ElCoM
ELECTRICAL COMPUTER MECHATRONICS

تقدم لجنة ElCoM الاكاديمية

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CH3: Relationships in chemical Reaction

mole = $6{,}02 \times 10^{23}$

Dozen = 12 object

Particle

atoms	molecule
Na, H	NaCl
He, Cl	HCl

- 1 mole O_2 molecule = $6{,}02 \times 10^{23}$ O_2 molecule
- 1 mole O_2 atom = $6{,}02 \times 10^{23}$ O atom.

* How many atom of c (carbon) in ,6 mole c atom?

$$\begin{array}{lcl} 1\text{ mole (C)} & \rightarrow & 6{,}02 \times 10^{23}\ \text{(C) atom} \\ ,6\text{ mole (C)} & \rightarrow & ??\quad x \end{array}$$

$$6{,}02 \times 10^{23} \times ,6 = x$$

$$= 3{,}612 \times 10^{23}\ \text{atom}$$

* How many mole of c atom in $3{,}01 \times 10^{23}$ atom c?

$$\begin{array}{lcl} 1\text{ mole (C)} & \rightarrow & 6{,}02 \times 10^{23} \\ x\ ?? & \rightarrow & 3{,}01 \times 10^{23} \end{array}$$

$$3{,}01 \times 10^{23} = x * 6{,}02 \times 10^{23}$$

,5 mole atom

$$\frac{1\ \text{Mole --}}{\text{Molar Mass}}$$ - Mole Factor

$$\frac{1\ \text{Mole (C)}}{12g(C)} \qquad \frac{1\ \text{Mole ---}}{6{,}02\times10^{23}\ \text{atom}} \quad , \quad \frac{6{,}02\times10^{23}\ \text{atom}}{1\ \text{Mole ---}}$$

*How many molecule of H_2O in 20 Mole H_2O molecule?

$$20\,\cancel{\underline{\text{Mole}}\ H_2O\ \text{molecule}} \times \frac{6{,}02\times10^{23}\ H_2O\ \text{molecule}}{1\cancel{\text{Mole}\ H_2O.\ \text{molecule}}}$$

$120{,}4\times10^{23}$ H_2O molecule

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* Molar Mass

1 Mole = $6{,}02\times10^{23}$

1 Mole = Molar Mass

1 Mole $\underline{C}$ atom = 12 g(C) atom

?? = 6(g) C atom

$\frac{6}{12}$

,5 Mole C atom

* How many grams of Na in ,7 mole Na atom?

$$\boxed{,7}\ \cancel{\text{mole Na}} \times \boxed{\frac{23\ g\ Na}{1\ \cancel{\text{mole Na}}}}$$

16,1 g(Na)

* How many atom of Na in 98,5 g Na?

$g \rightarrow mole \rightarrow atom$

$$98{,}5\ \cancel{g(Na)} \times \frac{1\ \cancel{\text{mole Na}}}{23\ \cancel{g(Na)}} \times \frac{6{,}02\times10^{23}\ \text{atom}}{1\ \cancel{\text{mole Na}}} = 25{,}7\ \text{atom (Na)}$$

$\boxed{1\ CO_2}$

$12 + (16\times2) = 44$

$$\frac{1\ \text{Molecule } CO_2}{1(C)\ \text{atom}} \quad / \quad \frac{1\ \text{Molecule } CO_2}{2\ (O)\ \text{atom}}$$

* How many (O) atom in 6 g CO_2?

$$6\ \cancel{g\ CO_2} \times \frac{1\ \cancel{\text{mole } CO_2}}{44\ \cancel{g(CO_2)}} \times \frac{6{,}02\times10^{23}\ \cancel{CO_2\ \text{molecules}}}{1\ \cancel{\text{mole } CO_2}} \times \frac{2(O)\ \text{atom}}{1\ \text{Molecule } CO_2}$$

1,64 (O) atom

* Mole chemical Reaction

* How many mole of Fe_2O_3 produced when 6 Mole O_2 reacted?

$$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$$

3 Mole O_2 → 2 Mole Fe_2O_3

6 Mole O_2 → ??

4 Mole Fe_2O_3

$$6\,\cancel{\text{Mole } O_2} \times \frac{2\,\text{Mole } Fe_2O_3}{3\,\cancel{\text{Mole } O_2}} = 4\,\text{Mole } Fe_2O_3$$

* How many grams of Fe_2O_3 produced when 6 Mol O_2 reacted?

