مدونة المناهج السعودية

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الموقع التعليمي لجميع المراحل الدراسية

في المملكة العربية السعودية

CHEM 101

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STUDENT'S BOOK:

General chemistry for preparatory year students

مكتبة الشقري

Course Grading

First exam: 30

Second exam: 30

Final term exam: 40 marks

Total: 100

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ساعاتي المكتبية الاثنين والاربعاء
من ١٠ الى ١١

غرفة رقم 203 a في الدور الأول من مبنى ٤

Chapter 1

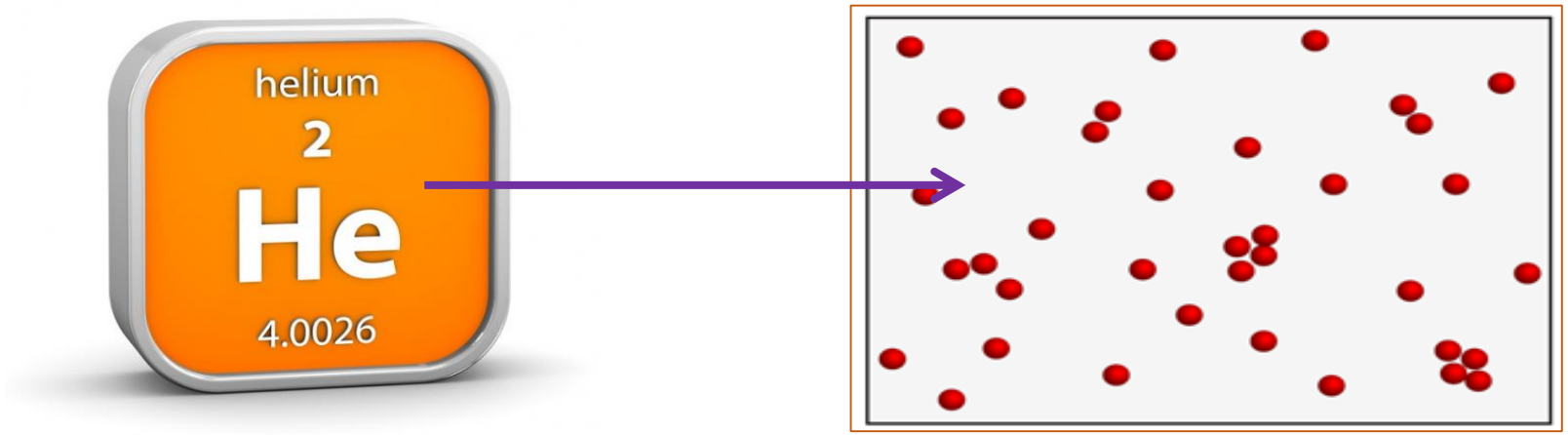
Introduction:

Matter and Measurements

Part 1

Definitions

1.1 ATOMS AND MOLECULES



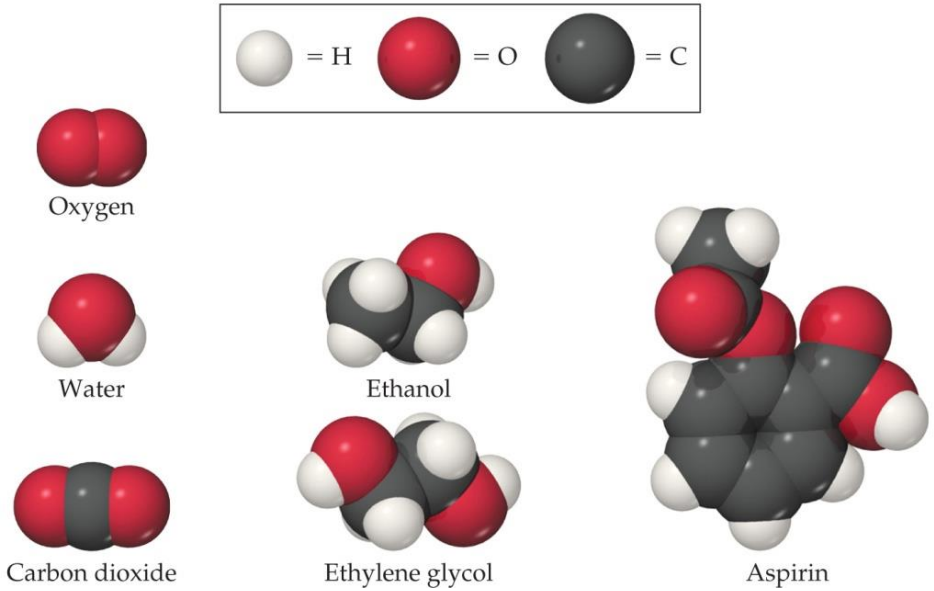
ATOMS:

They are the submicroscopic particles that constitute the fundamental building blocks of ordinary matter.

