# *General chem*

## Ch. 1

Luminous intensity $\xrightarrow{\text{units}}$ Candela (cd)

| | |
|---|---|
| exa | $10^{18}$ |
| peta | $10^{15}$ |
| tera | $10^{12}$ |
| hecto | $10^{2}$ |
| deka | $10$ |
| atto | $10^{-18}$ |

عدد S.F يتناسب طردياً مع
التأكد يعني هذا التأكد بنسبة ١٠٠٪
S.F = infinite number of S.F

### *Rules for counting Significant figures :-

1. Non zero integers count as significant figures ( $45 \times 10^{-3} \rightarrow 2$ S.F )
2. Zeros :-

P. leading zeros → not count (zeros at the lift sind from the non zeros) $0.0048 \rightarrow 2$ S.F

ب. captive zeros → count (between non zero) $0.0408 \rightarrow 3$ S.F

2. Trailing zeros → count if the number contains decimal point (at the right end of the number)

9000. → 4 S.F / 4.300 → 4 S.F / 150 → 2 S.F

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* **Accuracy** :- related to how much your figures closed to correct value
* **precision** :- " " " " " " " to each other

### * Temperature :

$$T_K = T_C + 273.15 \quad / \quad T_C = \frac{5}{9}(T_F - 32)$$

# ch. 2

- atom : electrons + Protons + neutrons

- nucleus :- small / extremely dense : account for almost all of the atom's mass

- Istopes :- Same number of protons but different numbers of neutrons
  ↳ identical chemical properties because the chemistry of an atom is due to its valence ($e^-$)

- الـ atomic mass لأي عنصر في الجدول الدوري له أكثر من نظير يتم وضعها حسب الـ avareg atomic mass

$$\text{avareg atomic mass} = (\text{atomic mass} \times \text{نسبة تواجده} \%)_{\text{istope } 1} + \text{ - - - - -}$$

- Atomic Number ⇒ $Z = P$
- Mass Number / atomic mass ⇒ $A = P + n$

- إذا طلب السؤال انه أوجد الاايش هو العنصر من الجدول الدوري فنبحث عنه حسب عدد $Z$ وليس $A$

- Chemical Bonds :-

1. Covalent bond :- between atoms by sharing electrons to form molecules (non of atoms should be metal) ($H_2O$)
2. Ionic bond :- force of attraction betwee oppositely charged ions ($NaCl$)

$NO$ / $Cl_2$ / $CO$ → diatomic molecule.

$NO$ / $CO$ → heterogeneous diatomic molecule.

$Cl_2$ / $O_2$ / $N_2$ → hemogeneous " " .

$H_2O$ → heterogeneous molecule

cation : positive ion (→ metal)
anion : Negative ion (↳ non-metal)

