chapter 1: Chemistry and measurments

* Modern chemistry

* Experiments & Explanation: scientific method

observation ⟹ experiments carried out under the same conditions ⟹ Hypothesis test, medification ⟹ law statement or mathmatical equation ⟹ theory tested explanation

* law of conservation of mass:

the total mass remains constant during a chemical change (chemical reaction).

- it must be a closed system.

matter

- **solid**
  - constant volume ✓
  - constant shape ✓
- **liquid**
  - constant volume ✓
  - changing shape
- **gas**
  - changing volume
  - changing shape

matter

- **substance** — physical change → **mixture**
  - H_2O, $NaCl$, CO_2
  - **element** ← chemical change — **compound**
    - Na, O, Br, Cl
    - 2 or more elements
    - $NaCl$, H_2O
  - 2 or mor substances
    - **Homogeneous** متجانس
    - **Heterogeneous** غير متجانس

- **chemicd change:** تغير مكونات المادة

example: burning, Rusting, combustion, decay, Rot, digesting, exploding, Mixing acid and base.

- **physical change:** تغيرات تحدث للمادة لا تغير من مكوناتها

example: melting, freezing, boiling, color, odor, temprature, solubility, conductivity, cracking, cutting.

*Properties:

- *Extensive properties: depend on the amount of the sample.

  ex.: Mass, length, volume ...

- *Intensive properties: don't depend on the amount of the sample

  ex.: Melting point, density, temp ...

ex.: Classify each of the following to element or compound?

a) hydrogen → element

b) water → compound

c) gold → element

d) sugar → compound

ex.: Classify each of the following to chemical or physical property?

a) boiling → physical

b) density → physical

c) growth → chemical

d) radioactive → chemical

e) sugar caramelization → chemical

ex.: classify each of the following to homogenous or heterogenous?

a) sea water → homo

b) milk shake → hetero

c) coffee → hetero

d) concrete → hetero

ex.: classify each of the following to extensive or intensive property?

a) area → extensive

b) color → intensive

c) mass → extensive

d) density → intensive

*Macroscopic : can be determine directly.

*microscopic : can be determine indirect.

*Measurement & Significant Figures:

Number + Unit

SI Units → وحدات عالمية متفق عليها من قبل العلماء

1] Prime Units:

- Length : meter (m)
- Mass : Kilogram (kg)
- Time : second (s)
- electrical current : Ampere (A)
- Amount of substance : mole (Mol)
- temprature : Kelvin (K)
- luminous intensity : candela (cd)

2] Derived units:

- Area : m^2
- Volume : m^3
- density : Kg/m^3
- speed : m/s
- accelaration : m/s^2
- force : $Kg.m/s^2$ (Newton)
- pressure : $Kg/m.s^2$ (Pascal)
- energy : $Kg.m^2/s^2$ (joule)

$cm = 10^{-2}\ m$

$10^{2}\ cm = m$

T	G	M	K	... m	d	c	m	μ	n	p
tera	giga	mega	Kilo		deci	centi	milli	micro	nano	pico
10^{12}	10^{9}	10^{6}	10^{3}	10^{0}	10^{-1}	10^{-2}	10^{-3}	10^{-6}	10^{-9}	10^{-12}

ex.: $mL \rightarrow 10^{-3}\ L$

$\mu s \rightarrow 10^{-6}\ s$

$TJ \rightarrow 10^{12}\ J$

$kPa \rightarrow 10^{3}\ Pa$

$GW \rightarrow 10^{9}\ W$

ex.: a) 8.9 cm to millimeters:

$$8.9\ \cancel{cm} \times \frac{1\ m}{10^{2}\ \cancel{cm}} = 8.9 \times 10^{-2}\ \cancel{m} \times \frac{10^{3}\ mm}{1\ \cancel{m}} = \boxed{89\ mm}$$

b) 9.05×10^{3} nW to kilo watt (KW):

$$9.05 \times 10^{3}\ \cancel{nW} \times \frac{1\ W}{10^{9}\ \cancel{nW}} \times \frac{1\ KW}{10^{3}\ \cancel{W}} = \boxed{9.05 \times 10^{-9}\ KW}$$