1.1 ATOMS AND MOLECULES

MOLECULES:

Atoms bind together in specific geometric arrangements to form **molecules**



A molecule has different physical and chemical behavior than its atoms

CHEMISTRY:

The science that seeks to understand the behavior of matter by studying the behavior of atoms and molecules

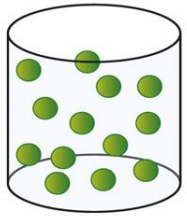
1.2 THE CLASSIFICATION OF MATTER

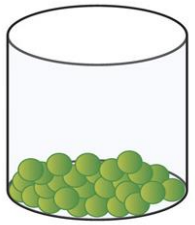
Matter is anything that has mass and takes up space.

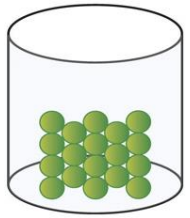
1.2 THE CLASSIFICATION OF MATTER

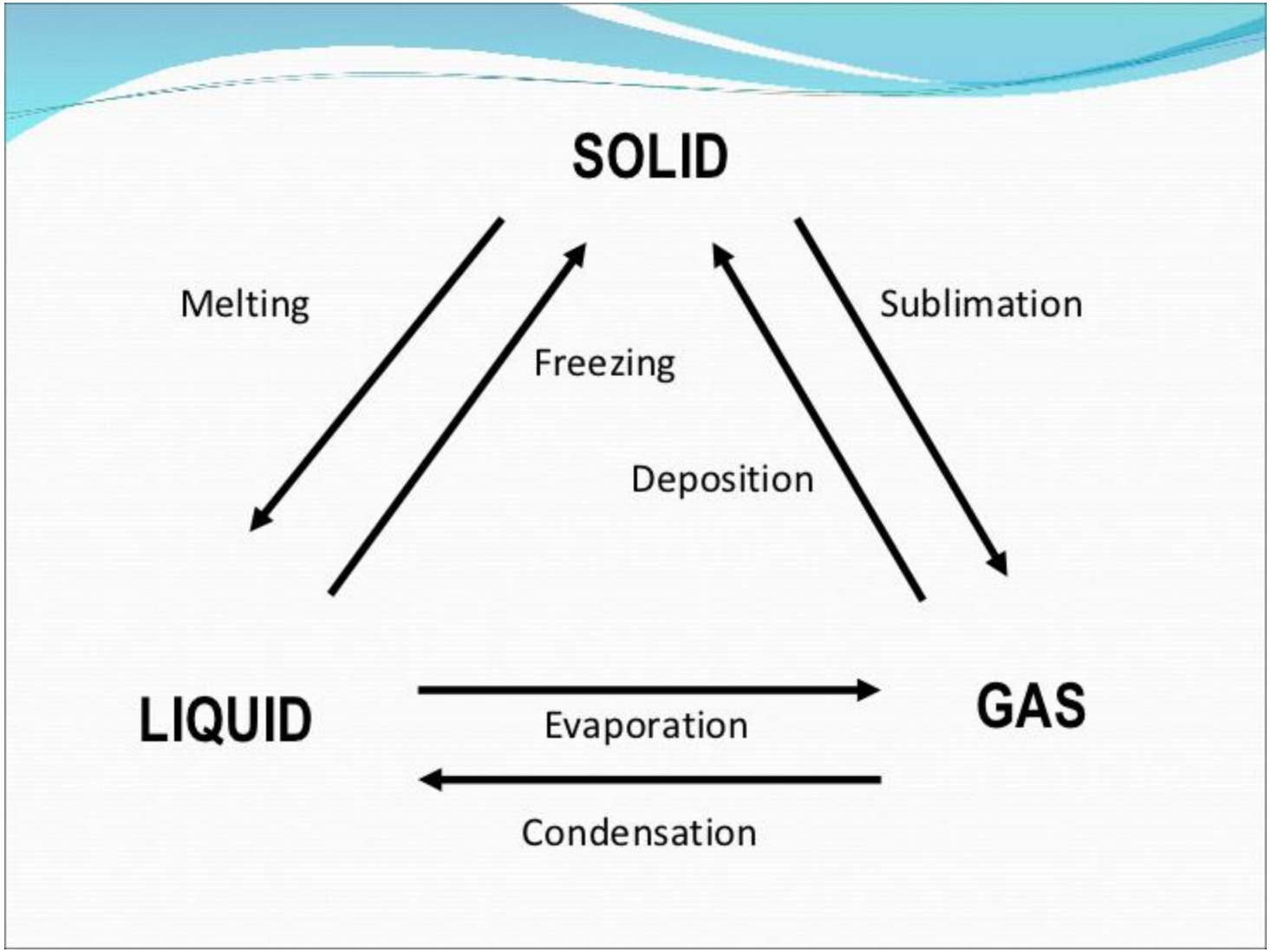
The States Of Matter: Solid, Liquid And Gas

Gas	Liquid	Solid
Molecules are separated by distance.	Molecules are close together but not held so rigidly in position and can move past on another.	Molecules are held close together in orderly fashion with little freedom of motion.
Have no definite shape.	Have no definite shape.	Have a definite shape.
Have no definite volume.	Have a definite volume .	Have a definite volume.