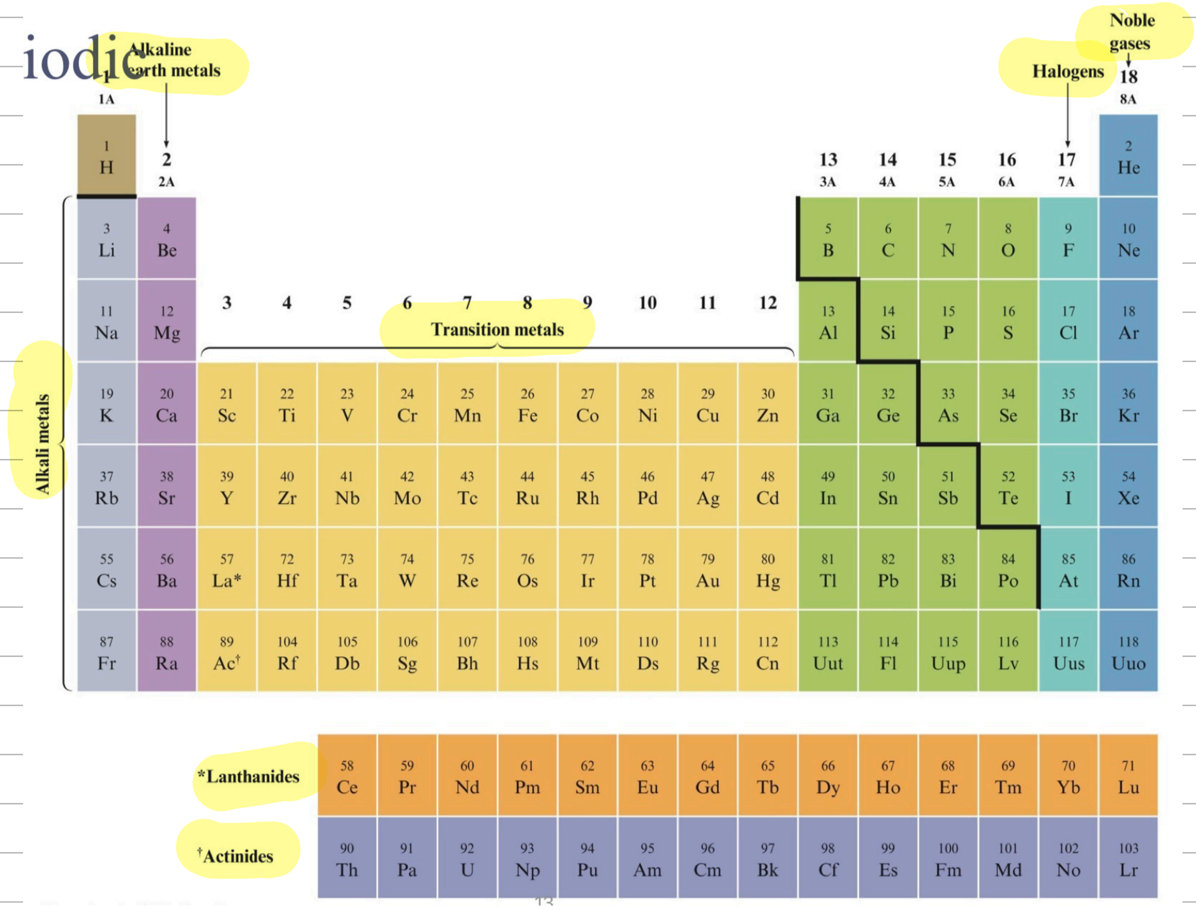
*periodic table :-

- Groups/Families :- elements in the same vertical columns ; have similar chemical properties

e.g. → Alkaline metals / Alkaline earth metals / Halogens / noble gases

- periods :- horizontal rows of elements

metals :
(representative + transition + lanthanides + actinides) elements



# * Naming compounds :

- Binary compound :- composed of two elements

1. Binary ionic compounds :- - metal + non-metal → Type I and II
  - Ionic compounds with polyatomic ions

* Type I :- NaCl → Sodium chloride

* Type II :- metals in these compounds form more than one positive charge (Fe +2, +3)
  $PbO_2$ → lead (IV) oxide
  FeS → Iron (II) sulfide

* Ionic compounds with polyatomic ions

| Name | Formula |
|---|---|
| ammonium | $NH_4^+$ |
| nitrite | $NO_2^-$ |
| nitrate | $NO_3^-$ |
| sulfite | $SO_3^{2-}$ |
| sulfate | $SO_4^{2-}$ |
| hydrogen sulfate (aka: bisulfate) | $HSO_4^-$ |
| thiosulfate | $S_2O_3^{2-}$ |
| oxalate | $C_2O_4^{2-}$ |
| hydroxide | $OH^-$ |

| IUPAC Name | older name | Formula |
|---|---|---|
| copper(I) | cuprous | $Cu^+$ |
| copper(II) | cupric | $Cu^{2+}$ |
| iron(II) | ferrous | $Fe^{2+}$ |
| iron(III) | ferric | $Fe^{3+}$ |
| lead(II) | plumbous | $Pb^{2+}$ |
| lead(IV) | plumbic | $Pb^{4+}$ |
| mercury(I) | mercurous | $Hg_2^{2+}$ |
| mercury(II) | mercuric | $Hg^{2+}$ |
| tin(II) | stannous | $Sn^{2+}$ |
| tin(IV) | stannic | $Sn^{4+}$ |

