BAB I

Materi dan Perubahannya

Disampaikan oleh : Dr. Sri Handayani
2013

1. Properties of Matter
2. Changes in Matter
3. Clasification of Matter
4. Elements and Compounds

1. PROPERTIES OF MATTER (SIFAT-SIFAT MATERI)

Tujuan :

- **Identify** the characteristics of a substance.
- **Distinguish** between physical and chemical properties.
- **Differentiate** among the physical states of matter.

Some Criteria for the Classification of Matter

- Properties
- State (solid, liquid, gas)
- Composition

Properties

- **Physical**: observed without changing the composition of the substance.

- **Chemical**: the ability of a substance to undergo a specific chemical change

Examples of Physical Properties

- Color, odor, hardness, density, melting point, boiling point, state, solubility.

Example: Physical Properties

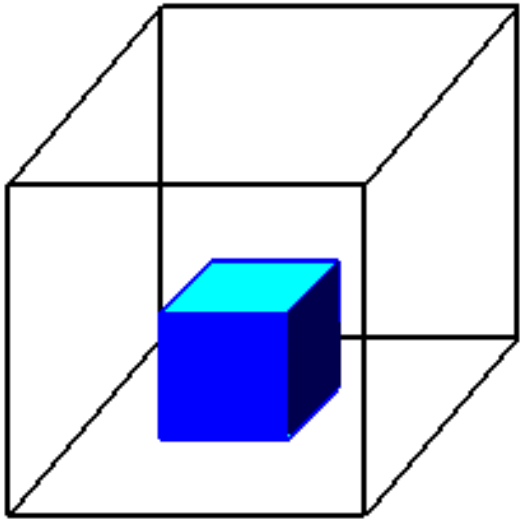
Substance		State	Color	Melting Point (C°)	Boiling Point (C°)	Density (g/cm^3)
Oxygen	O_2	Gas	Colorless	-218	-183	0.0014
Mercury	Hg	Liquid	Silvery-white	-39	357	13.5
Bromine	Br_2	Liquid	Red-brown	-7	59	3.12
Water	H_2O	Liquid	Colorless	0	100	1.00
Sodium Chloride	NaCl	Solid	White	801	1413	2.17

States of Matter

- Solid
  - fixed shape and volume, incompressible
- Liquid
  - fixed volume, takes the shape of its container
- Gas
  - takes the volume and shape of its container

States of Matter

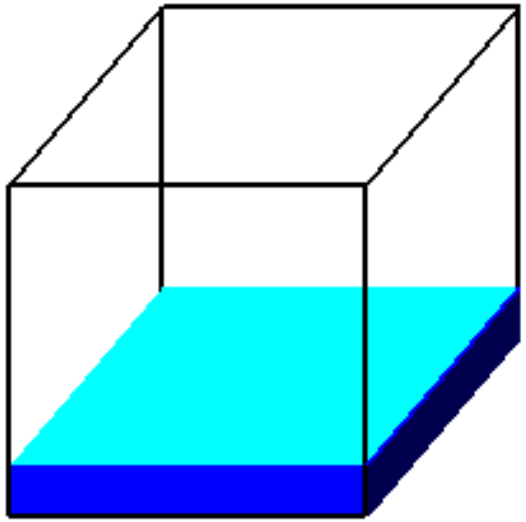
Glenn Research Center



Solid

Holds Shape

Fixed Volume

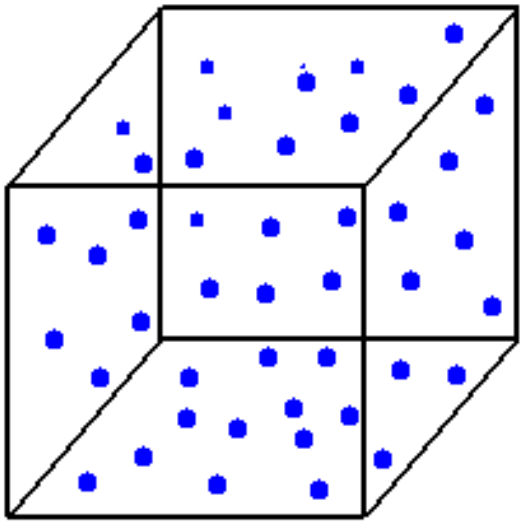


Liquid

Shape of Container

Free Surface

Fixed Volume

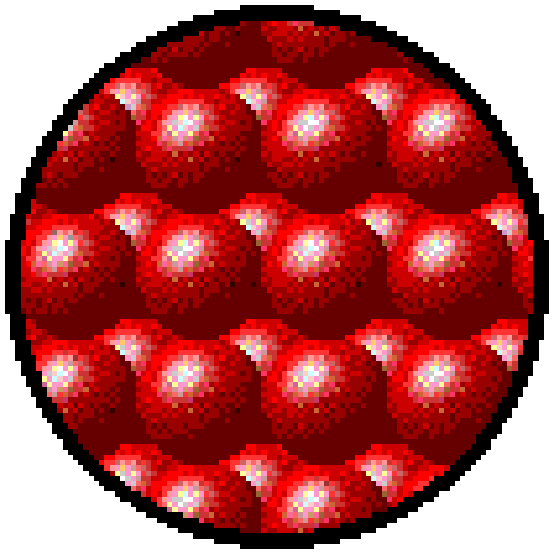


Gas

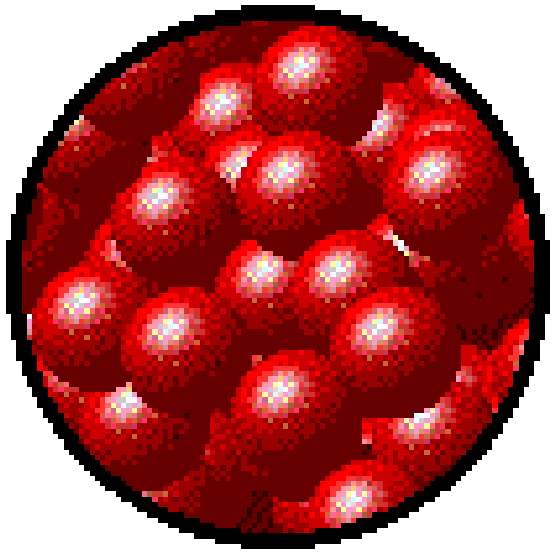
Shape of Container

Volume of Container

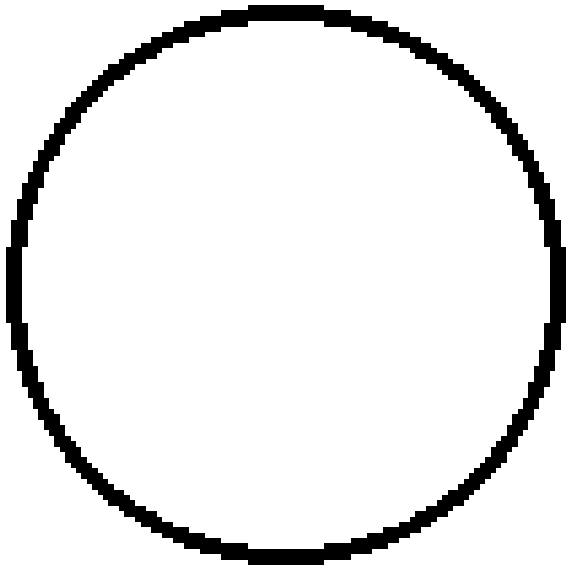
Solid



Liquid

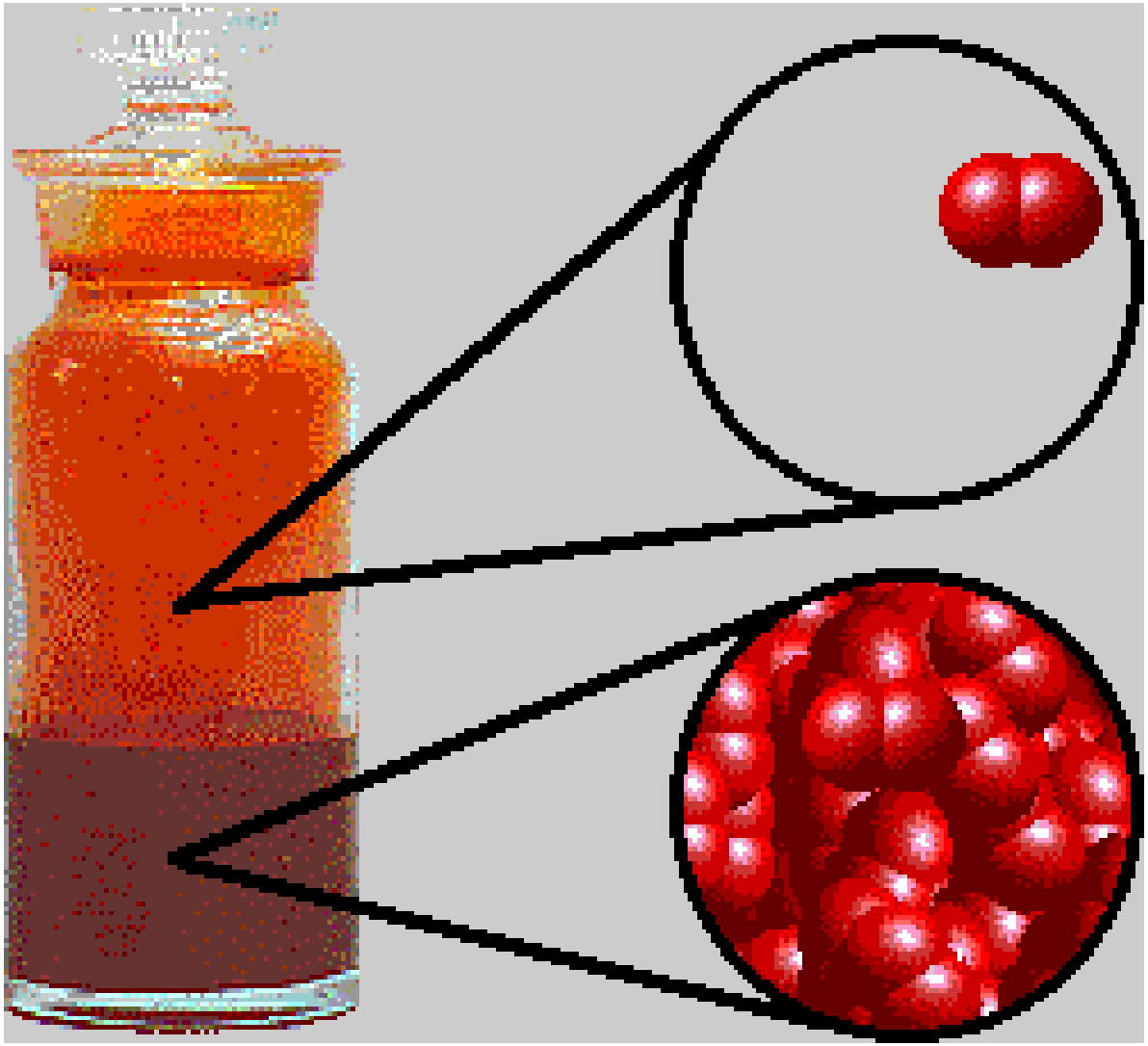


Gas



http://www.chem.purdue.edu/gchelp/atoms/states.html

Bromine



Gas
(Vapor)

Liquid

2. CHANGE OF MATTER

PERUBAHAN FISIKA

PERUBAHAN KIMIA

PERUBAHAN FISIKA

Physical Changes

- **Physical change**: a change in the physical properties of a substance.

- Composition does not change.