- Temprature scales :

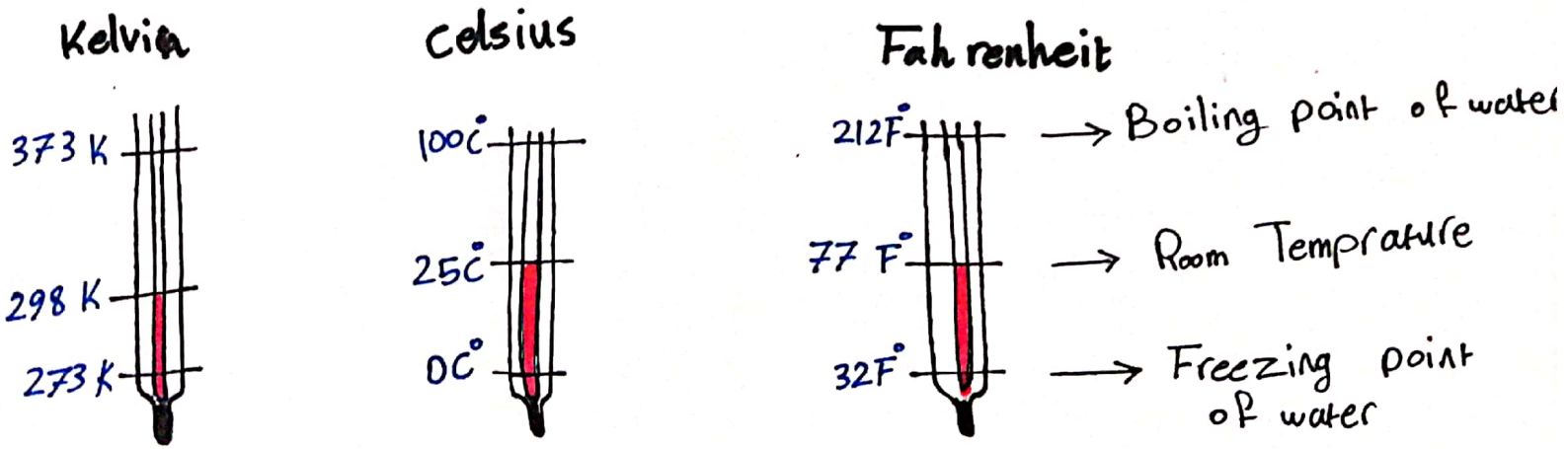
* The SI unit to the temprature is Kelvin "K" → remember

$K = C^\circ + 273$ $\quad F^\circ = (\frac{9}{5} \times C^\circ) + 32$ $\quad C^\circ = (F^\circ - 32) \times \frac{5}{9}$

⇒ The question always is "convert"

ex.: 1] 327.5 C° to F° $\quad F = (\frac{9}{5} \times 327.5) + 32 = 621.5\ F^\circ$

2] 172.9 F° to C° $\quad C = (172.9 - 32) \times \frac{5}{9} = 78.3\ C^\circ$



- Density & Specific gravity:

* Density = $\frac{\text{mass}}{\text{Volume}}$

units for density ⇒ Kg/cm^3 → SI unit

g/cm^3 or g/ml

$cm^3 = ml$

$dm^3 = L$

* specific gravity = $\frac{\text{density of substance}}{\text{density of water}}$

↳ it has no unit

ex.: calculate the density in g/ml if 586 g of the Bromine liquid (Br) occupies 188 ml ?

$$\text{density} = \frac{\text{mass}}{\text{Volume}} = \frac{586}{188ml} = 3.12\ g/ml$$

- Scientific Notation:

* an easier way to deal with numbers by putting only one number on the left of the decimal point.