| Name | Formula |
|---|---|
| phosphite | $PO_3^{3-}$ |
| phosphate | $PO_4^{3-}$ |
| hydrogen phosphate | $HPO_4^{2-}$ |
| dihydrogen phosphate | $H_2PO_4^-$ |
| perchlorate | $ClO_4^-$ |
| chlorate | $ClO_3^-$ |
| chlorite | $ClO_2^-$ |
| hypochlorite | $ClO^-$ |
| bromate | $BrO_3^-$ |
| iodate | $IO_3^-$ |

| Name | Formula |
|---|---|
| acetate<br>acetate | $CH_3COO^-$<br>$C_2H_3O_2^-$ |
| carbonate | $CO_3^{2-}$ |
| hydrogen carbonate (aka: bicarbonate) | $HCO_3^-$ |
| chromate | $CrO_4^{2-}$ |
| dichromate | $Cr_2O_7^{2-}$ |
| permanganate | $MnO_4^-$ |
| peroxide | $O_2^{2-}$ |
| cyanide | $CN^-$ |
| cyanate | $OCN^-$ |
| thiocyanate | $SCN^-$ |

* Binary covalent compounds (Type III) :- formed between 2 non-metals

# Ch.3

- the reference for atomic masses is $^{12}C$ because its atomic masses exactly 12 a.u
- the ratio of the mass of an istope to $^{12}C$ by mass spectrometer

avogadro's number

$$1 \text{ mole of substance} = 6.022 \times 10^{23} \text{ units of that substance}$$

$$1 \text{ mole}(C) = 6.022 \times 10^{23} \text{ C atoms} = 12.01 \text{ g } (C)$$

mass for 1 mole of substance = atomic mass

For elements $\rightarrow$ $n = \dfrac{\text{mass}}{\text{atomic mass}}$

1 mole of an element = $6.022 \times 10^{23}$ atoms = atomic mass

For molecule $\rightarrow$ $n = \dfrac{\text{mass}}{M.M}$ → Molar Mass

1 mole of a compound = $6.022 \times 10^{23}$ molecules = M.M

$$\%\text{mass} = \frac{\text{mass of element in compound}}{\text{mass of compound}} \times 100\%$$

Exercise: calculate the mass percent of ethanol (C2H5OH)?

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

$M.M(C_2H_5OH) = 2(12.011) + 6(1) + 16 = 46.022$

$\text{mass}(C_2H_5OH) = 46.022 \times 1 = 46.022\text{g}$

$M.M(O_2) = 16 \times 2 = 32 \rightarrow \text{mass} = 32 \times 3 = 96$

mass of compound = $46.022 + 96 = 142.022$

$$\%\text{mass}(C_2H_5OH) = \frac{\text{mass}(C_2H_5OH)}{\text{mass of compound}} \times 100\%$$

$$= \frac{46.022}{142.022} \times 100\% = 32.405\%$$

imp. note :- Coefficients can not be fractions, although they are usualty given as lowest integer multiples.

mass of reactants = mass of products

- Stoichiometric mixing :- all reactants are consumed and converted into products
- non-stoichiometric mixing :- Limiting reactant

when the reaction is 1:1 then the lower number of moles is the L.R but when the reaction is not 1:1 then simple calculation is needed to find out the L.R

percentage yield :- an important indicator of the efficiency of a particular laboratory or industrial reaction.

من الحسابات

$$\text{Percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

من التجربة (المختبر)

# ch 4

* **electrolyte** :- Substance that when dissolved in water produces a Solution that conducts electricity ,
  ↳ depends on the amount of ions

**strong electrolyte**
↓
completly ionized in water (100% dissociation)
like :- $HCl$ / $NaOH$ / $NaCl$

**weak electrolyte**
↓
Small degree of ionization in water
lik ; $HF$ / $NH_3$ / $NH_4F$
↳ weak salt

**nonelectrolyte**
↓
doesn't produce any ions
lik: sugar

$$M = \frac{n}{V}$$

**Dilution** :- adding water to a concentrated or stock solution to achieve the molarity desired for a particular solution .