- May be reversible or irreversible.
  - Examples:

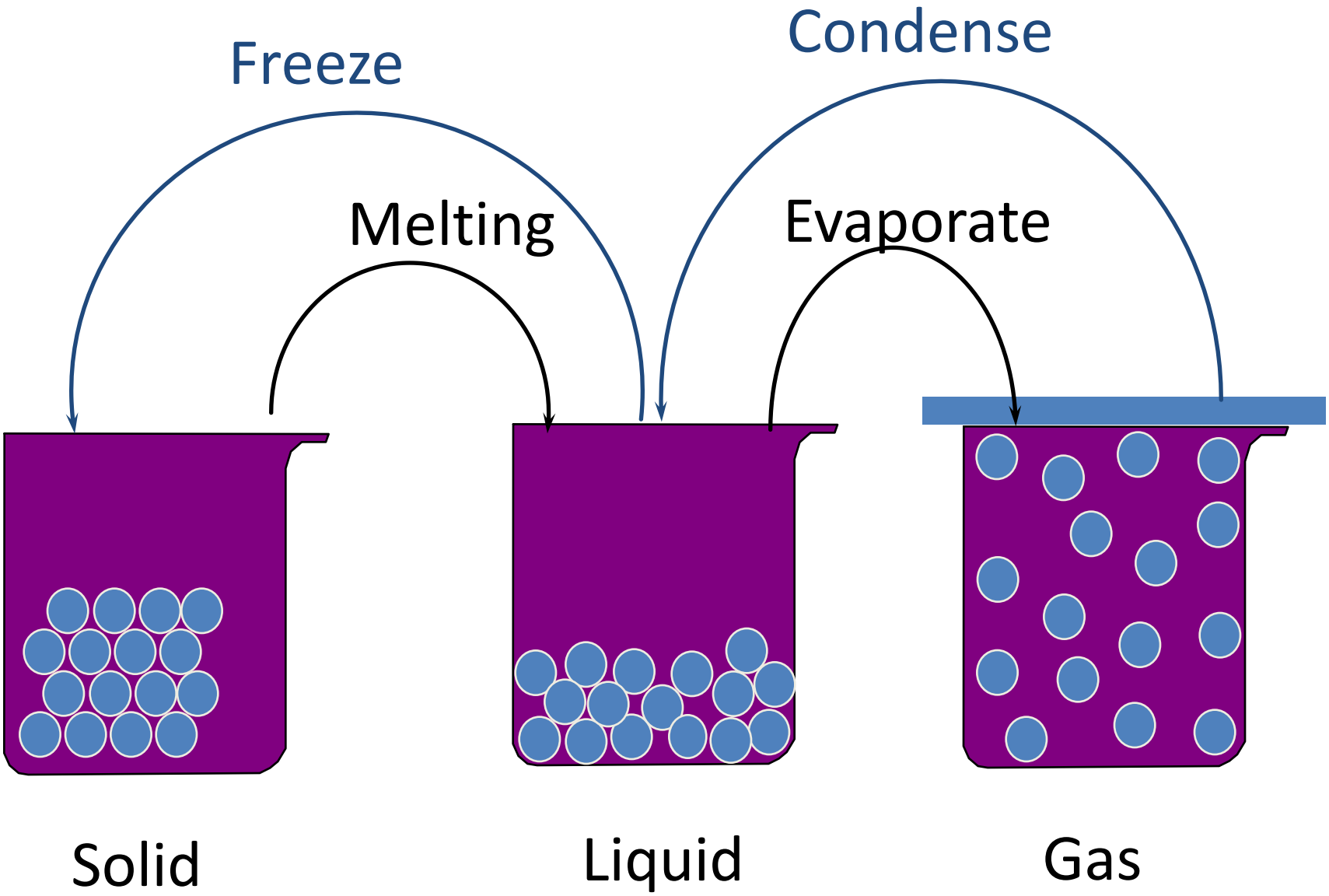
Reversible:

Irreversible:

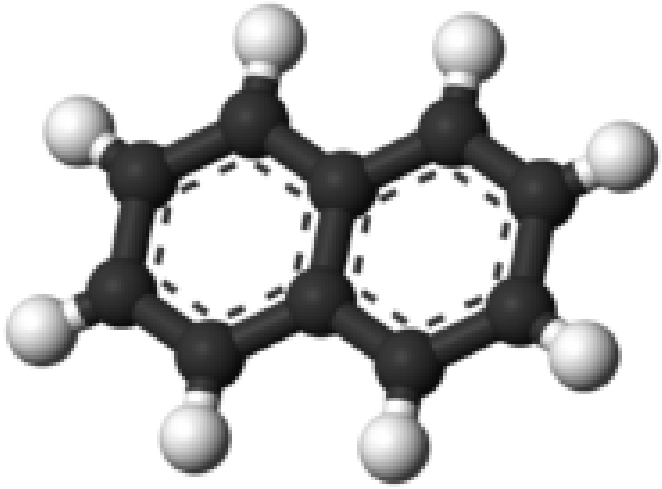
Perubahan Fisika

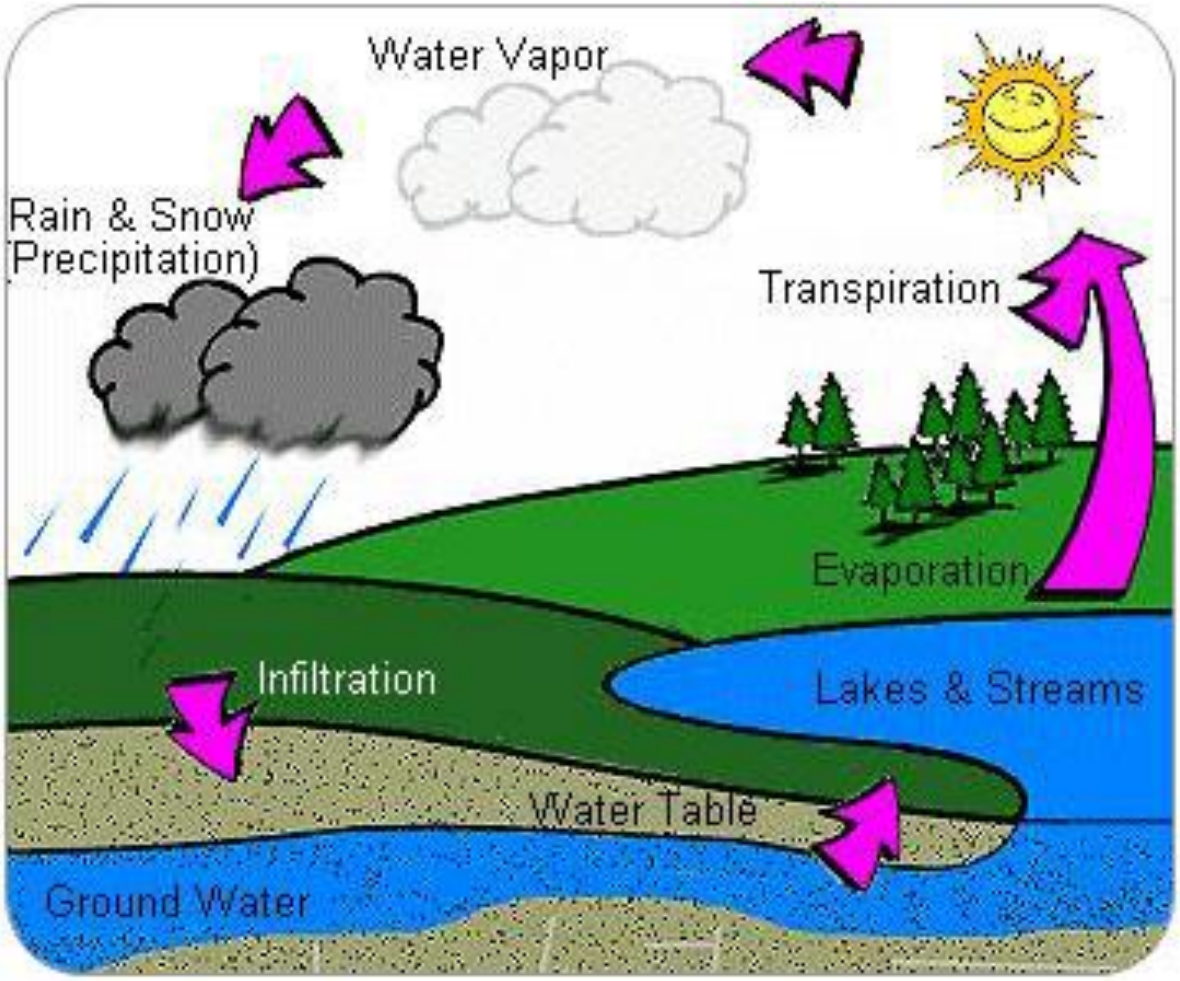
Melting	solid	→	liquid
Condensation	gas	→	liquid
Freezing	liquid	→	solid
Evaporation	liquid	→	gas
Sublimation	solid	→	gas

Boiling: Evaporation occurring beneath the liquid's surface.


Freeze
Condense
Melting
Evaporate
Solid
Liquid
Gas


happy choice
나프탈렌
Moth Repellent




Water Vapor
Rain & Snow
(Precipitation)
Transpiration
Evaporation
Infiltration
Lakes & Streams
Water Table
Ground Water

PERUBAHAN KIMIA

Chemical Change

- A change that produces matter with a different composition than the original matter.
- Atoms rearrange themselves into new combinations.

Chemical Properties

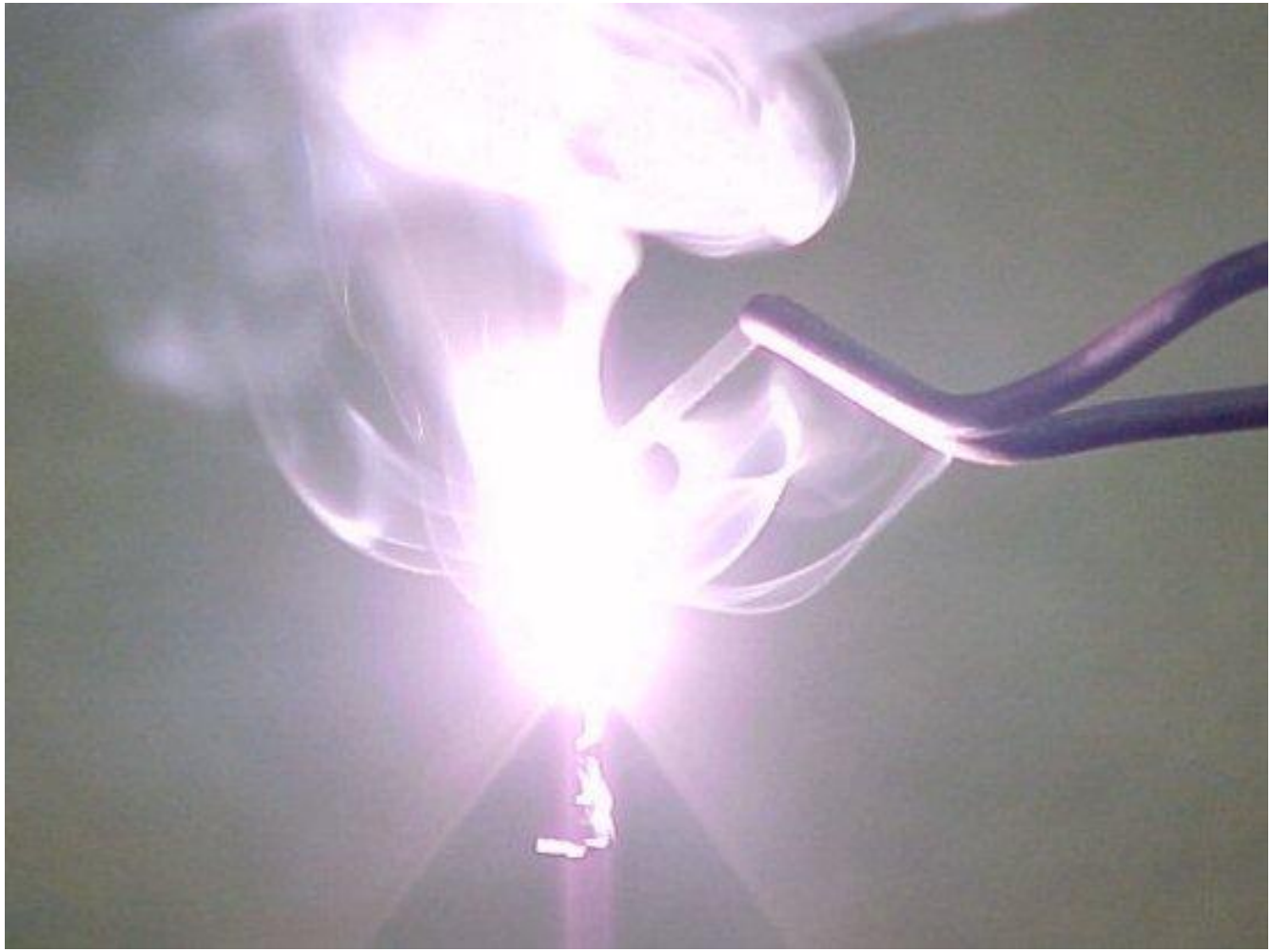
- The ability of a substance to transform into a new substance (to undergo a chemical change).

- Example: Magnesium reacts with oxygen to form magnesium oxide.