Gas

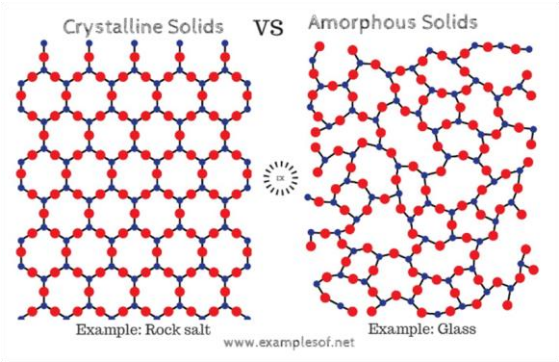

Liquid


Solid


SOLID
Melting
Freezing
Sublimation
Deposition
LIQUID
Evaporation
GAS
Condensation

Solids

crystalline	Amorphous
Its atoms or molecules are arranged in patterns with long-range, repeating order. Example: salt, diamond	Its atoms or molecules do not have any long-range order. Example: glass, plastic



Example :

1- ……. has no definite shape and volume.

A.Gas

B.Liquid

C.Solid

Example :

2- ……. molecules are held close together in orderly fashion with little freedom of motion.

A.Gas

B.Liquid

C.Solid

Example :

3- **Glass considered a/an ---------- solid material**

a- amorphous

b- liquid

c- crystalline

Example :

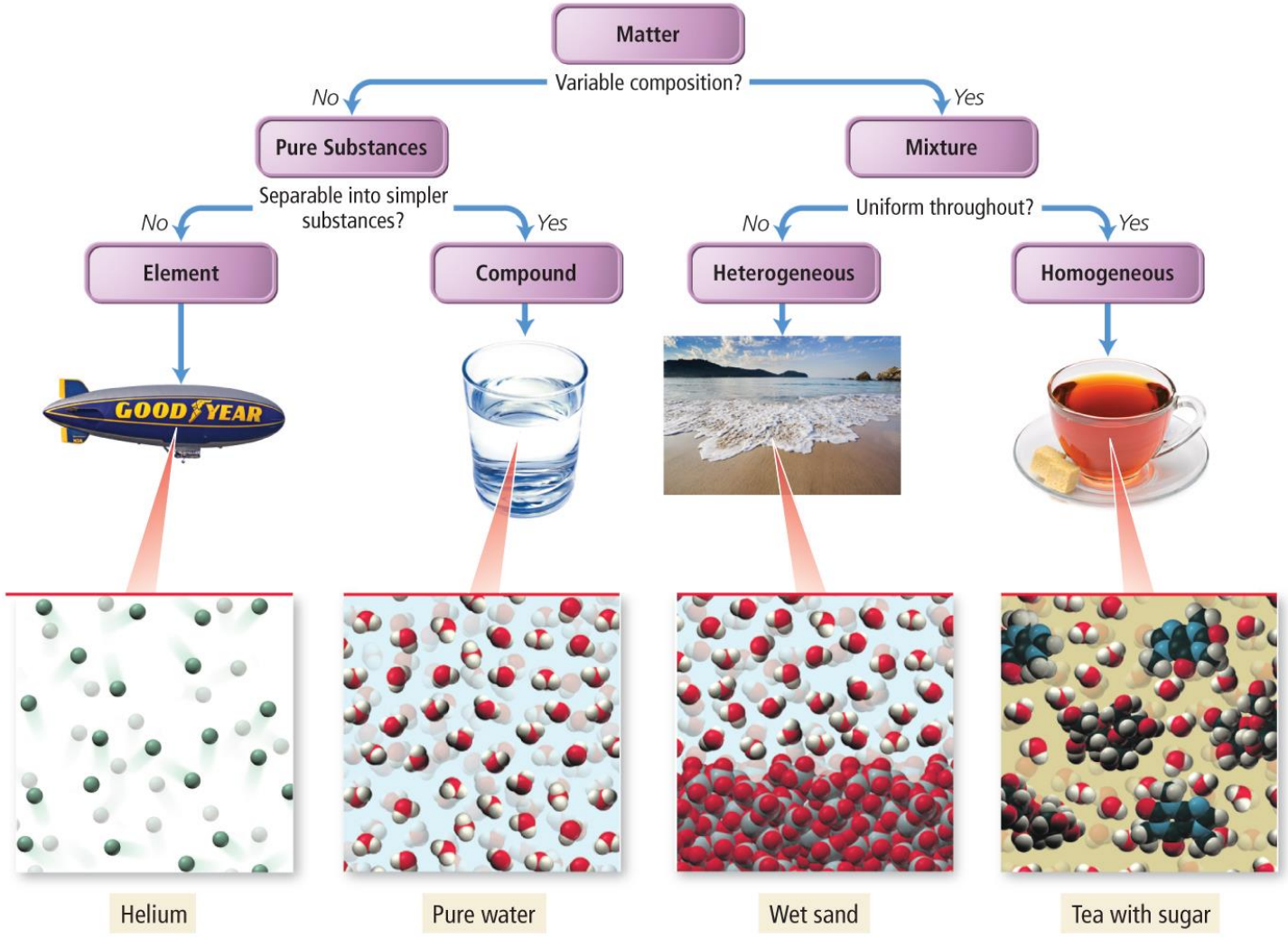
4- **Evaporation refers to which conversion:**