* dilution of water does not alter the number of moles of solute .

moles of solute before dilution = moles of solute after dilution

$$n = n$$

$$M_i V_i = M_f V_f$$

- Types of chemical reactions :-

1. Precipitation reactions :- one of the products is insoluble
2. Acid – Base reactions :- neutralization reactions ( النواتج ماء + ملح )
3. Oxidation – Reduction reactions (redox reactions) :- involve electron transfer

* لحساب the number of ions :-

number of ions = number of moles x avogadro's number

## * Rules for Solubility :-

1. $NO_3^-$ / $NH_4^+$ / alkaline metal (group 1A) → salts are soluble.
2. $Cl^-$ / $Br^-$ / $I^-$ → salts are soluble.
   except : ($Ag^+$, $Pb^{+2}$, $Hg_2^{+2}$)
3. Most sulfate ($SO_4^{-2}$) salts are soluble.
   except : $BaSO_4$, $PbSO_4$, $Hg_2SO_4$, $CaSO_4$
4. $BaCrO_4$ insoluble
5. Most $OH^-$, $S^{-2}$, $CO_3^{-2}$, $CrO_4^{-2}$, $PO_4^{-3}$ salts are insoluble
   except :- (group 1A, $NH_4^+$) → in rule number 1

* في ال ionic equation ال liquid وال solid بنزلهم بدون ما نفككهم

* في ال net ionic equation بنزيل ال spectator ions (الأيونات المتفرجة)

* For a strong acid / strong base reaction the net ionic equation is always :

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

* weak acid / strong base or weak base / strong acid reactions :

ex.

Molecular eqn: $CH_3COOH_{(aq)} + NaOH_{(aq)} \longrightarrow H_2O_{(l)} + CH_3COONa_{(aq)}$

ionic eqn : $CH_3COOH_{aq} + Na^+_{aq} + OH^-_{aq} \longrightarrow H_2O_{(l)} + CH_3COO^-_{aq} + Na^+_{aq}$

لا نفصلها بهذه الصورة ($CH_3COO^- + H^+$) لعدم تفككها كليًا

Net ionic eqn : $CH_3COOH_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)} + CH_3COO^-_{(aq)}$

### Rules for Assigning Oxidation States

- Oxidation state of an atom in an element = 0
- Oxidation state of monatomic ion = charge of the ion
- Oxygen = -2 in covalent compounds (except in peroxides where it = -1) H2O2
- Hydrogen = +1 in covalent compounds (except in hydrides, -1) $NH_3$
- Fluorine = -1 in compounds
- Sum of oxidation states = 0 in neutral compounds
- Sum of oxidation states = charge of the ion in ions
- LiH, NaH, H2CO3, MnO4-

* Oxidation :- increase in oxidation state , it happens by loss of electrons
(Reducing agent)
* Reduction :- decrease " " " , " " " gain of electron
(oxidizing agent)

## Ch.5

- the atmospheric pressures is measured by barometer
- the pressure of a gas confined in a container is measured by manometer
(car tire , home gas cylinder)

*** properties of gases :-**

1- uniformly fill any container and take its shape.
2. easily compressed.
3- Mixes completely with any other gas.
4- Exerts pressure on its surroundings.

$$\boxed{P = \frac{\text{force}}{\text{area}}}$$

$P \rightarrow N/m^2 = \text{pascal (pa)}$

1 atm = 101.325 Kpa = 101325 pa = 1.01325 bar = 760 mmHg
= 760 torr = 14.7 lb/in²

*** Ideal gas law :-**

$PV = nRT$ , $R = 0.08206$ L.atm/mole.K
(constant)
ممكن تختلف عن هذه القيمة
وهذا بيعتمد على وحدة (P)

$$\boxed{\frac{P_i V_i}{T_i} = \frac{P_f V_f}{T_f}}$$

- Standard Molar volume of an Ideal gas (SMV) :-

for 1 mole of an ideal gas at (0) C and 1 atm , the volume of the gas is 22.42 L

- STP :- 0 C° , 1 atm

$$\boxed{\begin{aligned} \text{density} &= d = \frac{\text{mass}}{V} \\ d &= mm \frac{P}{RT} \end{aligned}}$$