Magnesium Mg

Burning of Magnesium

$2Mg + O_2 \rightarrow 2MgO$

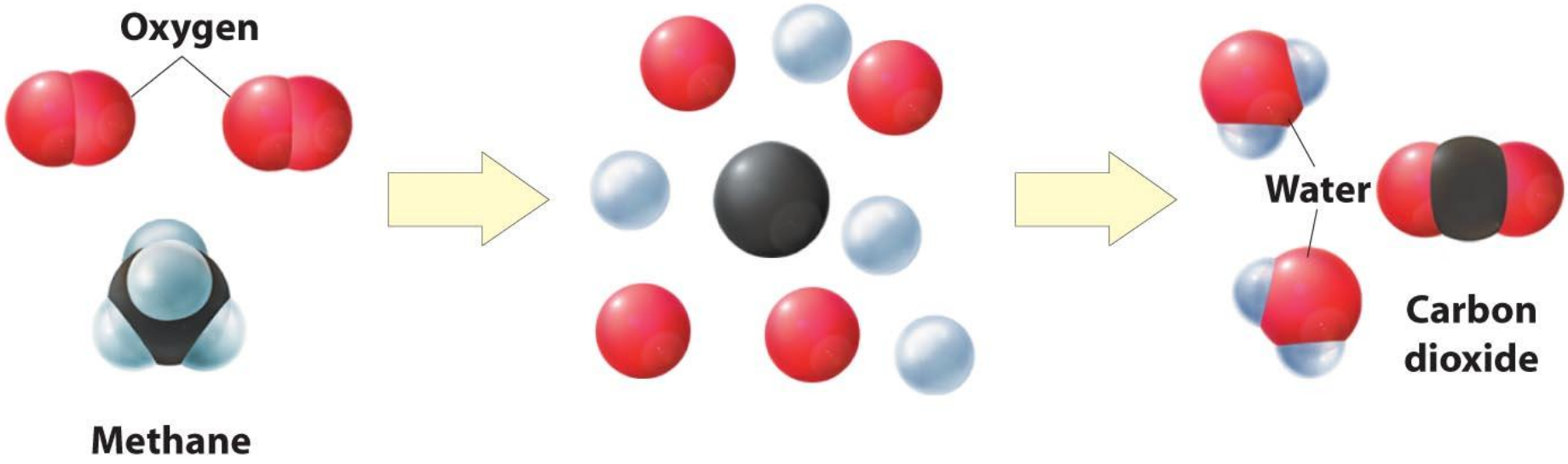


Burning of Methane

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Burning of Methane

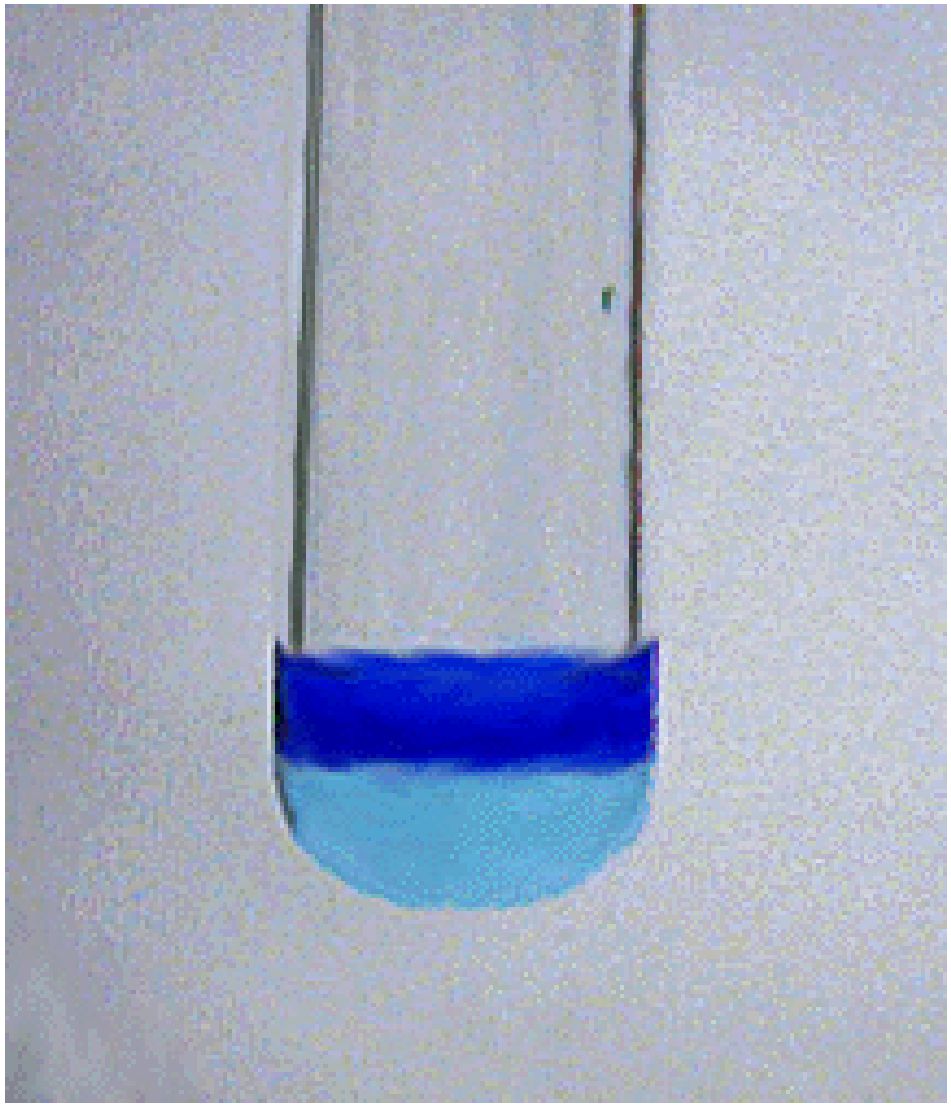
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$



Recognizing a Chemical Change

- energy exchange
- production of a gas
- color change
- formation of a precipitate
- Odor/smell

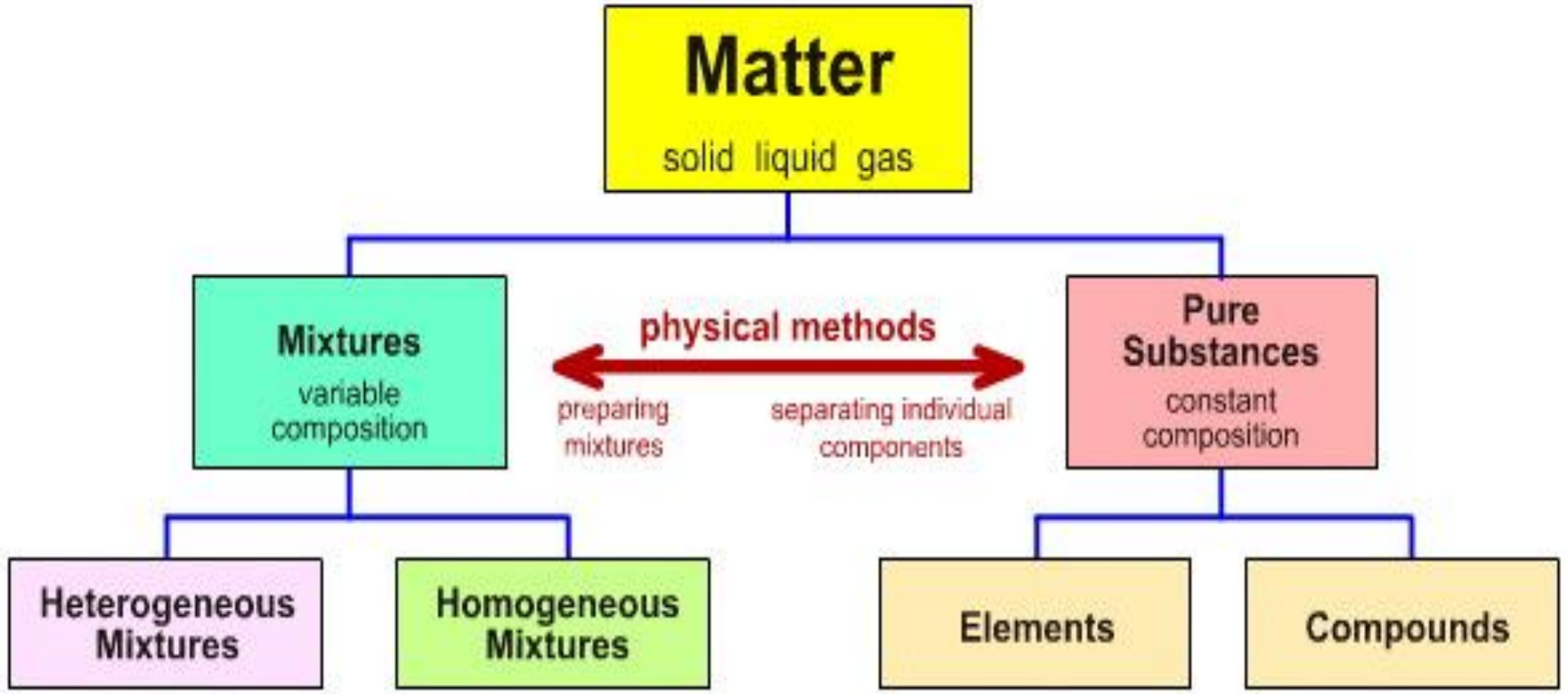
Formation of a Precipitate



$Cu(OH)_2$

Precipitate

3. Classification of Matter (by composition)



A. MIXTURE

A. Mixture

Mixture: a physical blend of two or more substances that are not chemically combined.

- Homogeneous

- Heterogeneous

Mixture

- A physical blend of two or more substances.

Mixtures

- Homogeneous

- Heterogeneous

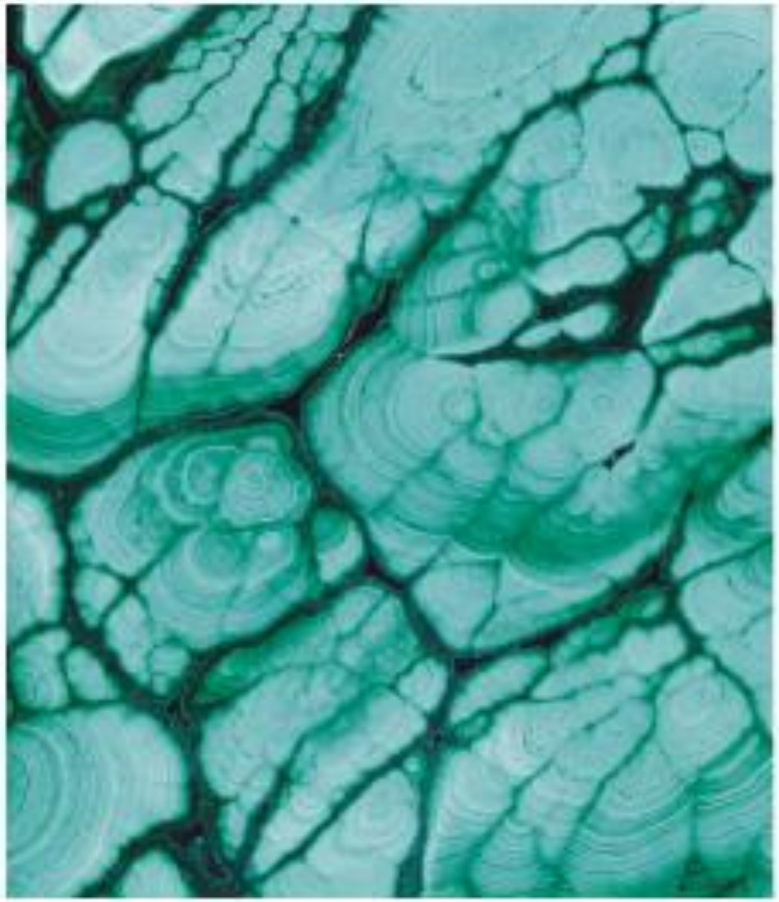
Homogeneous mixture (solution)

- Uniform composition throughout.
- One phase.

Phase of a Mixture

- A part of a mixture with uniform properties and composition.

Copper II Sulfate and its solution in water.



(a)

(b)

Example: Stainless Steel

A homogeneous mixture of:

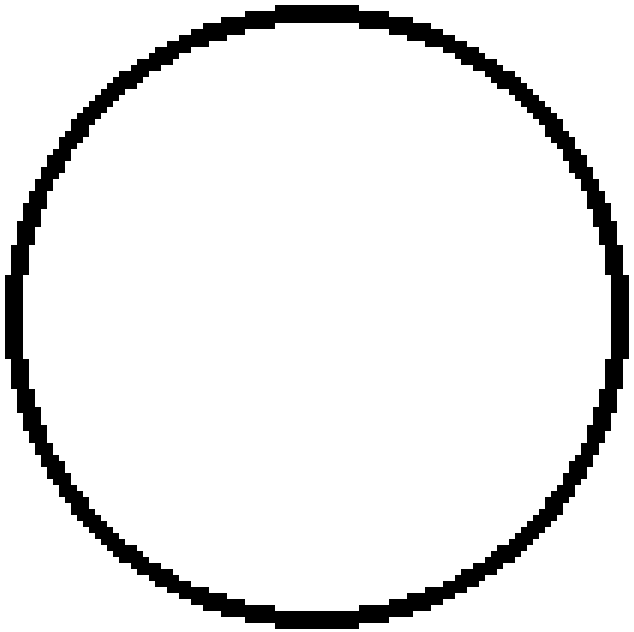
-Iron (Fe)

-Chromium (Cr)

-Nickel (Ni)

Example: Gaseous Mixture

- Elements argon and nitrogen and a compound (water vapor).



Heterogeneous Mixtures

Example:

Oil and vinegar

- Non-uniform composition throughout the mixture
- Two or more phases.

Note:

- Mixtures can be physically separated.