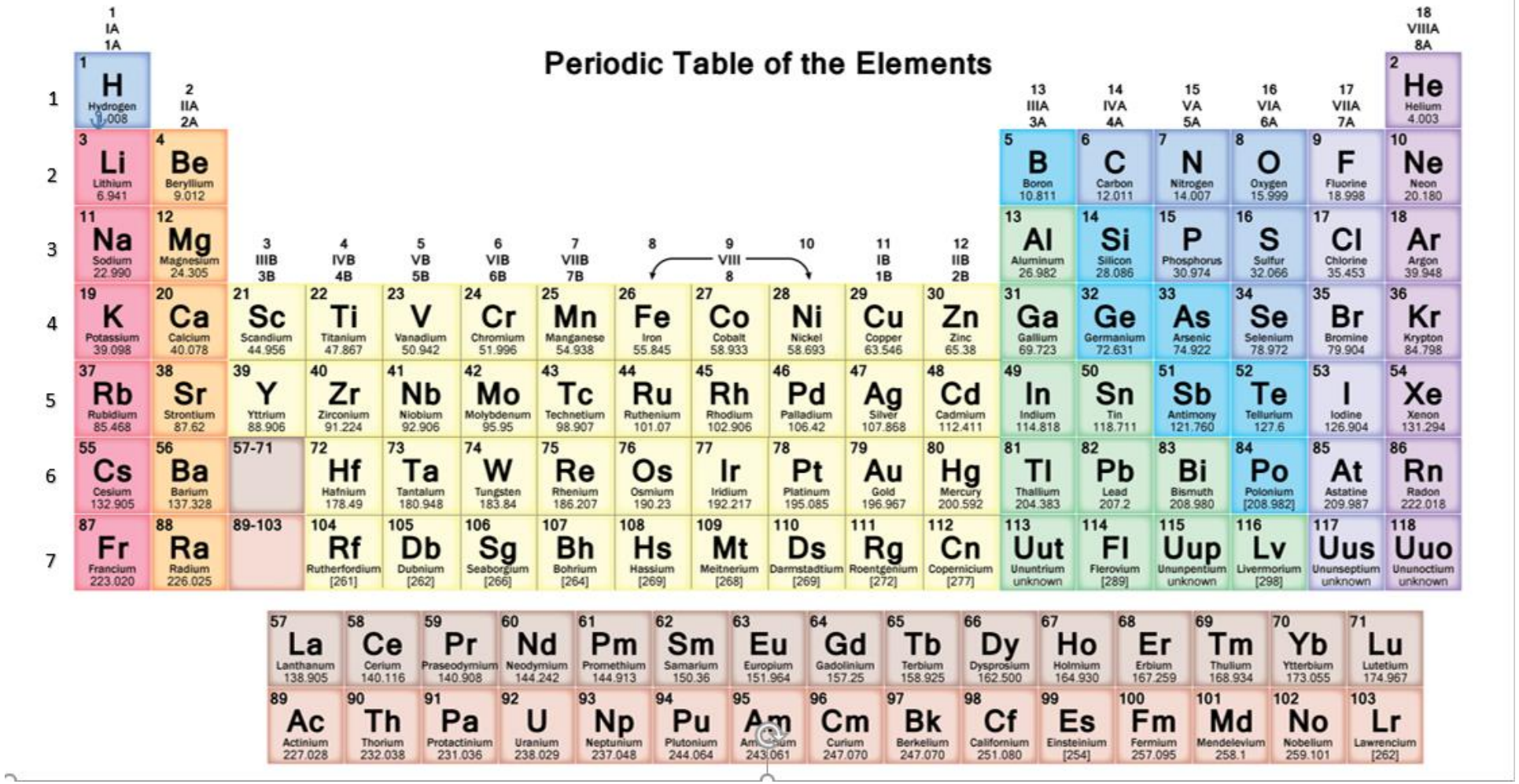
a- liquid to solid

b- liquid to gas

c- gas to liquid

Classifying Matter According To Its Composition: elements, Compounds And Mixtures