$$6\,\cancel{\text{Mole } O_2} \times \frac{2\,\cancel{\text{Mole } Fe_2O_3}}{3\,\cancel{\text{Mole } O_2}} \times \frac{160\text{ g}}{1\,\cancel{\text{Mole } Fe_2O_3}} = 640\text{ g } Fe_2O_3$$

* How many grams of Fe_2O_3 produced when 192g O_2 reated

$$192\,\cancel{\text{g } O_2} \times \frac{1\,\cancel{\text{Mole } O_2}}{32\,\cancel{\text{g}}} \times \frac{2\,\cancel{\text{Mole } Fe_2O_3}}{3\,\cancel{\text{Mole } O_2}} \times \frac{160\text{ g } Fe_2O_3}{1\,\cancel{\text{Mole } Fe_2O_3}}$$

$$= 640\text{ g } Fe_2O_3$$

* Limiting Reagent

$$\overset{5}{\underline{\underline{2H_2}}} + \overset{7}{O_2} \longrightarrow 2H_2O$$

10 Mole H_2 7 Mole O_2 → 2 Mole

∴ Limiting Reagent

Ex:- 12g Zn react with 6.5g S according to the following Rxn

$$\overset{,18}{Zn} + \overset{,202}{S} \longrightarrow ZnS$$

[1] predict Limiting Reagent $\boxed{\underline{Zn}}$

$$12\cancel{g\,Zn} \times \frac{1\,Mole}{65,38\,\cancel{g\,Zn}} = ,18\ Mole\ Zn$$

$$6,5\,\cancel{g\,S} \times \frac{1\,Mole}{32,065\,\cancel{g\,S}} = ,202\ Mole\ \cancel{Zn}S$$

[2] calculate grams for excess Reagent

$$,202 - ,18 = ,022 \text{ mole (s)}$$

$$,022 \cancel{\text{mole}} \times \frac{32,065\ (g)}{\text{moles}} = ,705\ \cancel{g}\ (s)$$

[3] calculate grams of ZnS

$$,18 \cancel{\text{mole Zn}} \times \frac{1 \cancel{\text{mole ZnS}}}{1 \cancel{\text{mole Zn}}} \times \frac{97,445\ (g)\ \text{ZnS}}{1 \cancel{\text{mole ZnS}}} = 17,54\ (g)\ \text{ZnS}$$

[4] calculate The persent yield for Zn if 8g ZnS produced experimentaly

$$\frac{8}{17,54} \times 100\%$$

$$= 45\%$$

* 5g Al react with 5g O_2 to produce Al_2O_3, according to this following Rxn. calculate the grams of Al_2O_3

$$\overset{,046}{4Al} + \overset{,052}{3O_2} \rightarrow 2Al_2O_3$$

$$5\,\cancel{g\,Al.} \times \frac{1\,Mole}{27\,\cancel{g\,Al}} = ,185\ Mole\ Al.$$

$$5g\,O_2 \times \frac{1\,Mole}{32\,g\,O_2} = ,156\ Mole\ O_2$$

$$,185\,\cancel{Mole\,Al.} \times \frac{2\,Mole\,\cancel{Al_2O_3}}{4\,\cancel{Mole\,Al}} \times \frac{102\,Al_2O_3\,(g)}{1\,\cancel{Mole\,Al_2O_3}}$$

$$\boxed{9,4\,g}$$

* % of element in compounds

M.M $C_6H_{12}O_6$ = 180

1 %C in $C_6H_{12}O_6$ $\frac{6 \times 12}{180} \times 100\% = 40\%$

2 % O in $C_6H_{12}O_6$ 53,4%

3 %H in $C_6H_{12}O_6$ 6,6%

100 - 93,4 = 6,6%

$$* \frac{\text{number of element} \times \text{M.M (element)}}{\text{M.M (compounds)}} \times 100\%$$

* what is mass persent of Na in ($NaHCO_3$)?

M.M = 83,9

A) 1,2%

B) 14,3%

[✓ C)] 57,1%

D) 27,4%

$$\frac{1 \times 22,9}{83,9} \times 100\%$$

* The empirical and molecular formula

$(CH_2O)\times 6_n \rightarrow C_6H_{12}O_6$

- what is empirical formula of compound contain 85,7% by mass (C) and 14,3% by mass (H) ?