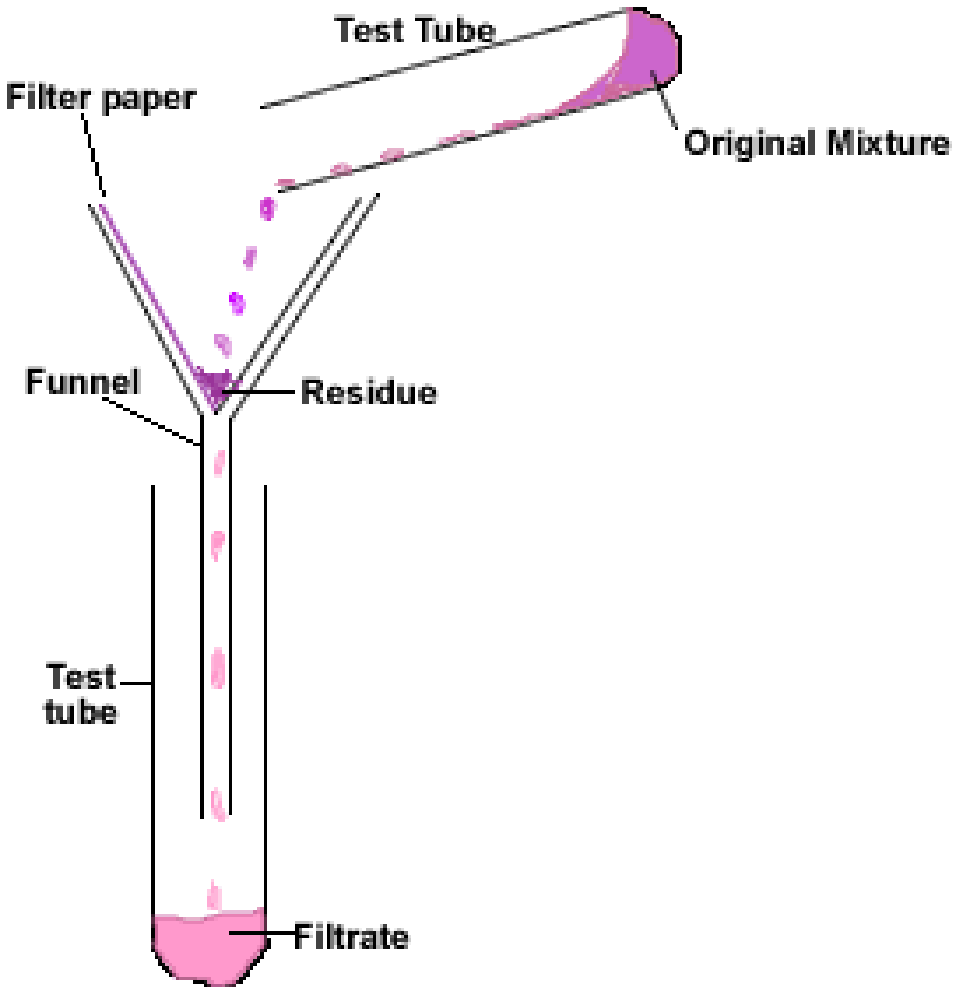
- Mixtures exhibit physical properties similar to the components of the mixture.

Separation Methods

- Use differences in the physical properties of the components of the mixture.

Example: Separate iron filings from sulfur using a magnet.

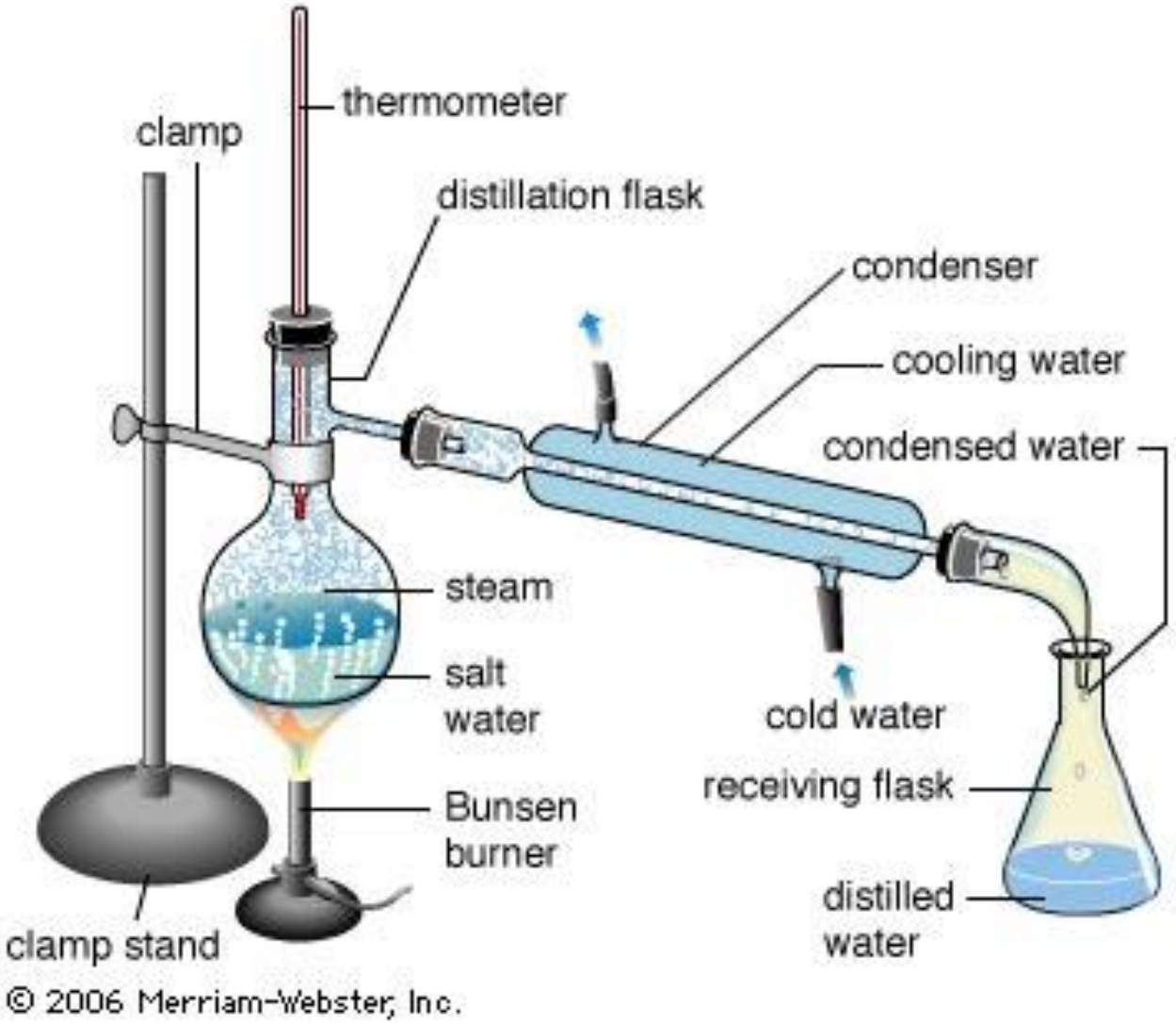
Filtration: separates a solid from a liquid in a heterogeneous mixture



Distillation:

-separate dissolved solids from a liquid

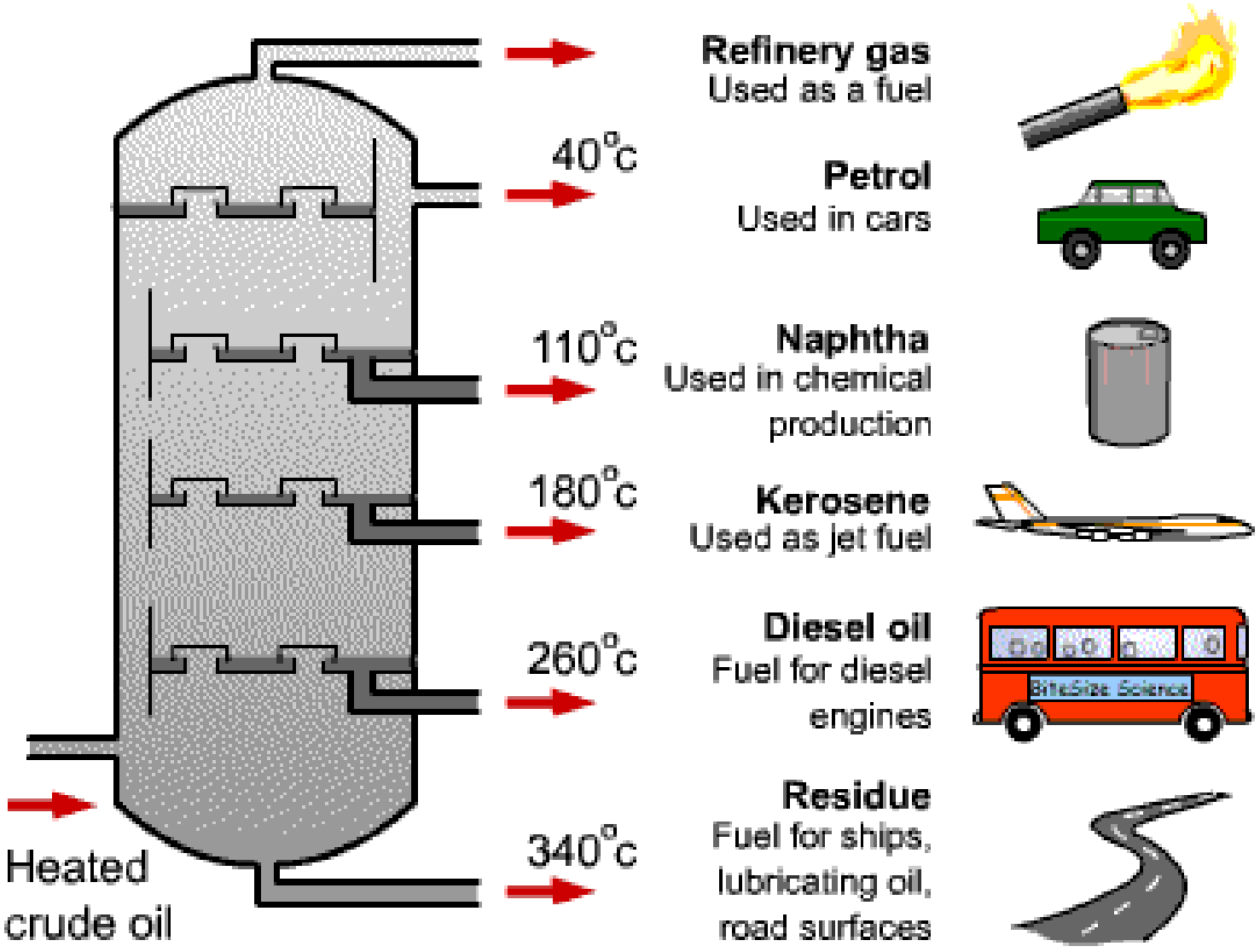
-uses boiling and condensation.

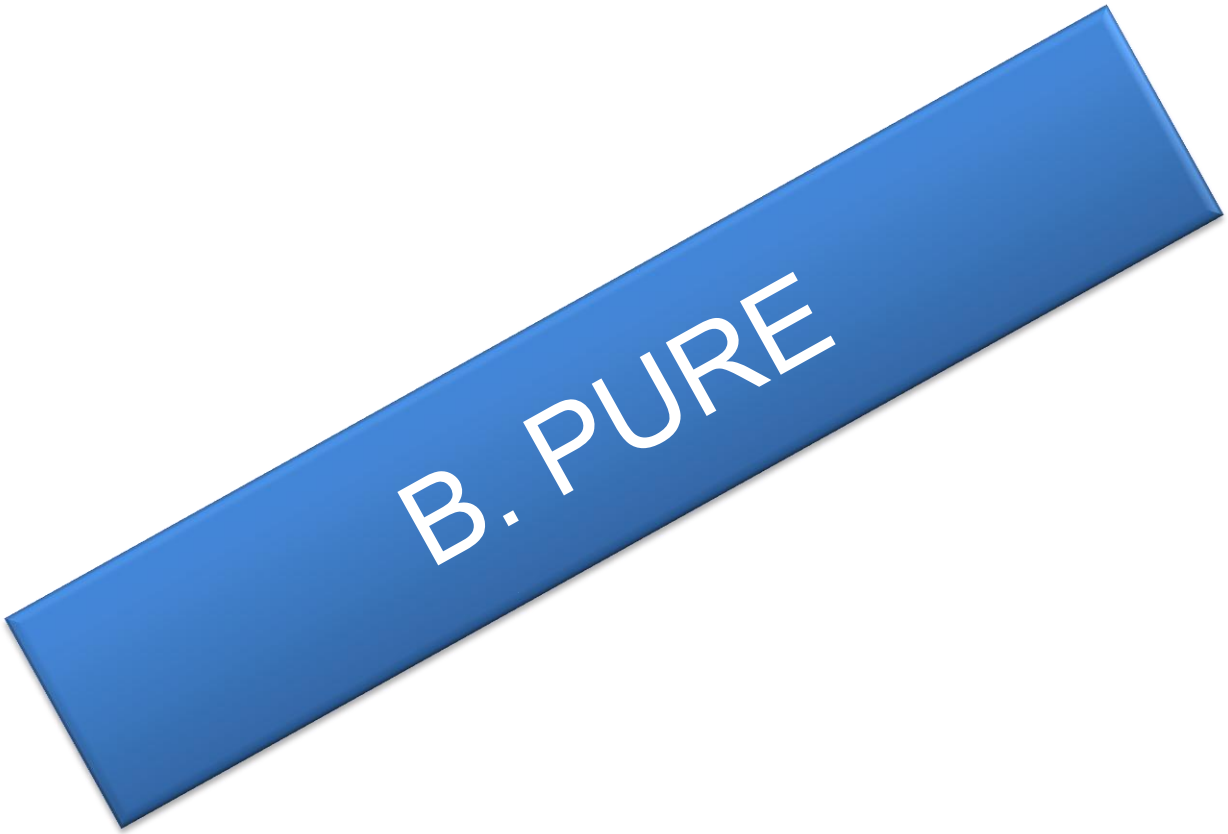


Distillation of Crude Oil (Refining)

- Crude Oil is a mixture of Hydrocarbons

Distillation of Crude Oil




B. PURE

B. (Pure) Substance

- Matter that has a uniform and definite composition.
  - –Elements : atom and structure
  - –Compounds

Elements

- The simplest substances.
- Can not be separated into simpler substances.
- Building blocks of all matter.
- More than 100 known elements.
- Represented by chemical symbols.