Periodic Table of the Elements
1 IA 1A
2 IIA 2A
3 IIIB 3B
4 IVB 4B
5 VB 5B
6 VIB 6B
7 VIIB 7B
8 9 VIII 10 8
11 IB 1B
12 IIB 2B
13 IIIA 3A
14 IVA 4A
15 VA 5A
16 VIA 6A
17 VIIA 7A
18 VIIIA 8A
1 H Hydrogen 1.008
2 He Helium 4.003
3 Li Lithium 6.941
4 Be Beryllium 9.012
5 B Boron 10.811
6 C Carbon 12.011
7 N Nitrogen 14.007
8 O Oxygen 15.999
9 F Fluorine 18.998
10 Ne Neon 20.180
11 Na Sodium 22.990
12 Mg Magnesium 24.305
13 Al Aluminum 26.982
14 Si Silicon 28.086
15 P Phosphorus 30.974
16 S Sulfur 32.066
17 Cl Chlorine 35.453
18 Ar Argon 39.948
19 K Potassium 39.098
20 Ca Calcium 40.078
21 Sc Scandium 44.956
22 Ti Titanium 47.867
23 V Vanadium 50.942
24 Cr Chromium 51.996
25 Mn Manganese 54.938
26 Fe Iron 55.845
27 Co Cobalt 58.933
28 Ni Nickel 58.693
29 Cu Copper 63.546
30 Zn Zinc 65.38
31 Ga Gallium 69.723
32 Ge Germanium 72.631
33 As Arsenic 74.922
34 Se Selenium 78.972
35 Br Bromine 79.904
36 Kr Krypton 84.798
37 Rb Rubidium 85.468
38 Sr Strontium 87.62
39 Y Yttrium 88.906
40 Zr Zirconium 91.224
41 Nb Niobium 92.906
42 Mo Molybdenum 95.95
43 Tc Technetium 98.907
44 Ru Ruthenium 101.07
45 Rh Rhodium 102.906
46 Pd Palladium 106.42
47 Ag Silver 107.868
48 Cd Cadmium 112.411
49 In Indium 114.818
50 Sn Tin 118.711
51 Sb Antimony 121.760
52 Te Tellurium 127.6
53 I Iodine 126.904
54 Xe Xenon 131.294
55 Cs Cesium 132.905
56 Ba Barium 137.328
57-71
72 Hf Hafnium 178.49
73 Ta Tantalum 180.948
74 W Tungsten 183.84
75 Re Rhenium 186.207
76 Os Osmium 190.23
77 Ir Iridium 192.217
78 Pt Platinum 195.085
79 Au Gold 196.967
80 Hg Mercury 200.592
81 Tl Thallium 204.383
82 Pb Lead 207.2
83 Bi Bismuth 208.980
84 Po Polonium [208.982]
85 At Astatine 209.987
86 Rn Radon 222.018
87 Fr Francium 223.020
88 Ra Radium 226.025
89-103
104 Rf Rutherfordium [261]
105 Db Dubnium [262]
106 Sg Seaborgium [266]
107 Bh Bohrium [264]
108 Hs Hassium [269]
109 Mt Meitnerium [268]
110 Ds Darmstadtium [269]
111 Rg Roentgenium [272]
112 Cn Copernicium [277]
113 Uut Ununtrium unknown
114 Fl Flerovium [289]
115 Uup Ununpentium unknown
116 Lv Livermorium [298]
117 Uus Ununseptium unknown
118 Uuo Ununoctium unknown
57 La Lanthanum 138.905
58 Ce Cerium 140.116
59 Pr Praseodymium 140.908
60 Nd Neodymium 144.242
61 Pm Promethium 144.913
62 Sm Samarium 150.36
63 Eu Europium 151.964
64 Gd Gadolinium 157.25
65 Tb Terbium 158.925
66 Dy Dysprosium 162.500
67 Ho Holmium 164.930
68 Er Erbium 167.259
69 Tm Thulium 168.934
70 Yb Ytterbium 173.055
71 Lu Lutetium 174.967
89 Ac Actinium 227.028
90 Th Thorium 232.038
91 Pa Protactinium 231.036
92 U Uranium 238.029
93 Np Neptunium 237.048
94 Pu Plutonium 244.064
95 Am Americium 243.061
96 Cm Curium 247.070
97 Bk Berkelium 247.070
98 Cf Californium 251.080
99 Es Einsteinium [254]
100 Fm Fermium 257.095
101 Md Mendelevium 258.1
102 No Nobelium 259.101
103 Lr Lawrencium [262]

Definitions

Mixture is a combination of two or more substances in which the substances retain their distinct identities.

Homogenous mixture:
composition of the mixture is the same throughout.
Example: Salty water

Heterogeneous mixture
composition is not uniform.
Example: the mixture contains iron fillings and sand

Pure substance: is a form of matter that has a definite composition and district properties

Example: water , sugar and gold.

Element: is a substance that can not be separated into simpler substances by chemical means

Example: Gold (Ag), Oxygen (O).