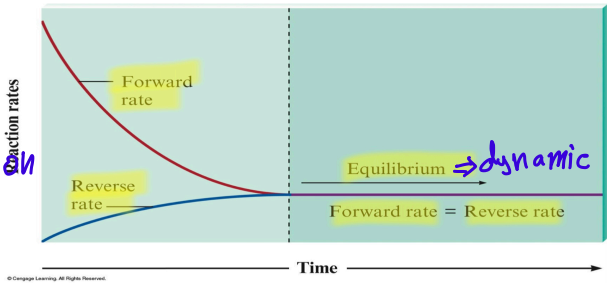
* the total pressure exerted is the sum of the pressure that each gas would exert if it were alone under the same conditions of V, T, n.

$$P_{total} = P_1 + P_2 + P_3$$ في حال كان مجموعة من الغازات في نفس ال container

## Ch.13

* After the equilibrium is reached, none of the reactants or products has a concentration of zero

* Chemical Equilibrium :-
A state of the system where the concentration of all products and reactants remain constant with time.




$$jA + kB \longrightarrow mC + nD$$

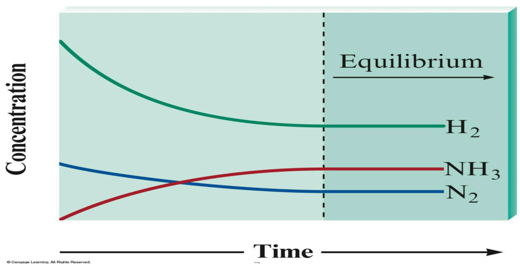
$$K = \frac{[C]^m \cdot [D]^n}{[A]^j \cdot [B]^k}$$

equilibrium expression

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

concentration decreases

increases




$$K' = \frac{1}{K}$$ في حالة التفاعل العكسي *

- When a balanced equation for a reaction is multiplied by a factor of (n)

$$K' = K^n$$

$$xX_{(g)} + yY_{(g)} \rightleftharpoons zZ_{(g)} + wW_{(g)}$$

$$K_p = \frac{P_Z^z \cdot P_W^w}{P_X^x \cdot P_Y^y} = K(RT)^{\Delta n_g}, \quad \Delta n_g = n_p - n_r$$

بس في حالة المواد الغازية

* $\Delta n_g = 0 \Rightarrow K_p = K$   * $\Delta n_g > 0 \Rightarrow K_p > K$
* $\Delta n_g < 0 \Rightarrow K_p < K$

- Homogeneous equilibria :- involve the same phas.
$(s, g, aq)$ تكون المواد الناتجة والمتفاعلة لها نفس الحالة الفيزيائية *

- Heterogeneous equilibria :- involve more than one phase.

* the position of a heterogeneous equilibrium doesn't depend on the amount of pure solid or liquids present because their concentrations are constant.

$$2KClO_{3(s)} \rightleftharpoons 2KCl_{(s)} + \underline{3}O_{2(g)} \quad , \quad P_{O_2} = 3.1 \text{ atm}$$

$$K_p = P_{O_2}^3 \quad , \quad \Delta n_g = 3 \quad , \quad K_p > K \quad , \quad K = [O_2]^3$$

* $K > 1$ means that at equilibrium the reaction system consist of mostly products or the equilibrium lies to the right.

* $K < 1$ means that " " " " " " mostly reactants or " " " to the left.

- Reaction Quotient (Q) :- used when all of the initial concentration are non-zero.

* $Q = K$ → (just at equilibrium), No shift will occur
* $Q > K$ → the System shifts to the left. After equilibrium consuming products and forming reactants, until equilibrium is achieved
* $Q < K$ → " " " " right. Before " " reactants " " products " " ".

- K will change depending upon the temperature.

* Endothermic reaction :- energ is a reactant, K increase, shift to right
* Exothermic reaction :- " " a product, K decrease, shift to left

- Pressure effect K when at least one of the reactants is gas
- Addition of inert gas doesn't affect the equilibrium position.

- **Arrhenius :-**
  * acids :- produce $H^+$
  * bases :- produce $OH^-$

- **Bronsted – lowry :-**
  * acids :- proton ($H^+$) donor
  * bases :- proton ($H^+$) acceptor

→ HA / A⁻ acid/base conjugate pair

→ Conjugate acid/base pair are related by one proton tranfer

- **Lewis :-**
  * acids :- electron pair acceptor
  * bases :- electron pair donor

- **Strong acid :-**
  Ionization equilibrium lies far to the right.
  Yields a weak conjugate base. → ضعيف جداً جداً

- **Strong base :-** → نفس الفكرة
  yield a weak conjugate acid.