Chemical Symbols of Elements

- System started by Jons Berzelius (Sweden, 1779-1848)
- One or two first letters of name of the element.
- Many elements names have roots from: Latin, Greek, mythology, geography, names of scientists.

Examples:

- Americium, Am
- Einsteinium, Es
- Bromine, Br
- Helium, He

- Lead(Plumbum), Pb
- Niobium, Nb
- Iron (Ferrum), Fe
- Mendelevium, Md

Compound

- A substance that contains two or more elements chemically combined.

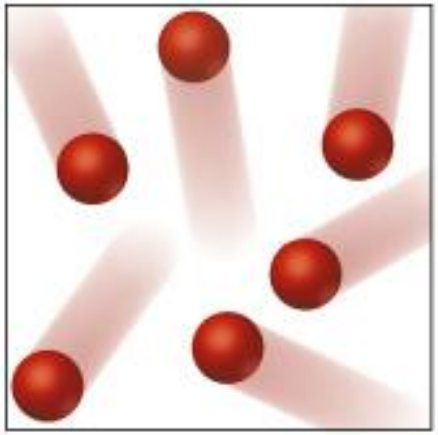
- Compounds have different properties from the individual substances.

(Ex: H_2O)

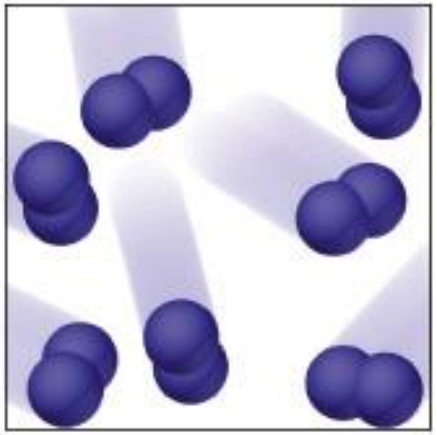
Example: H_2O

Substance or mixture?

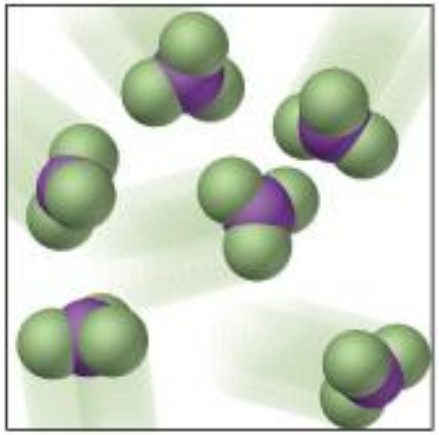
- If composition is fixed and may not change→substance



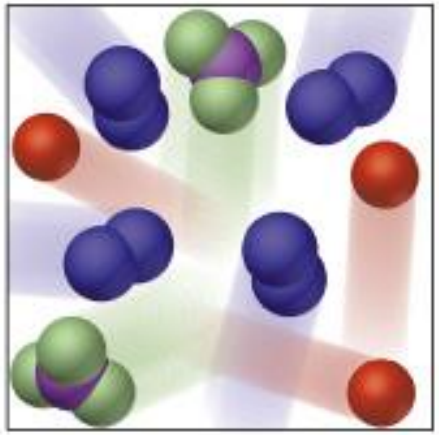
(a) Atoms of an element



(b) Molecules of an element



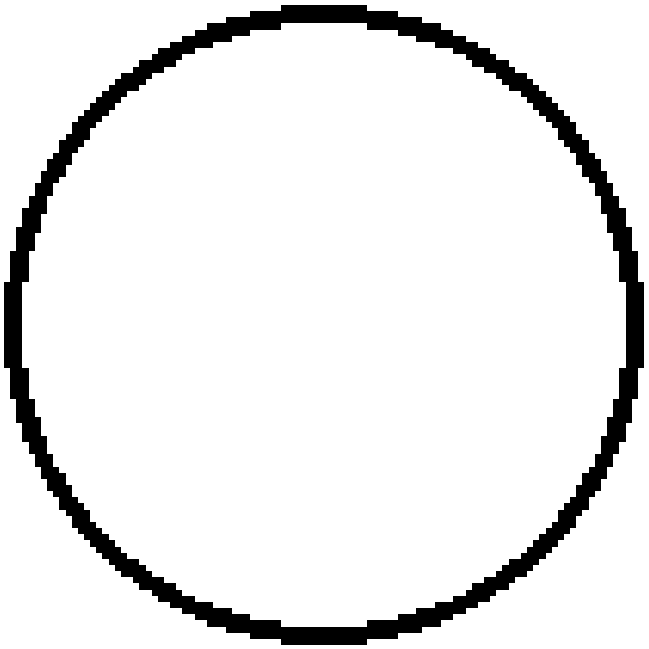
(c) Molecules of a compound



(d) Mixture of elements and a compound

H_2O composition is fixed-compound

Gaseous Phase



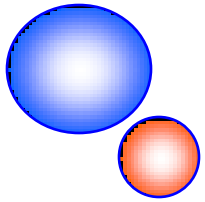
Liquid Phase

ATOM DAN STRUKTUR ATOM

ATOM DAN STRUKTUR ATOM

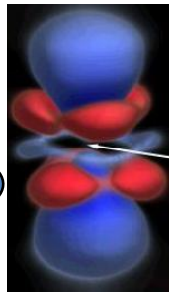
Definisi awal ttg konsep atom → Berlangsung > 2000 thn

Dulu



Atom sbg bola keras

Sekarang

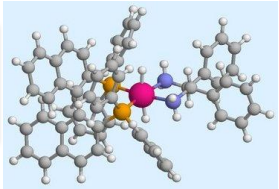


Atom sbg awan materi yg kompleks

~ 90 jenis atom

- 1 jenis → 1 unsur

- Jutaan senyawa dihslkan

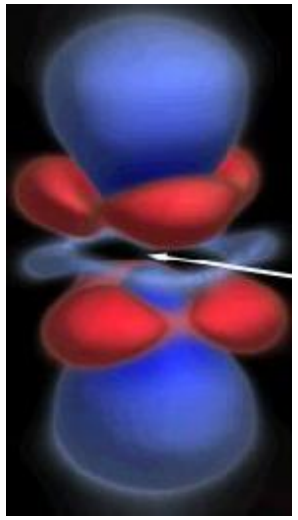


Atom sbg penyusun semua benda
Proses perubahan benda → tdk akan menghilangkan atom penyusunnya

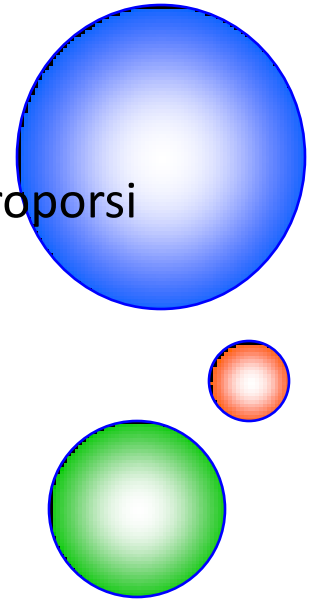
Atom Abadi

ATOM DAN STRUKTUR ATOM

KONSEP YUNANI TTG ATOM



- **Pandangan filosof Yunani**
  Konsep kemampuan utk dipecah yg tiada berakhir
- **Leucippus** (Abad ke-5 SM)
  Ada batas kemampuan utk dibagi, shg hrs ada bgn yg tdk dibagi lagi
- **Democritus** (380-470 SM)
  Atomos: partikel yg tdk dpt dibagi lg
  Atom stp unsur berbeda bentuk & ukurannya
  Bhn adl campuran atom-atom berbagai unsur dgn proporsi yg berbeda
  Bhn satu diubah mjd bhn yg lain dgn mengubah proporsinya
- **Lucretius**
  Sifat atom suatu bhn dlm "***On the Nature of Things***"



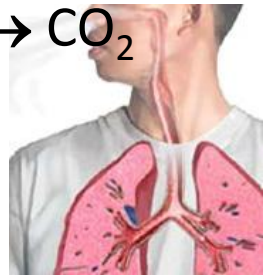
ATOM DAN STRUKTUR ATOM

2.2 HUKUM LAVOISIER

Antonie Laurent Lavoisier (1743-1794)

Jk reaksi kimia berlangsung dlm sistem tertutup, mk total bobot sistem tdk berubah

- Reaksi dekomposisi merkuri oksida: $HgO \rightarrow Hg + 1/2\ O_2$
- Reaksi pembakaran batubara: $C + O_2 \rightarrow CO_2$
- Respirasi: O_2 (konsumsi) $\rightarrow CO_2$

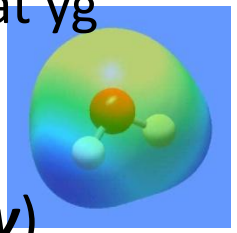


Definisi Pemikiran:

Definisi Kerja **Robert Boyle** dlm ***The Sceptical Chemist*** (1661)

Unsur : zat yg tdk dpt dipecah lbh sederhana lg

Senyawa : 2 atau lebih unsur yg bergabung membentuk zat yg kompleks



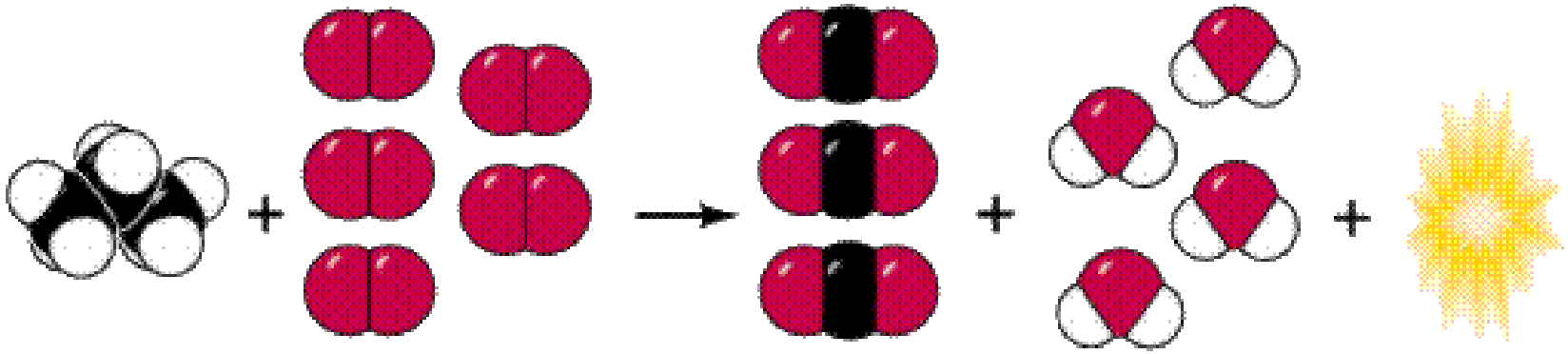
BAPAK ILMU KIMIA (***Elementary Treatise on Chemistry***)

ATOM DAN STRUKTUR ATOM

HUKUM KEKEKALAN MASSA

"Materi tdk dibentuk atau dirusak selama perubahan kimia"

Tdk dpt menciptakan dr sesuatu yg tdk ada, bhn baru dpt dibuat dgn cara penggabungan atom-atom



C_3H_8 + 5 O_2 → 3 CO_2 + 4 H_2O + Heat and light

Propane + Oxygen gas → Carbon dioxide + Water + Heat and light

ATOM DAN STRUKTUR ATOM

2.3 HUKUM PROUST

Joseph Louis Proust (1799)

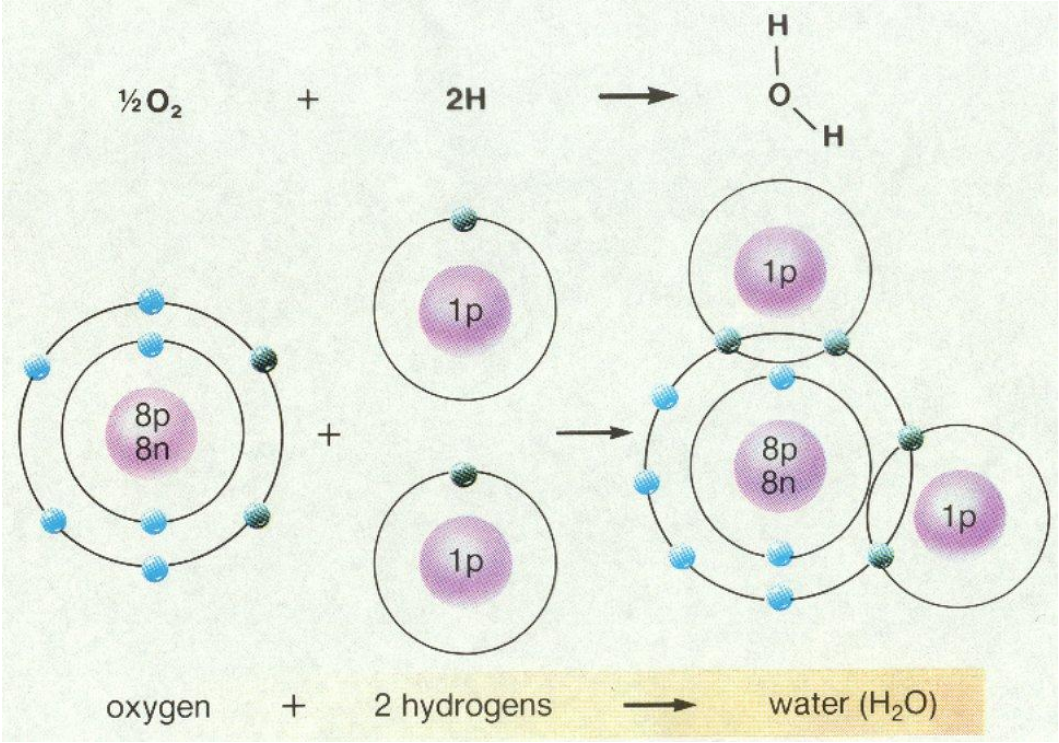
Hukum Perbandingan Tetap:

"Suatu bhn tdr dr unsur-unsur dgn perbandingan tertentu & perbandingan tsb tetap"

Percobaan Proust:

$CuCO_3 \rightarrow Cu + C + O_2$

5,3 4 1



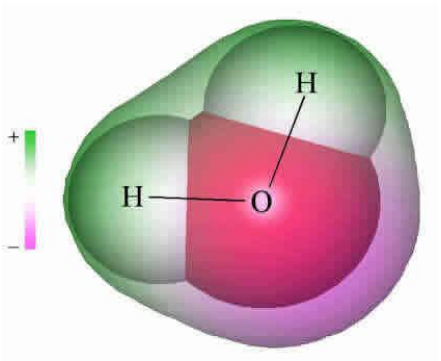
ATOM DAN STRUKTUR ATOM

J. J Berzelius (1779-1848)

Pb	+	S	→	PbS
Abu-abu		Kuning		Hitam mengkilap
10g		1,56g		11,56g
10g		3,00g		11,56g + 1,44g S
18g		1,56g		11,56g + 8g Pb

Henry Cavendish (1783)

$H_2 + 1/2\ O_2 \rightarrow H_2O$

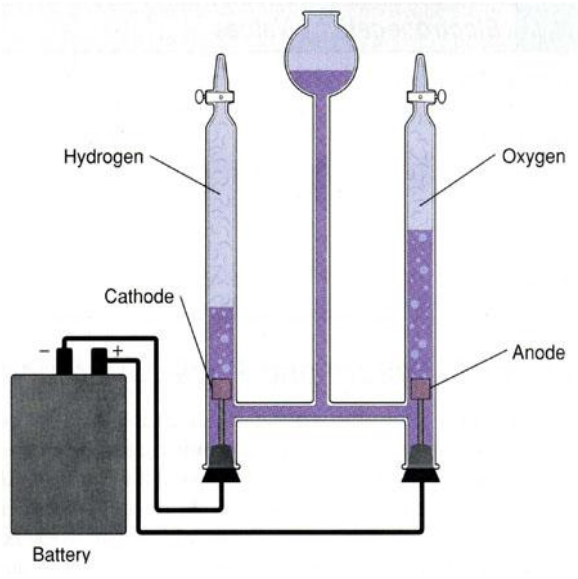


William Nicholson & Anthony Carlisle (1889)

Elektrolisis Air:

$H_2O \rightarrow H_2(g) + 1/2\ O_2(g)$

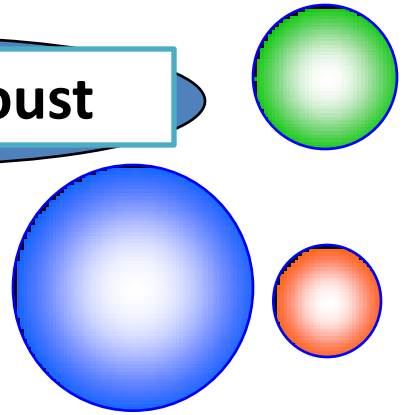
2 bag volume 1 bag volume



ATOM DAN STRUKTUR ATOM

Hukum Lavoiser

Hukum Proust



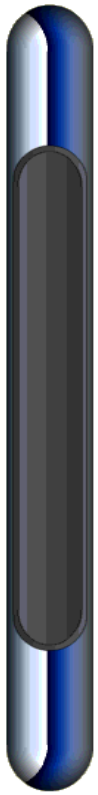
TEORI ATOM DALTON

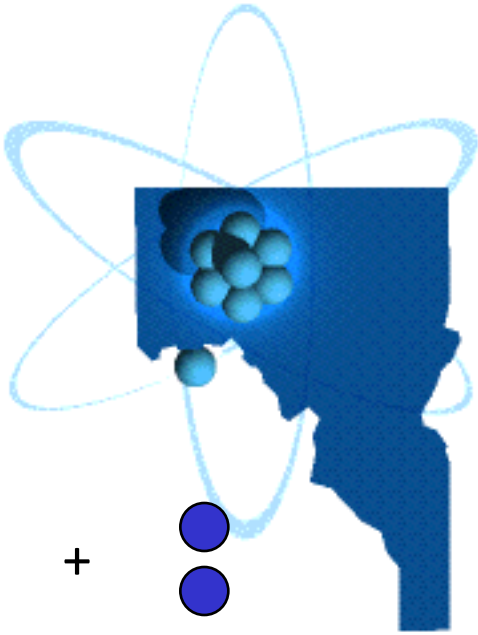
Asumsi-asumsi Dalton

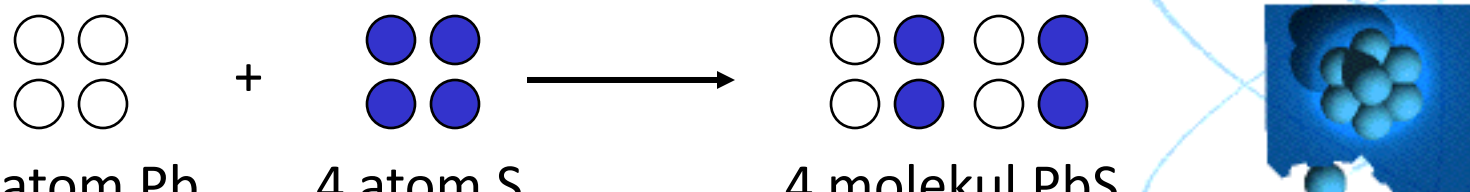
1. Semua unsur terbebtuk dr partikel kecil yg tdk dpt dirusak & tdk dpt dibagi, yg disebut atom
2. Semua atom suatu unsur tertentu, sama, tetapi atom dr unsur-unsur yg berbeda tdk sama
3. Atom-atom dr unsur yg berbeda bergabung membentuk suatu senyawa
4. Reaksi kimia mengubah cara atom-atom bergabung membentuk seny ttp tidak mengubah atom-atomnya

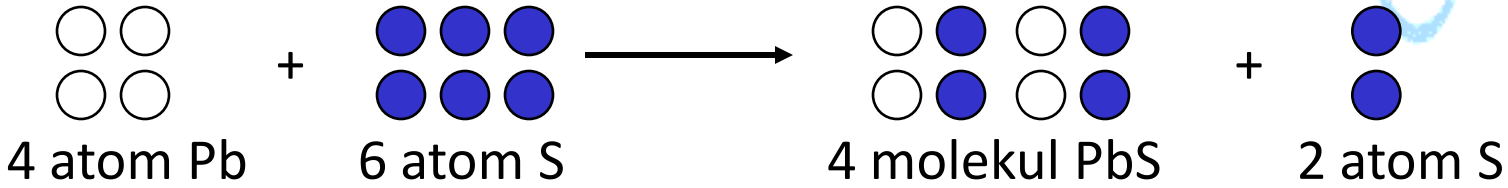
ATOM DAN STRUKTUR ATOM

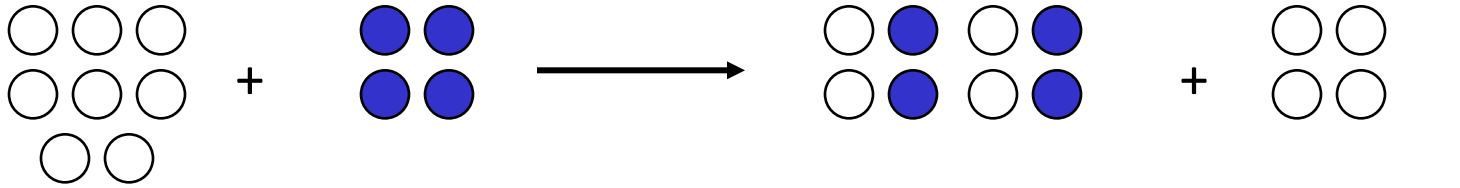
Hukum Perbandingan Tetap





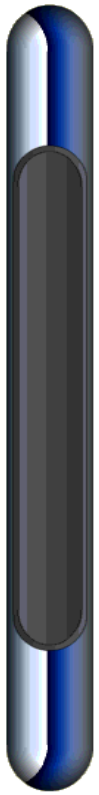


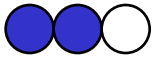




ATOM DAN STRUKTUR ATOM

Hukum Perbandingan Berganda

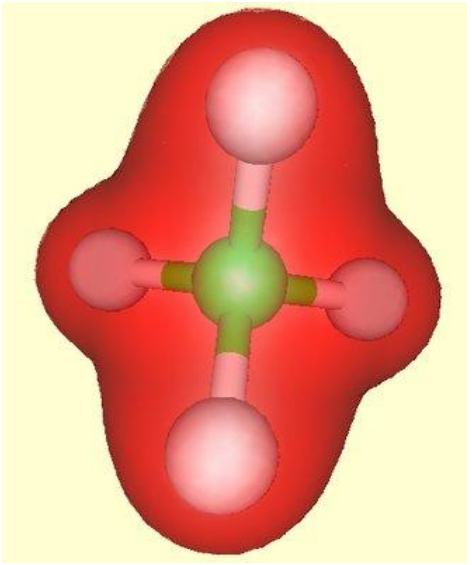


		Rasio atom O & 2 atom N
	Nitrit oksida	1
	Nitrat oksida	2
	Nitrogen dioksida	4

● Atom Nitrogen ○ Atom Oksigen

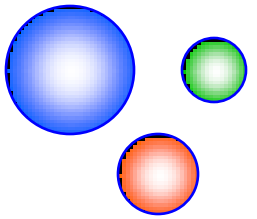
Hukum Kekekalan Massa

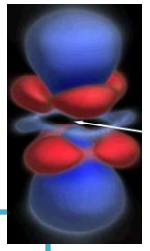
1 atom C + 2 atom O → 1 molekul CO_2



ATOM DAN STRUKTUR ATOM

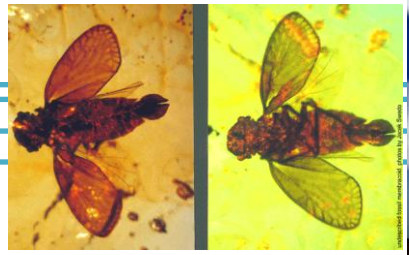
2.5 ATOM, NYATA dan RELEVAN





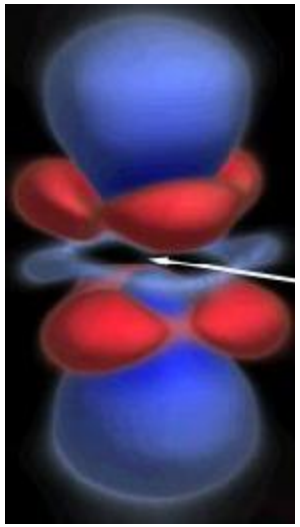
Apakah atom nyata ?
Atom tdk dpt terlihat tp nyata sbg konsep & merupakan konsep yg tinggi manfaatnya

Apakah atom relevan ?
Ilmu & teknologi modern berdasarkan pd konsep atom



ATOM DAN STRUKTUR ATOM

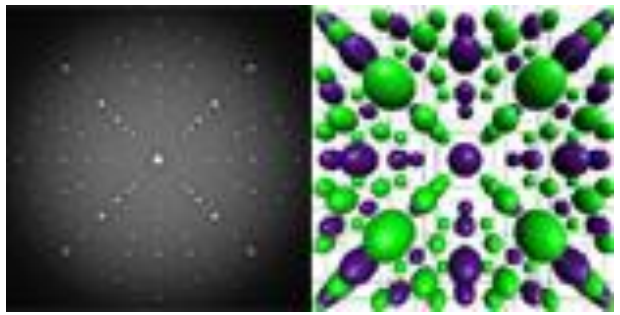
2.6 STRUKTUR ATOM



Atom sgt kecil & tdk dpt dilihat

Rekaman bayangan atom:

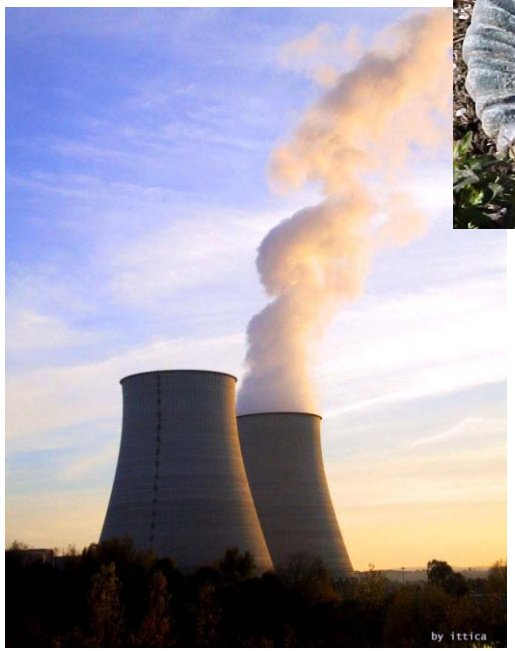
1. Prof. Albert Crewe (Univ. Chicago, 1970)
   Bayangan atom U & Th
2. Gert Erlich & W.R.Graham (Univ. Illinois, 1974)
   Bayangan atom pd permukaan kristal
3. G.W. Stroke (Univ. New York, 1976)
   Lokasi & ukuran relatif atom C, Mg, & O dlm satu bagian kristal

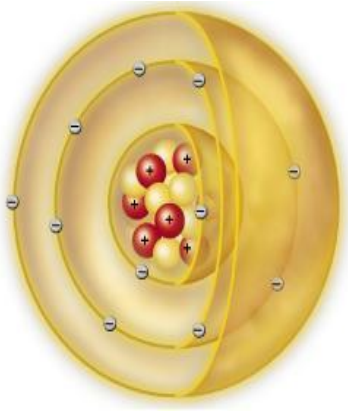


ATOM DAN STRUKTUR ATOM

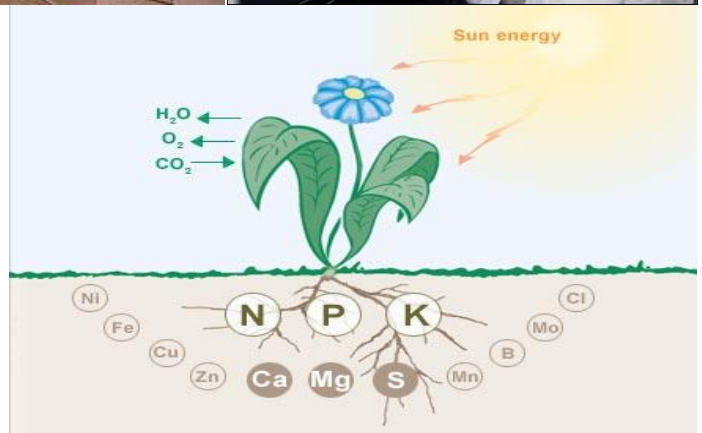
Mengapa struktur atom dipelajari?

1. Penyusunan bagian-bagian atom akan menentukan sifat materi
2. Mengetahui bgm atom bergabung,
   & bgm mengubah bhn sesuai dgn yg dibthkan
3. Berguna utk kesehatan
4. dll



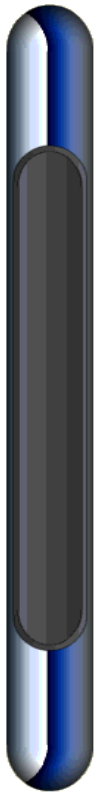


(c) Sodium
11 protons
11 neutrons
11 electrons
in 3 shells

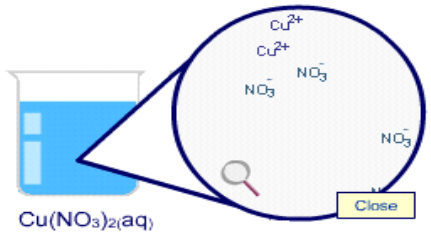


ATOM DAN STRUKTUR ATOM

2.9 ATOM DALAM ABAD 19

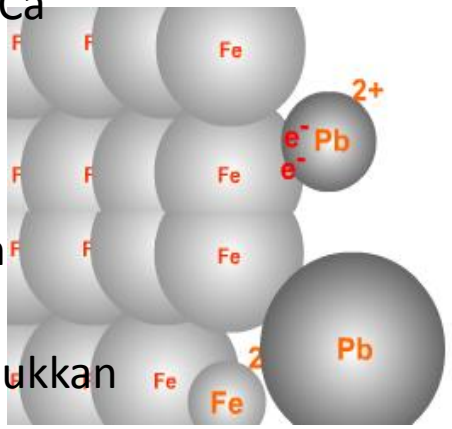


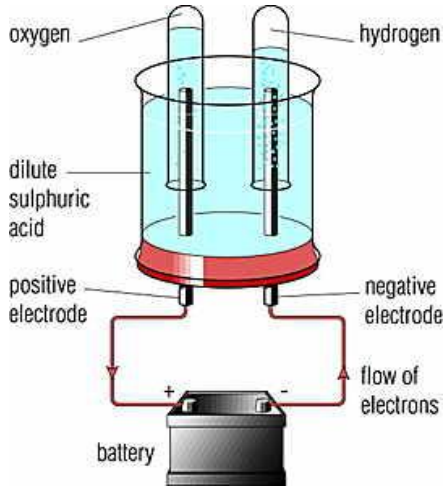
Dalton (1803): Atom tdk dpt dibagi & keras
Nicholson & carlisle (1889): Materi bersifat listrik
Sir humpry Davy (1807): Membuat batere→K,Na,Mg,Sr,Ba,&Ca



Michael Faraday (1791-1867): Elektrokimia

- Elektrolisis : Pemecahan senyawa oleh arus listrik
- Elektrolit : Suatu senyawa yg ketika cair atau dijadikan larutan,dpt melewatkan arus listrik
- Elektroda : Batang karbon/lempengan logam yg dimasukkan ke dlm cairan/larutan
- Katoda : Elektroda yg bermuatan negatif
- Anoda : Elektroda yg bermuatan positif
- Ion : Atom-atom yg bermuatan
- Anion : Ion yg bermuatan negatif
- Kation : Ion yg bermuatan positif

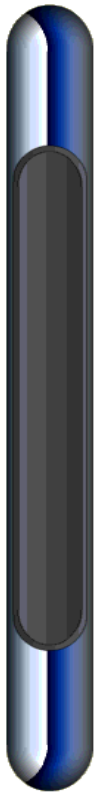




ATOM DAN STRUKTUR ATOM

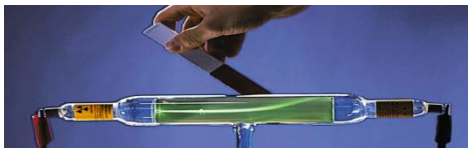
Percobaan Faraday: Atom bersifat listrik

→ gagal krn tabung tdk cukup hampa



William Crookes (1875)

Tabung gas hampa



Sinar katoda: Berkas sinar yg dihslkan dari katoda ke anoda

Joseph John Thomson (1897)

- Sinar katoda adl sinar yg bermuatan negatif (elektron) yg dibelokkan oleh medan listrik magnet
- Sinar katoda tdk bergantung pd bhn katoda & gas dlm tabung
- Mengukur perbandingan m/e

Eugen Goldstein (1886)

- Sinar kanal bermuatan positif (proton), & dibelokkan oleh medan listrik & magnet
- Sinar katoda mempunyai massa yg beragam, tergantung pd jenis gas
- Massa yg plg ringan (terbentuk jk ada sedikit H_2) = 1837 massa e
- Massa elektron = 9,1 x 10^{-28} g

ATOM DAN STRUKTUR ATOM

2.10 SINAR X dan RADIOAKTIFITAS

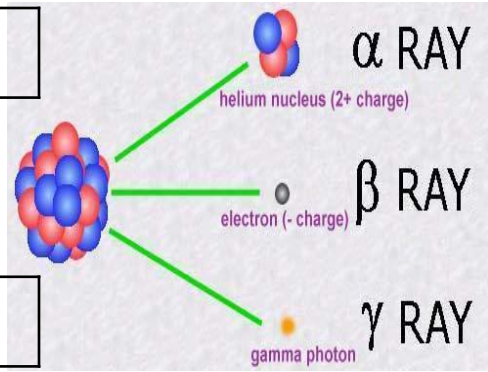
Wilhelm konrad Roentgen (1895)
Sinar X : sinar yg keluar dari anoda ketika sinar katoda sdg bekerja, tdk dibelokkan oleh medan listrik & magnet

Antoine Henri Becquerel
Marie Sklodowska Curie
Pierre Curie

→ **Unsur Radioaktifitas**

Rutherford:Jenis radiasi radioaktifitas

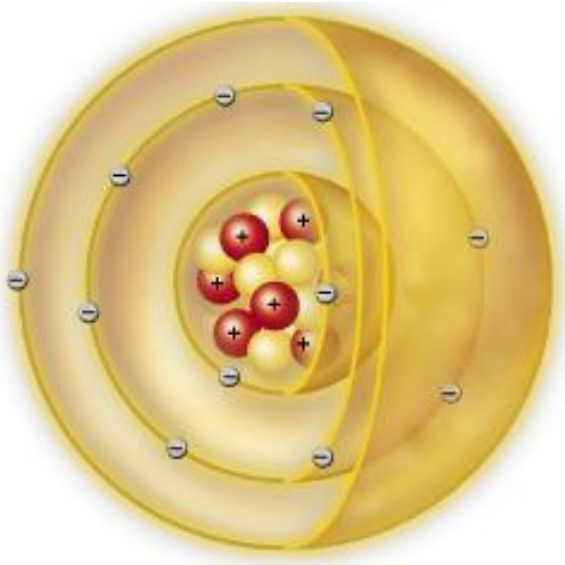
Nama	Simbol	Massa (sma)	Muatan
Alfa	α	4	2^+
Beta	β	1/1837	1^-
Gamma	γ	0	0



ATOM DAN STRUKTUR ATOM

MODEL ATOM RUTHERFORD

- ✓ Atom tdr inti yg bermuatan positif
- ✓ Massa atom terpusat pd inti yg bermuatan kecil
- ✓ Sebagian atom merupakan ruangan kosong, pd jrk tertentu tdp elektron

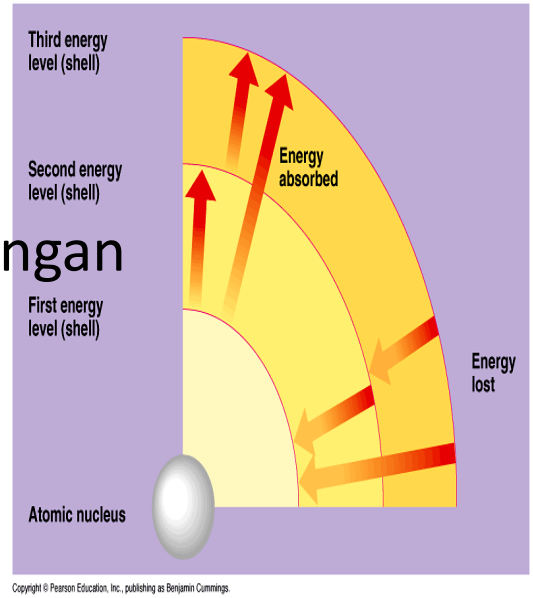


(c) Sodium
11 protons
11 neutrons
11 electrons
in 3 shells

Partikel	Simbol	Massa (sma)	Muatan
Proton	p	1	1^+
neutron	n	1	0
Elektron	e	1/1837	1^-

ATOM DAN STRUKTUR ATOM

2.13 SUSUNAN ELEKTRON : MODEL ATOM BOHR



<u>Spekrum Cahaya</u> : Kontinu/berkesinambungan
Sinar dgn berbagai λ

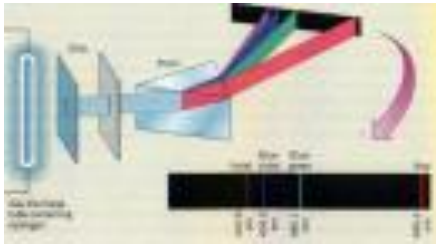
<u>Spektrum Atom</u> : Diskontinu/diskrit
Spektrum garis/pita

⇨ e^- mengorbit sekeliling inti pd lintasan yg berbeda, dgn Ek tertentu & Ep tertentu

⇨ Gerakan e^- mencegah jatuhnya e^- ke dlm inti atom

⇨ e^- dpt berpindah dr lintasan dgn tkt E dasar → E yg lebih tinggi jk menyerap E & sebaliknya

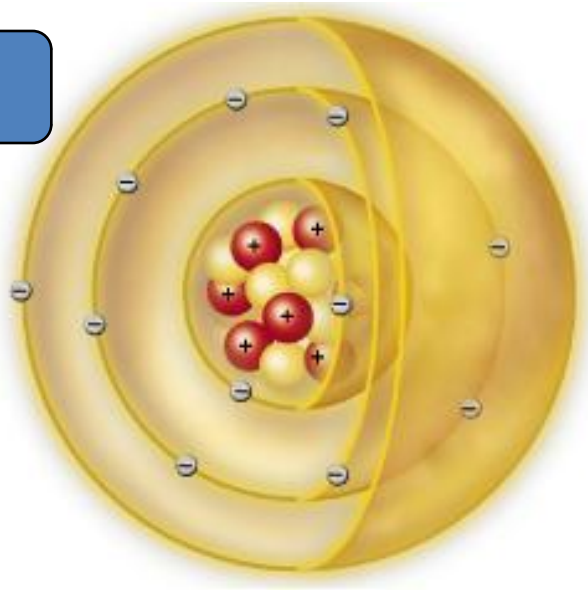
⇨ Stp level lintasan tkt E diisi oleh sjml e^- ttt