Compound is a substance composed of atoms of two or more elements chemically united in fixed proportions

- Compounds can only be separated into their pure components (elements) by chemical means.

Example: water (H_2O).

1.3 PHYSICAL AND CHEMICAL CHANGES AND PHYSICAL AND CHEMICAL PROPERTIES

Types of Properties

Physical Properties	Chemical Properties
can be observed without changing a substance into another substance. Some examples include boiling point, density, mass, or volume.	can only be observed when a substance is changed into another substance. Some examples include flammability, corrosiveness, or reactivity with acid.

Types of Changes

Physical Changes	Chemical Changes
They are changes in matter that do *not* change the composition of a substance. ◦Examples include changes of state, temperature, and volume.	result in new substances. ◦Examples include combustion, oxidation, and decomposition.

EXAMPLE 1.1 Physical and Chemical Changes and Properties

Determine whether each change is physical or chemical. What kind of property (chemical or physical) is demonstrated in each case?

(a) the evaporation of rubbing alcohol

(b) the burning of lamp oil

(c) the bleaching of hair with hydrogen peroxide

(d) the forming of frost on a cold night

SOLUTION

(a) When rubbing alcohol evaporates, it changes from liquid to gas, but it remains alcohol—this is a physical change. The volatility (the ability to evaporate easily) of alcohol is a physical property.

(b) Lamp oil burns because it reacts with oxygen in air to form carbon dioxide and water—this is a chemical change. The flammability of lamp oil is a chemical property.

(c) Applying hydrogen peroxide to hair changes pigment molecules in hair that give it color—this is a chemical change. The susceptibility of hair to bleaching is a chemical property.

(d) Frost forms on a cold night because water vapor in air changes its state to form solid ice—this is a physical change. The temperature at which water freezes is a physical property.

17- The tarnishing of a copper penny is an example of a:

a- chemical change

b- physical change

c- chemical property

d- physical property

18- The condensation of water vapor is an example of a:

a- chemical change

b- physical change

c- chemical property

d- physical property

19- The formation of polyethylene from ethylene is an example of a:

a- chemical change

b- physical change

c- chemical property

d- physical property

20- The burning candle is an example of a:

a- chemical property

b- physical change

c- chemical change

d- physical property

21- Tendency of iron to rust is a ---------- .

a- physical change

b- chemical change

c- physical property

d- chemical property

- Which of the following statements describes a chemical property?

a-iron has a tendency to rust

b- the forming of frost

c-Hemoglobin molecules have a red color.

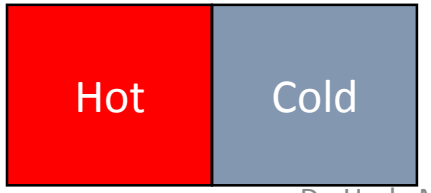
d-When a glass of water is left out in the sun, the water gradually disappears.

1.4 ENERGY: A FUNDAMENTAL PART OF PHYSICAL AND CHEMICAL CHANGE

1. The 1st principle (The law of conservation of energy)

Energy is neither created nor destroyed. It can only be transformed from one form to another or transferred from one system to another

2. The 2nd principle to note is the tendency of systems with HIGH potential energy to change in a way that LOWERS their potential energy.



Part 2

Units & prefixes

1.5 THE UNITS OF MEASUREMENT

Common unit systems

English system: inches, yards and pounds

Metric system

The International System of units (SI Units)

METRIC SYSTEM

Base Quantity	Name of unit	Symbol
Length	meter	m
Mass	gram	g
Time	second	s
volume	Liter or cubic centimeter	L cm^3 (cc)
Temperature	Kelvin or degree Celsius	K C^o
Amount of substance	mole	mol

THE INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

1-Base units

Base Quantity	Name of unit	Symbol
Length	meter	m
Mass	Kilogram	Kg
Time	second	s
Electrical current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

2- Derived units

Volume (m^3), Speed (m/s)

EXAMPLES

The SI unit of Time is

(a) (a)The second

(b) The mole

(b) (c) The gram

(d) The candela

The mole is the SI unit of

(a) Current

(b) Amount of substance

(c) Temperature

(d) Length

The Meter: A Measure of Length

The distance light travels through a vacuum in a certain period of time 1/299,792,458 second

1 yard = 36 inches

1 meter = 39.37 inches

The Kilogram: A Measure of Mass

Kilogram : The mass of a metal cylinder kept at the International Bureau of Weights and Measures at Sevres, France

Mass

is a measure of the quantity of matter in an object

SI unit of mass is the **KILOGRAM (kg)**

Common unit of mass is the **GRAM ($1g = 1\times10^{-3}\,kg$)**

Weight

Gravitational pull on the matter within it

weight = *g* x mass

The Second: A Measure of Time

Second (s) : The duration of 9,192,631,770 periods of the radiation emitted from a certain transition in a cesium-133 atom