$65443.2 = 6.54432 \times 10^{4}$

$0.000256 = 2.56 \times 10^{-4}$

$2578.25 = 2.57825 \times 10^{3}$

* Remember: 1] $10 \times 10^{2} + 33 \times 10^{3} = 10 \times 10^{2} + 330 \times 10^{2} = 340 \times 10^{3}$

or $= 1 \times 10^{3} + 33 \times 10^{3} = 34 \times 10^{3}$

2] $10^{2} \times 10^{3} = 10^{5}$

-Significant figures (S.F): الأرقام المعنوية

1 أي رقم ماعدا الصفر يعتبر
رقم معنوي
762 → 3 S.f

2 الأصفار بين الأرقام تعتبر
رقم معنوي
70602 → 5 S.f

3 الأصفار على يسار الرقم
لا تحسب
0.0029 → 2 S.f

4 الأصفار على يمين الرقم
تحسب
1.3920 → 5 S.f

ex.: a) 56.9060 ⇒ 6 S.f b) 0.0920 ⇒ 3 S.f

c) 9020 ⇒ 4 S.f d) 1.02×10^3 ⇒ 3 S.f

* قد يسأل بالأرقام المعنوية عن عملية حسابية يريد جوابها النهائي بطريقة (S.f)

1] إذا كانت العملية (×, ÷): يجب أن يكون الرقم المعنوي للجواب النهائي مثل أقل رقم معنوي بالمعادلة.

$5.2505 \times 3.20 = 16.8016 \approx 16.8$

5 S.f — 3 S.f — 3 S.f ☑

2] إذا كانت العملية (+, -): يجب أن يكون الجواب النهائي مثل أقل رقم يحوي منازل عشرية.

$3.50 + 1.666 = 5.166 \approx 5.17$

منزلتين عشريات — 3 منازل عشرية — منزلتين عشريات ☑

$5 < x \rightarrow 1+$
$5 > x \rightarrow$ مثل ما هي

ex.: Carry out:

a] $5.6792 + 0.6 + 4.33 = 10.6092$

4 — (1) — 2 — $= 10.6$

b] $(0.102 / 0.0821) + (273 / 1.01) =$

3 s.f — 3 s.f — 3 s.f — 3 s.f

$= 1.24 + 270$

2 — 0

$= 271$

- Exact numbers: are either defined numbers or the result of a count.

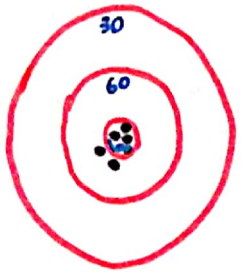
  * for example: dozen is defined as 12 objects
    Pound is defined as 16 ounces

6572
(4 S.f)

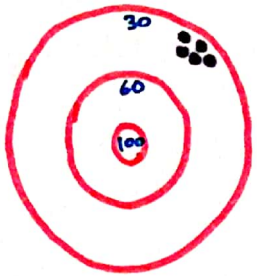
- Accuracy and Precision:

  * Accuracy: tell us how close measurement is to the true value.

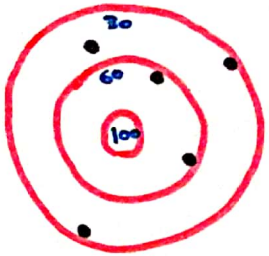
  * Precision: refers to how closely two or more measerements agree with one another.



more accuracy
more precision



less accuracy
more precision



no accuracy
no precision

- Dimensional Analysis: "convert"

ex: The volume of a room is $1.08 \times 10^8\ dm^3$, what is the volume in m^3?

$$1.08 \times 10^8\ \cancel{dm^3} \times \frac{1\ m^3}{10^3\ \cancel{dm^3}} = 1.08 \times 10^5\ m^3$$

ex: $0.09\ Km^2$ to cm^2?

$$0.09\ \cancel{Km^2} \times \frac{10^6\ \cancel{m^2}}{1\ \cancel{Km^2}} \times \frac{10^4\ cm^2}{1\ \cancel{m^2}} = 0.09 \times 10^{10} = 9 \times 10^8\ cm^2$$

ex: 1.07 Kg to lb?

$$1.07\ \cancel{Kg} \times \frac{10^3\ \cancel{g}}{1\ \cancel{Kg}} \times \frac{1\ lb}{453.6\ \cancel{g}} = 2.5589 = 2.56\ lb$$

$1\ lb = 453.6\ g$

$1\ ft = 0.3\ m$

$1\ mile = 1.61\ Km$

$1\ in = 2.5\ cm$

$1\ ft = 12\ in$