- **Weak acid :-** weak base → نفس الفكرة
  Ionization equilibrium lies far to the left.
  The weake the acid, the stronger its conjugate base

* water is amphoteric (auto ionization) : behaves either as an acid or as a base.

$$K_w = [H^+].[OH^-] = 1 \times 10^{-14} \text{ at } 25\,C^\circ$$

* $[H^+] = [OH^-] \Rightarrow pH = 7$ (neutral)
* $[H^+] > [OH^-] \Rightarrow pH < 7$ (acidic)
* $[H^+] < [OH^-] \Rightarrow pH > 7$ (basic

- If the equilibrium lies to the right, $K_a / K_b > 1$
  لأنه تركيز النواتج يكون أعلى
- " " " " " left, $K_a / K_b < 1$
  لأنه تركيز المتفاعلات يكون أعلى

$$K_a = \frac{[H_3O^+][A^-]}{[HA]} \quad , \quad K_b = \frac{[OH^-][BH^+]}{[B]}$$

- The number of decimal places in the log is equal to the number of Significant figures in the original number.

2 S.F

$$[H^+] = 1.0 \times 10^{-9}\ M$$

$$pH = 9.\underline{00}$$

2 decimal places

$pH = -\log [H^+]$ , $pOH = -\log [OH^-]$ , $pH + pOH = 14$

* إذا سأل عن مكونات المحلول لحمض قوي / قاعدة قوية بتكون

- في حالة الحمض القوي :- القاعدة المرافقة / $H_2O$ / $H^+$ - في حالة القاعدة القوية: الحمض المرافق / $H_2O$ / $OH^-$

* Two factors for acidity in binary compounds :-

1. Bond polarity : كلما زادت القطبية (الفرق في الكهروسلبية) بتزيد قوة الحمض

2. Bond Strength : كل ما زادت بتقل قوة الحمض لهيك الحمض القوي مثل HCl بتكون الرابطة ما بين $H^+$ و $Cl^-$ ضعيفة جدا فبسهل من تفككها

* Oxyacids :- $H-O-X$ ($HOCl$ , $HOBr$)

- كلما زادت عدد ذرات ال $O_2$ بتزيد قوة الحمض (لأنه $O_2$ بتعمل على زيادة القطبية)
- كما زادت قدرة $X$ على انها تجذب ال $e^-$ نحوها بتزيد قوة الحمض (لأنه يؤدي إلى زيادة الفرق في الكهروسلبية).

فهم مش حفظ

* Oxides :-

- Acidic oxides (acid Anhydrides) :- $O-X$ is strong and covalent. ($SO_2$ , $NO_2$ , $CO_2$)

- بتفاعلوا مع ال $H_2O$ فبيتكون حمض وهو الذي يجعل المحلول حمضي

$$SO_{2\,(g)} + H_2O_{(l)} \longrightarrow H_2SO_{3\,(aq)}$$

يتفكك الينتج ($H^+$)

- Basic oxides (basic Anhydrides): O−X bond is ionic ($K_2O$, $CaO$)

X has a very low electronegativity

- يتفاعل مع ال $H_2O$ و بتكون قاعدة وهي التي تجعل المحلول قاعدي

$$K_2O_{(s)} + H_2O_{(l)} \longrightarrow 2KOH_{(aq)}$$

يتفكك لينتج ($OH^-$)

- Buffer Solutions resist a change in pH

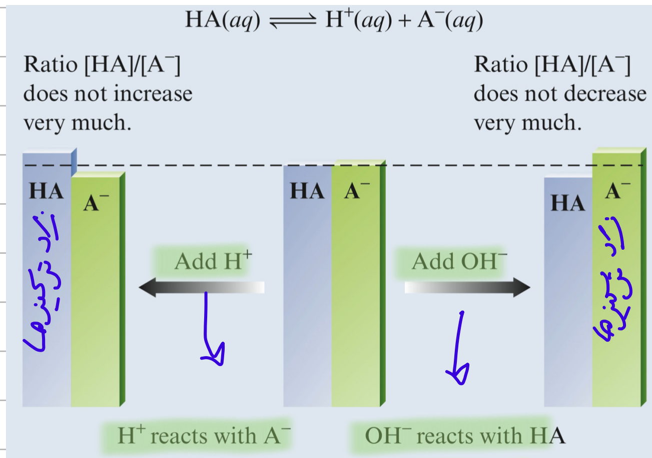
Buffer :- weak acid and its conjugate base
weak base and its conjugate acid