The Kelvin: A Measure of Temperature

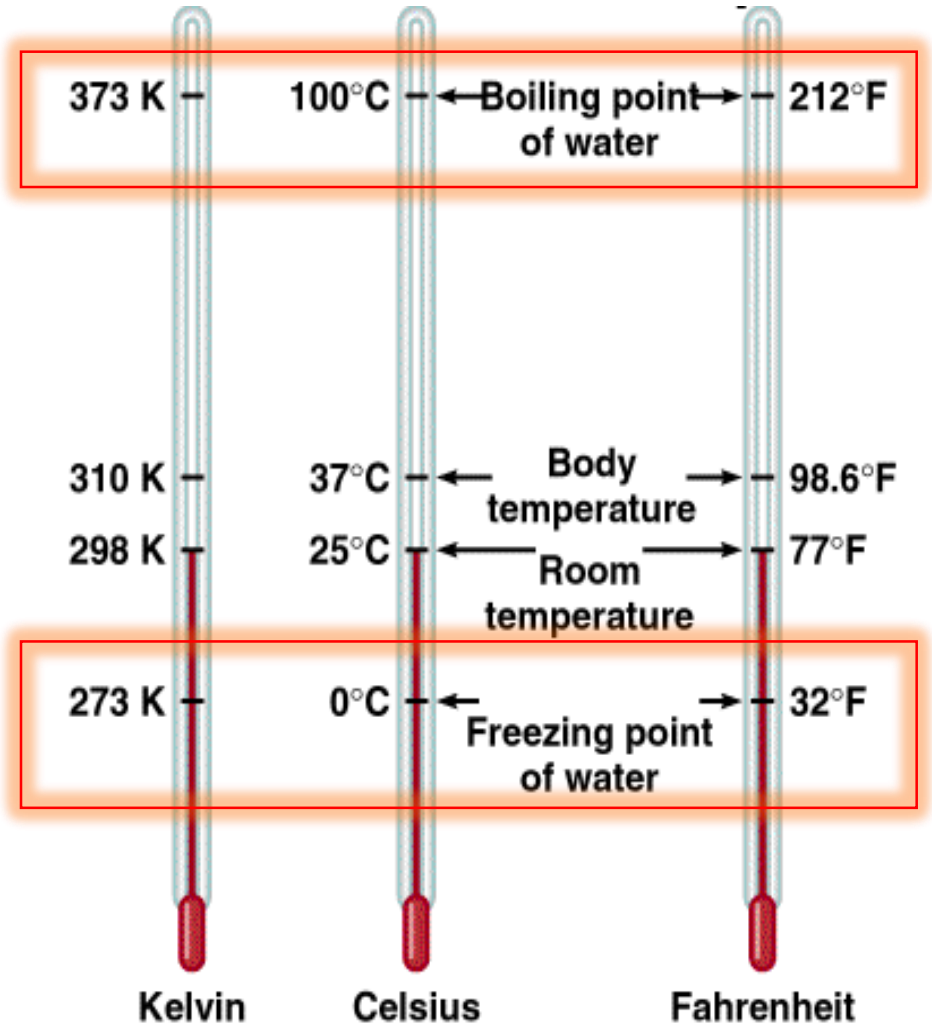
The temperature: it is a measure of the amount of average kinetic energy of the atoms or molecules that compose the matter.

Temperature Scales

There are three temperature scales, their units are:

1. Degrees Celsius ^0C
2. Degrees Fahrenheit ^0F
3. Kelvin K

KELVIN IS THE SI BASE UNIT OF TEMPERATURE



$$K = {}^{o}C + 273.15$$

Convert 15 degrees Celsius to kelvin.

$$15\ {}^{o}C = ?\ K$$

$$K = {}^{o}C + 273.15$$

$$K = 15 + 273.15$$

$$K = 288.15$$

Convert 313.15 kelvin to degrees Celsius .

313.15 K = ? ^{o}C

$$K = {}^{o}C + 273.15$$

$$313.15 = {}^{o}C + 273.15$$

$$313.15 - 273.15 = {}^{o}C$$

$$^{o}C = 40$$

$$^{o}C = \frac{(^{o}F - 32)}{1.8}$$

Convert 172.9 ^{0}F to degrees Celsius.

$$^{0}C = \frac{(^{o}F - 32)}{1.8}$$

$$^{0}C = \frac{(172.9 - 32)}{1.8} = 78.3$$

$$^{o}C = \frac{(^{o}F - 32)}{1.8}$$

Convert 20 degrees Celsius to ^{0}F.

$$^{0}C = \frac{(^{o}F - 32)}{1.8}$$

$$20 = \frac{(^{o}F - 32)}{1.8}$$

$$20 \times 1.8 = {}^{0}F - 32$$

$$^{0}F = 68$$

Ex: Convert -77°F to kalvin ?