$85,7\%\ (C) \rightarrow 85,7(g)\ (C) \times \frac{1\ mole}{12\ g(C)} = \frac{7,14\ mole\ (C)}{7,14} = 10\ mole\ (C)$

$14,3\%\ (H) \rightarrow 14,3(g)\ (H) \times \frac{1\ mole}{1\ g(H)} = \frac{14,3\ mole(H)}{7,14} = 2\ mole\ (H)$

1 C

1 H $>$ CH_2

* White powder is analyzed and found to contain 43,64% (P) and 56,3% (O) by mass (Molar mass of compound = 283,88 g Mol)

what is [I] empirical formula P_2O_5

[II] Molecular formula P_4O_{10}

2,5

2,3 × 3

7,9

$43,64\%\ (P) \rightarrow 43,64(g) \times \frac{1\,\text{Mole}}{30,99\ (P)} = 1,41\ \text{Mole}\ (P) = 1\ \text{Mole}\ (P)$

×2 2 Mole P

$56,3\%\ (O) \rightarrow 56,3(g) \times \frac{1\,\text{Mole}}{16\,g\ O} = 3,51\ \text{Mole}\ (O) = \underset{\times 2}{2,5}\ \text{Mole}\ (O)$

5 Mol

$$n = \frac{\text{M.M Molecular formula}}{\text{M.M empirical formula}} = \frac{283,88}{142} = 2$$

$$(P_2O_5) \times 2 \xrightarrow{\text{Molecular}} P_4O_{10}$$

* اسئلة تشاتشات CH3

Q1: How many atoms are in 4,30g of CO_2?

↳ mm = 44

$\boxed{1.}$ $1,80 \times 10^{23}$ atoms

2. $6,01 \times 10^{22}$ atoms

3- $1,16 \times 10^{26}$ atoms

4. $6,04 \times 10^{24}$ atoms

$$4,3\,\cancel{g\,CO_2} \times \frac{1\,mole\,CO_2}{44\,\cancel{g\,CO_2}} \times \frac{6,02 \times 10^{23}}{1\,mole\,CO_2} \times 3$$

Q2: How many oxygen atoms are there in 5,00g of ($Na_2Cr_2O_7$) [molar mass of $Na_2Cr_2O_7$ = 261,97 g/mol]

1- $1,64 \times 10^{21}$ Oxygen atoms

$\boxed{2.}$ $8,04 \times 10^{22}$ oxygen atoms

3- $1,15 \times 10^{22}$ oxygen atom

4. $,133 \times 10^{4}$ oxygen atom

$$5g\,\cancel{Na_2Cr_2O_7} \times \frac{1\,Mole}{261,97\,\cancel{g}} \times \frac{6,02 \times 10^{23}\,\cancel{molecle}}{1\,\cancel{Mole}} \times \frac{7\,O\,atom}{1\,\cancel{molucle}}$$

$$18 \times 10^{23}$$

$$8 \times 10^{22}$$

Q3:- $C_2H_5OH_{(l)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}$

if the density of ethanol (C_2H_5OH) is ,789 g/ml, How many milliliters of ethanol are needed to produce 20 g of CO_2? molar mass [H=1, C=12, O=16]

$D = \frac{m}{\boxed{V}}$

1- 8,86 ml

$\boxed{2}$ 13,3 ml

3- 26,5 ml

4- 53,1 ml

$20 g CO_2 \times \frac{1 mole CO_2}{44 g CO_2} \times \frac{1 mole of ethanol}{2 mole CO_2} \times \frac{46 g}{1 mole ethanol}$

10,45 g ethanol

$,789 = \frac{10,45}{V}$

Q4:- combustion analysis of ,6 g of an unknown compound containing carbon, hydrogen and oxygen produced 1,043 g of CO_2 and ,567 g H_2O, what is empirical formula of the compound? [m.m. C=12, O=16, H=1]

1- $C_2H_{10}O_3$

2- C_2H_5O

3- $C_2H_5O_2$

$\boxed{4-}$ $C_3H_8O_2$

$m_C = X_C \, m_T$ $\quad C = ,28$

$m_C = \frac{12}{44} \times 1,043$ $\quad C = ,02 \text{ mol} = \frac{3}{2} \times 2$

$m_H = \frac{2}{18} \times ,567$ $\quad m_H = ,063 \rightarrow ,063 \text{ mol}$ $\quad 4 \times 2$

$m_O = ,6 - (,28 + ,063)$ $\quad m_O = ,257$ $\rightarrow ,016 \text{ mol}$ $\quad 1 \times 2$