- Hendrson–Hasselbalch equation :-

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

$$pOH = pK_b + \log \frac{[BH^+]}{[B]}$$

* تعتمد ال pH لل buffer على النسبة بين الحمض الضعيف وقاعدته المرافقة وبتظل قيمة ال pH ثابتة مادام هذه النسبة ثابتة (إذا كان تركيز مكونات ال buffer أعلى من تركيز $H^+$ و $OH^-$ المضاف)




Effect of added $H^+$ or $OH^-$ on a buffered system.

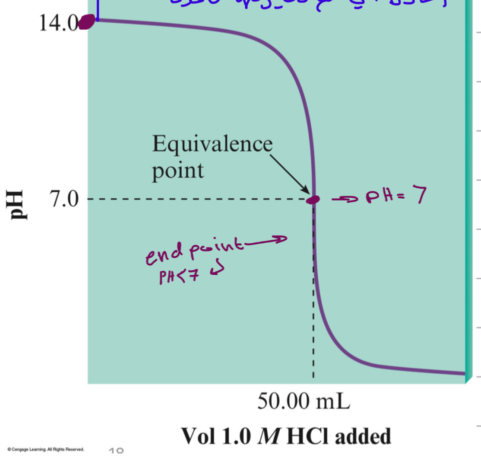
- Titration Curve

* Equivalence (Stoichiometric) point:
النقطة التي تتعادل فيها جميع مولات المضاف (سواء حمض / قاعدة) مع الحمض / القاعدة إلي بدنا نعايرها
و تكون pH = 7 (في حال كانت المعايرة بين حمض قوي و قاعدة قوية)

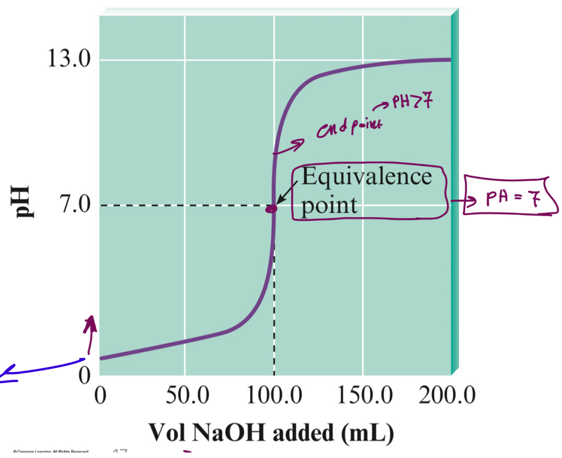
* end point :- هي إلي بتحدد انتهاء المعايرة وبتكون قريبة من نقطة التكافؤ ومدى قربها بيعتمد على الدقة في المعايرة

*معلومة إضافية :-
- عند معايرة حمض ضعيف بقاعدة قوية تكون ال pH عند نقطة التكافؤ > 7
- عند معايرة قاعدة ضعيفة بحمض قوي تكون ال pH عند نقطة التكافؤ < 7

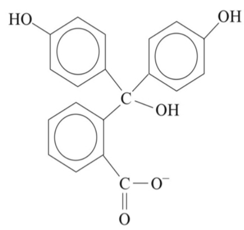
ال PH الابتدائية > 7 إذن
الحالة التي تتم معايرتها قاعدة



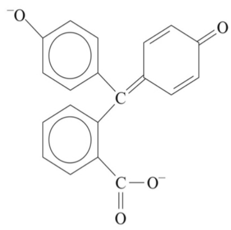

ال pH الابتدائية < 7 إذن
الحالة التي تتم معايرتها هي حمض




phenolphthalein →




Colorless acid form, HIn




Pink base form, $In^-$

* Methyl orange :- yellow in basic
red in acidic