A. 212.6 K

B. -212.6 K

C. -28.1 K

D. +13.5 K

PREFIXES USED WITH SI UNIT

Exa-	E	10^{18}	1 exameter (Em)=1x10^{18}m
Peta-	P	10^{15}	1 petameter (Pm)=1x10^{15}m
tera-	T	10^{12}	1 terameter (Tm)=1x10^{12}m
giga-	G	10^{9}	1 gigameter (Gm)=1x10^{9}m
mega-	M	10^{6}	1 megameter (Mm)=1x10^{6}m
kilo-	K	10^{3}	1 kilometer (Km)=1x10^{3}m
Meter , Liter, gram			
deci-	d	0.1 or 10^{-1}	1 decimeter(dm)= 1x10^{-1} m
centi-	c	0.01 or 10^{-2}	1 centimeter (cm)=1x10^{-2}m
milli-	m	10^{-3}	1 milimeter (mm)=1x10^{-3}m
micro-	µ	10^{-6}	1 micro meter (µm)= 1x10^{-6}m
nano-	n	10^{-9}	1 nano meter (nm) =1x10^{-9}m
pico-	p	10^{-12}	1 pico meter (pm)=1x10^{-12} m
femto-	f	10^{-15}	1 femto meter (fm)=1x10^{-15} m
Atto-	a	10^{-18}	1 atto meter (am)=1x10^{-18} m

EXAMPLES

The SI prefixes Mega- represents:

(a) 10^{-6}

(b) 10^{6}

(c) 10^{3}

(d) 10^{9}

1 Kg =

(a) 10^{-6} g

(b) 10^{3} g

(c) 10^{-1} g

(d) 10^{9} g

Convert 3terameter to gigameter

3 terameter = x gigameter

$3\ (10^{12}) = x\ (10^{9})$

$$\frac{3\ (10^{12})}{(10^{9})} = x$$

$3\times 10^{3}=x$

Convert 0.8 microsecond to centisecond

$$0.8 \text{ microsecond} = x \text{ centisecond}$$

$$0.8\ (10^{-6}) = x\ (10^{-2})$$

$$\frac{0.8\ (10^{-6})}{(10^{-2})} = x$$

$$0.8 \times 10^{-4} = x$$

$$8 \times 10^{-5} = x$$

Convert 0.02 megagram to picogram

$$0.02 \text{ megagram} = x \text{ picogram}$$

$$0.02\ (10^{6}) = x\ (10^{-12})$$

$$\frac{0.02\ (10^{6})}{(10^{-12})} = x$$

$$2\times 10^{16} = x$$

Convert 5 m to pm

$5\ m = x\ pm$

$5\ (1) = x\ (10^{-12})$

$$\frac{5}{(10^{-12})} = x$$

$5 \times 10^{12} = x$

Convert 5 cm^3 to m^3

$$5\ cm^3 = x\ m^3$$

$$5\ (10^{-2})^3 = x\ (1)^3$$

$$5 \times 10^{-6} = x$$

Convert 6.6 m^2 to dm^2

$$6.6\ m^2 = x\ dm^2$$

$$6.6\ (1)^2 = x\ (10^{-1})^2$$

$$6.6 = x \times 10^{-2}$$

$$\frac{6.6}{10^{-2}} = x$$

$$660 = x$$

$$6.6 \times 10^2 = x$$

Ex: Which of these quantities represents the largest mass?

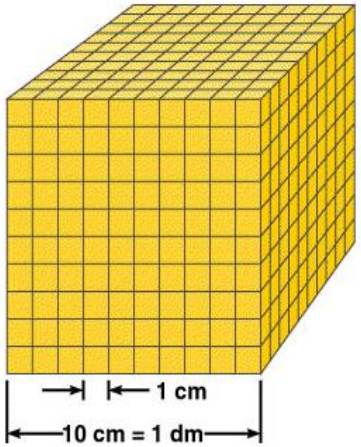
A. 2.0×10^2 mg

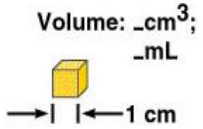
B. 0.0010 kg

C. 1.0×10^5 μg

D. 2.0×10^2 cg

VOLUME





Volume= width x length x height

= m x m x m = m^3

SI derived unit for volume is cubic meter (m^3)

Another common units of volume

1- $1dm^3 = 1L$

2- $1cm^3 = 1mL$

Calculating Density

DENSITY

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{\text{kg}}{\text{m}^3} = \text{kg/m}^3$$

SI derived unit for density is kg/m^3

Another common units of density

$$g/L = 1\ g/dm^3$$

$$1\ g/mL = 1\ g/cm^3$$

Example 1.1

Gold is a precious metal that is chemically unreactive. It is used mainly in jewellery, dentistry, and electronic devices. A piece of gold ingot with a mass of 301 g has a volume of 15.6 cm^3. calculate the density of gold.

$$d = \frac{m}{V}$$

$$d = \frac{301\ g}{15.6\ cm^3}$$

$$= 19.3\ g/cm^3$$