ATOM DAN STRUKTUR ATOM

jml e^- max pd lintasan = $2n^2$

Lintasan dgn
- $n=1 \rightarrow \Sigma e^- = 2$
- $n=2 \rightarrow \Sigma e^- = 8$
- $n=3 \rightarrow \Sigma e^- = 18$
- $n=4 \rightarrow \Sigma e^- = 32$

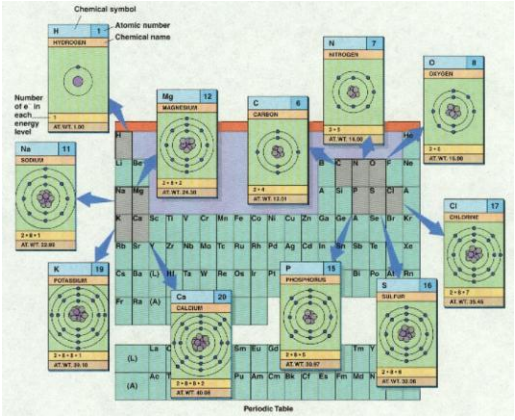


(c) Sodium
11 protons
11 neutrons
11 electrons
in 3 shells

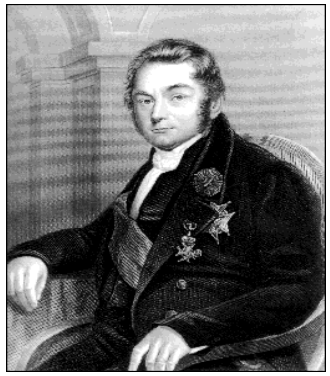
2.14 TINGKAT ENERGI & DAFTAR PERIODIK

John Dalton: - Tabel bobot atom relatif

"**Sistem Baru Falsafah Kimia**"
- Byk yg tdk benar



ATOM DAN STRUKTUR ATOM



Berzelius (1828): - Tabel bobot atom 54 unsur
- Sesuai dgn sistem modern

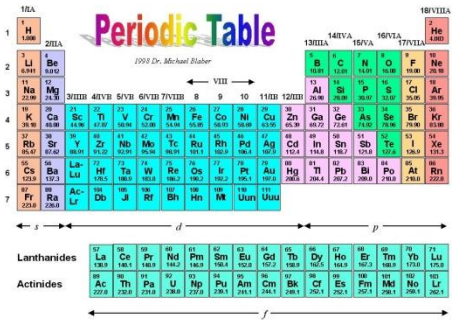
D.I. Mendeleev (1889):

- Daftar periodik bdsrkan peningkatan bobot atom
- Menyediakan ruang kosong utk unsur-unsur yg blm ditemukan
- Unsur yg mempunyai sifat yg sama

TABELLE II

REIHEN	GRUPPE I. — R^2O	GRUPPE II. — RO	GRUPPE III. — R^2O^3	GRUPPE IV. RH^4 RO^2	GRUPPE V. RH^3 R^2O^5	GRUPPE VI. RH^2 RO^3	GRUPPE VII. RH R^2O^7	GRUPPE VIII. — RO^4
1	H=1							
2	Li = 7	Be = 9,4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27,3	Si = 28	P = 31	S = 32	Cl = 35,5	
4	K = 39	Ca = 40	— = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56, Co = 59, Ni = 59, Cu = 63.
5	(Cu = 63)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Yt = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 108.
7	(Ag = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	J = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er = 178	?La = 180	Ta = 182	W = 184	—	Os = 195, Ir = 197, Pt = 198, Au = 199.
11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208	—	—	
12	—	—	—	Th = 231	—	U = 240	—	— — — —

ATOM DAN STRUKTUR ATOM



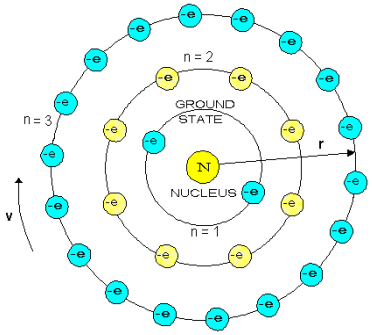
DAFTAR PERIODIK MODERN :

- Disusun berdasarkan nomor atom

  No atom = $\sum$ proton dlm inti

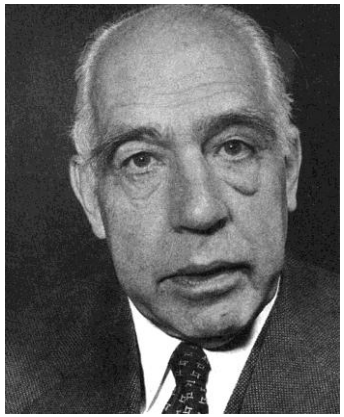
  $\sum$ elektron di luar inti (utk atom netral)

- ***Golongan***: sifat kimia mirip & e^- valensi sama
- ***Perioda***: e^- terluar pd perioda ttt py tkt E yg sama



THE BOHR MODEL OF THE ATOM

THE ANGULAR MOMENTUM OF EACH ELECTRON = $MVr = nh / (2\pi)$



<u>Kelemahan model atom Bohr</u>:

Model Bohr didsrkan **Pergerakan Planet Kepler** (Radiasi Kontinu),

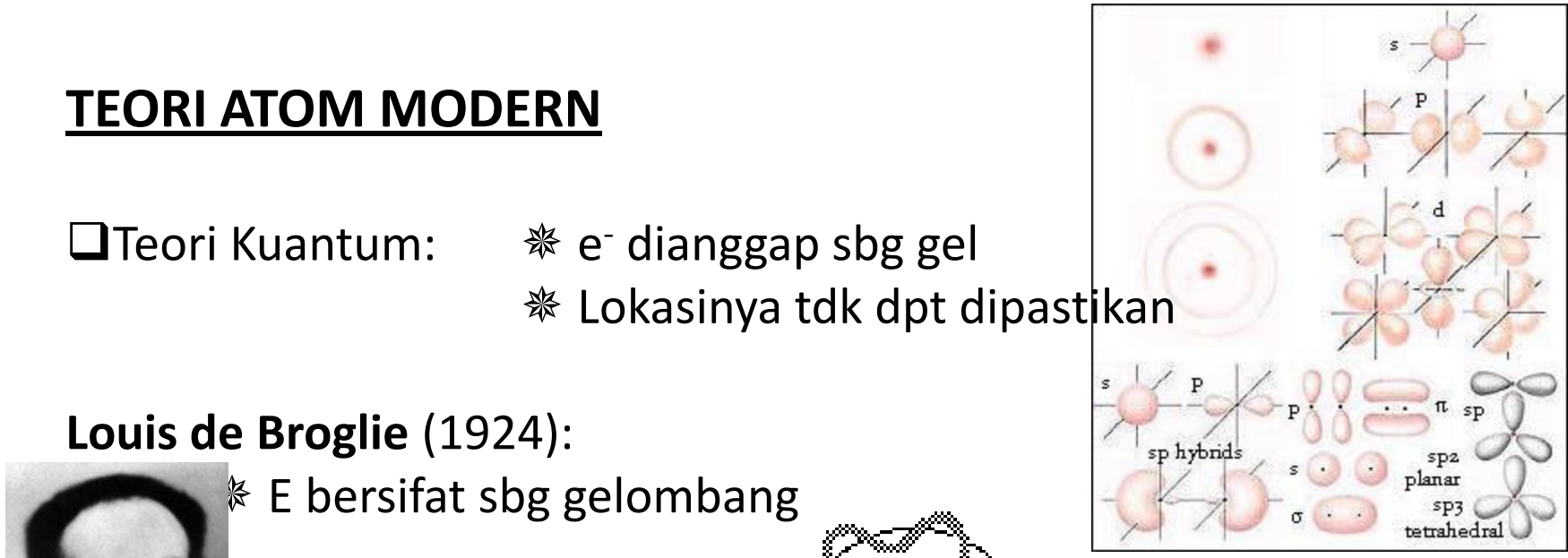
kenyataannya : atom hy mhslkan spektrum grs

Tdk dpt menjelaskan spektrum atom yg lbh kompleks dr atom H

ATOM DAN STRUKTUR ATOM

TEORI ATOM MODERN

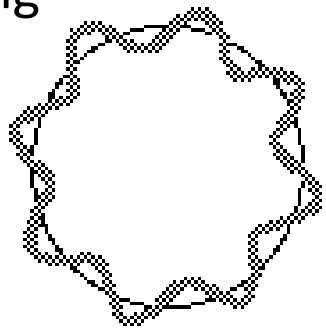
- Teori Kuantum:
  - e^- dianggap sbg gel
  - Lokasinya tdk dpt dipastikan



Louis de Broglie (1924):

- E bersifat sbg gelombang

$$\lambda = \frac{h}{mv}$$



Erwin schrodinger (1927):

fungsi gelombang atau orbital

The Time Dependent Schrödinger Equation

We may write

$$-\frac{\hbar}{i}\frac{\delta\Psi(t)}{\delta t} = \mathcal{H}\Psi(t)$$

where

$$\mathcal{H} = \sum_I \frac{1}{2m_i}\left(p_i - \frac{e_i}{c}\mathcal{A}\right)^2 + V(r) = \mathcal{H}_{molecule} + \mathcal{H}_{radiation} + \mathcal{H}_{int}$$

with

$$\mathcal{H}_{molecule} = \mathcal{H}_o = \sum_i \left(\frac{p_i^2}{2m_i} + V(r)\right); \quad \mathcal{H}_o|n\rangle = E_n^{(o)}|n\rangle$$

$$\mathcal{H}_{rad} = \sum_s \frac{\omega_s}{2}(a_s a_s^+ + a_s^+ a_s); \quad \mathcal{H}_{rad}|N_s\rangle = \sum_s (N_s + \tfrac{1}{2})\hbar\omega_s|N_s\rangle$$

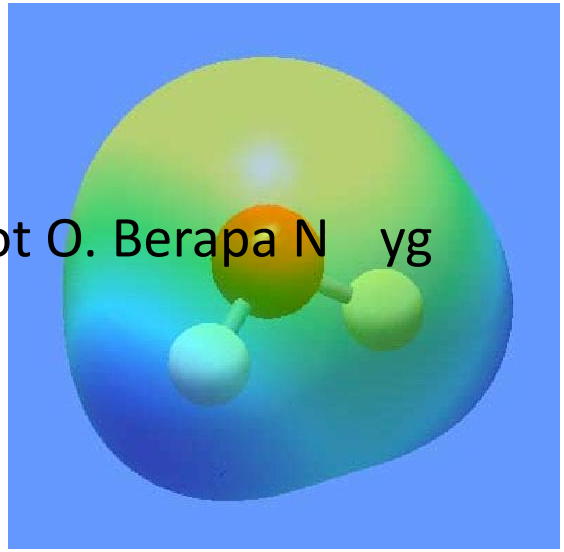
$$\mathcal{H}_{int} = \mathcal{H}_{int}^{(1)} + \mathcal{H}_{int}^{(2)}$$

ATOM DAN STRUKTUR ATOM

1. Rasio C:H dlm gas CH4 adl 3:1. Berapa hidrogen yg dibutuhkan utk 900 g karbon?

***Jawab*:**

$$900\ g\ C \times \frac{1\ g\ H}{3\ g\ C} = 300\ g\ H$$



2. Nitrous oksida tdr 7 bgn bobot N & 4 bgn bobot O. Berapa N yg diperoleh jk O dihslkan sbyk 36 g?

Jawab:

$$36\ g\ O \times \frac{7\ g\ N}{4\ g\ O} = 63\ g\ N$$

3. Rasio S:H dlm HS adlh 16:1. Bila bobot S=32 & H=1, berapa perbandingan atom dlm gas tsb?

Jawab:

$$\frac{32\ satuan\ S}{1\ atom\ S} \times \frac{1\ satuan\ H}{16\ satuan\ S} \times \frac{1\ atom\ H}{1\ satuan\ H} = \frac{2\ atom\ H}{1\ atom\ S} \approx H_2S$$

ATOM DAN STRUKTUR ATOM

4. Berapakah jml e max pd tkt E ke 5?

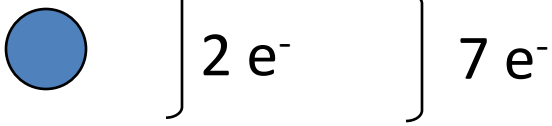
Jawab:

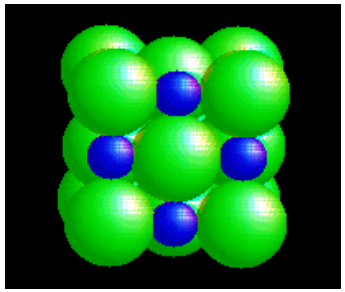
$$2n^2 = 2 \times 5^2 = 50$$

5. Gambarkan kulit e^- Fluor & Natrium?

Jawab:

a. F adl unsur dgn no atom 9, mempunyai 9 e^-
2 e^- mengisi kulit ke-1, sisanya di kulit ke-2





b. Na adl unsur dgn no atom 11, mempunyai 11 e^-
2 e^- mengisi kulit ke-1, 8 e^- di kulit ke-2, sisanya di kulit ke-3