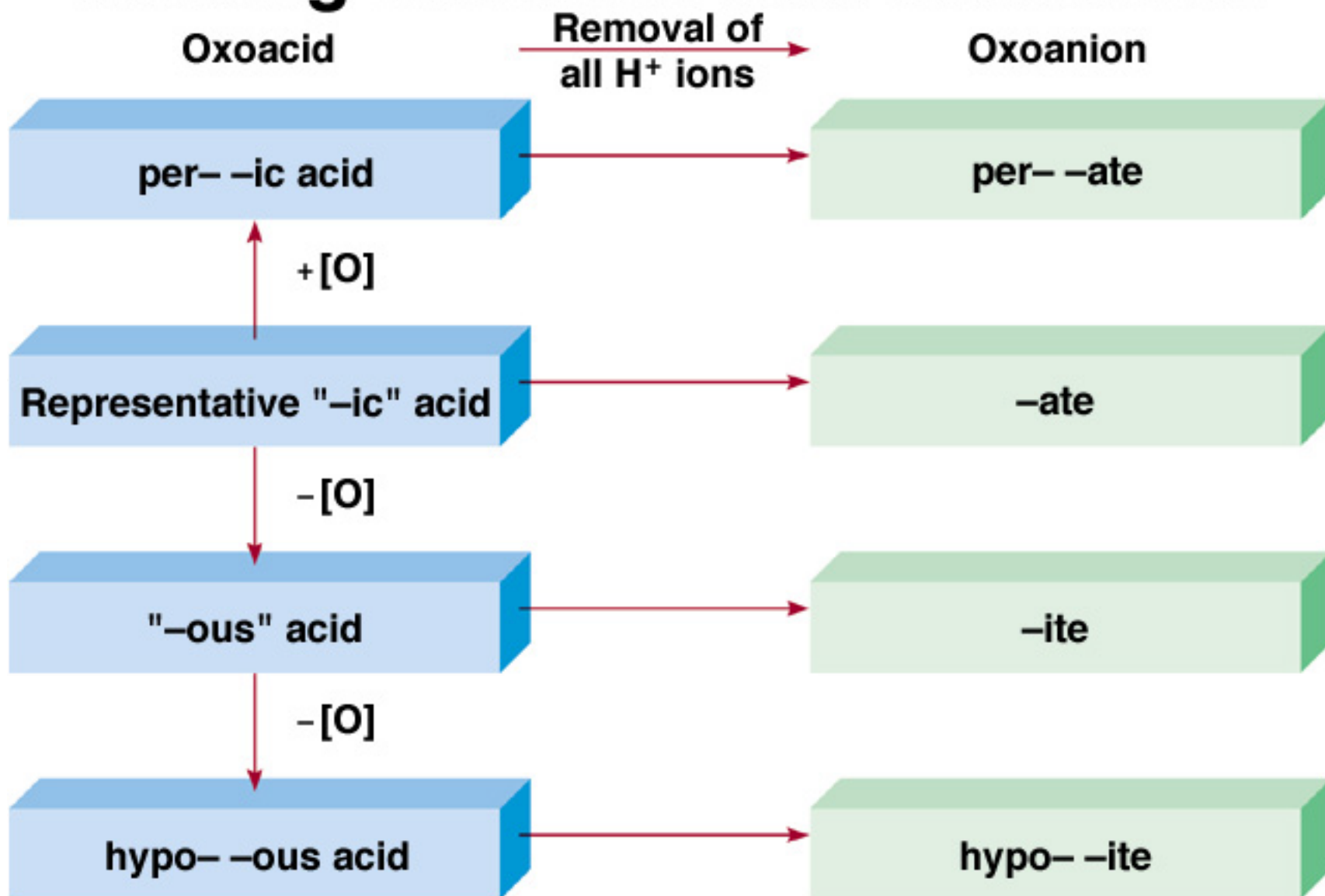


$HNO_3$

**TABLE 2.5****Some Simple Acids**

<b>Anion</b>	<b>Corresponding Acid</b>
F <sup>-</sup> (fluoride)	HF (hydrofluoric acid)
Cl <sup>-</sup> (chloride)	HCl (hydrochloric acid)
Br <sup>-</sup> (bromide)	HBr (hydrobromic acid)
I <sup>-</sup> (iodide)	HI (hydroiodic acid)
CN <sup>-</sup> (cyanide)	HCN (hydrocyanic acid)
S <sup>2-</sup> (sulfide)	H <sub>2</sub> S (hydrosulfuric acid)

# Naming Oxoacids and Oxoanions



**TABLE 2.6****Names of Oxoacids and Oxoanions That Contain Chlorine****Acid****Anion**HClO<sub>4</sub> (perchloric acid)ClO<sub>4</sub><sup>-</sup> (perchlorate)HClO<sub>3</sub> (chloric acid)ClO<sub>3</sub><sup>-</sup> (chlorate)HClO<sub>2</sub> (chlorous acid)ClO<sub>2</sub><sup>-</sup> (chlorite)

HClO (hypochlorous acid)

ClO<sup>-</sup> (hypochlorite)

**Basa** dapat digambarkan sebagai zat yang menghasilkan ion hidroksida ( $\text{OH}^-$ ) ketika dilarutkan dalam air.

$\text{NaOH}$

sodium hidroksida

$\text{KOH}$

potasium hidroksida

$\text{Ba}(\text{OH})_2$

barium hidroksida



TABLE 2.7

**Common and Systematic Names of Some Compounds**

<b>Formula</b>	<b>Common Name</b>	<b>Systematic Name</b>
H <sub>2</sub> O	Water	Dihydrogen monoxide
NH <sub>3</sub>	Ammonia	Trihydrogen nitride
CO <sub>2</sub>	Dry ice	Solid carbon dioxide
NaCl	Table salt	Sodium chloride
N <sub>2</sub> O	Laughing gas	Dinitrogen monoxide
CaCO <sub>3</sub>	Marble, chalk, limestone	Calcium carbonate
CaO	Quicklime	Calcium oxide
Ca(OH) <sub>2</sub>	Slaked lime	Calcium hydroxide
NaHCO <sub>3</sub>	Baking soda	Sodium hydrogen carbonate
Na <sub>2</sub> CO <sub>3</sub> · 10H <sub>2</sub> O	Washing soda	Sodium carbonate decahydrate
MgSO <sub>4</sub> · 7H <sub>2</sub> O	Epsom salt	Magnesium sulfate heptahydrate
Mg(OH) <sub>2</sub>	Milk of magnesia	Magnesium hydroxide
CaSO <sub>4</sub> · 2H <sub>2</sub> O	Gypsum	Calcium sulfate dihydrate