$C_3H_8O_2$

Q5: Combustion analysis of ,150g of an unknown compound containing carbon, hydrogen and oxygen produced ,2607g of CO_2 and ,1418g of H_2O, what is the empirical formula of the compound? M.M C=12

O=16

H=1

$M_C = \frac{12}{44} \times ,2607 = ,0711\,g \rightarrow ,006$

1- $C_2H_3O_2$

$M_H = \frac{2}{18} \times ,1418 = ,0157\,g$

2- C_2H_5O

$\boxed{3-}$ $C_3H_8O_2$ $M_O = ,15 - (,0711 + ,0157) = ,0632 = ,004$ mol

4- $C_2H_{10}O_3$

$C \rightarrow 1 \times 2$ $O \rightarrow 2$

$H \rightarrow 4 \times 2$ $H \rightarrow 8$

$C \rightarrow \frac{3}{2} \times 2$ $C \rightarrow 3$

$C_3H_8O_2$

Q6: 1 Mole of which of the following will contain the largest number of atoms?   1 Mole = $6,02 \times 10^{23}$ atom

1- Argon (atomic mass = 39,9 g/mol)

2- silver (atomic mass = 107,8 g/mol)

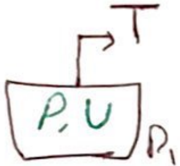
3- Magnesium (atomic mass = 24,3 g/mol)

$\boxed{4.}$ 1 Mole of any element will contain the same number of atoms

CH5:- Gass

- Boyles low

$\underline{\underline{P_1V_1 = P_2V_2}}$



$\overset{P_1}{1} \times \overset{V_1}{8} = 8 \doteqdot P_2 \times V_2$

$2 \times V_2 = 8$

$2 \times 4 = 8$

$P_1 \times V_1 = \boxed{\text{ثابت}} = \underrightarrow{P_2 V_2}$

Ex:- sample of the gas is $\overset{V_1}{6,4L}$ at pressure $\overset{P_1}{0,7}$atm, what will be new volume If the pressure chang to 1,4 atm

$P_1 V_1 = P_2 V_2$

$,7 \times 6,4 = 1,4 \times V_2$

$$V_2 = \cancel{1,4}\ \frac{\cancel{,7} \times 6,4}{\cancel{1,4}\ 2} = \underline{\underline{3,2L}}$$

- charles law $\boxed{T, V} \to \underline{\underline{P}}$ $\boxed{K = C + 273}$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

V_1 420×10^{-3} T_1 $18 + 273 =$ T_2

Ex: sample of oxgen gas has Volume 420ml at temp 18C° what temp (in C°) is needed to change the Volume to (640ml)?

V_2 $\overline{640 \times 10^{-3}}$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{420 \times 10^{-3}}{18 + 273} = \frac{640 \times 10^{-3}}{T_2}$$

$7488\,K = T_2$ $7488 = C + 273$

$T_2 = 7215$

- gay - lussac's law $\boxed{P, T} \to V$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

P_1 T_1

Ex: sample of He gas has pressure of 20atm at temp 18C° what pressure in mmHg if the temp resen to 62C°

T_2

$1atm = 760mmHg$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \to \frac{20}{(18+273)} = \frac{P_2}{(62+273)}$$

$P_2 = 23{,}02 \times 760$

$17498{,}2\,mmHg$

* combind gas low

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

T	$P_1 V_1 = P_2 V_2$
P	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
V	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Ex: sample of He gas has volume of $\underset{}{\overset{V_1}{\underline{,18L}}}$ apressure of $\overset{P_1}{\underline{,8atm}}$ and $\overset{T_1 (29+273)}{\text{temp } \underline{29°C}}$ what is the new $\underset{T_2}{\underline{\text{temp}}}$ in $\underline{\underline{(C)}}$ if the gas at volume of $\underset{V_2 = 90 \times 10^{-3}}{90 mL}$ and pressure $\underset{\sim}{3,2}$atm?

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{,8 \times ,18}{\cancel{19}\ 302} = \frac{3,2 \times ,09}{T_2}$$

$T_2 = 6045 - 273$

$\boxed{T_2 = 331°C}$

STP

- standard condition
- Temp = 273 K
- pressure = 1atm / 760 mmHg
- 1mol gas = 22,4 L

$P_1 = $ ~~760 mmHg~~ 1atm $T_1 = 273$

Ex: sample of neon gas has volume of $\overset{V_1}{15L}$ at STP what is the volume of the gas at $\underset{P_2}{2atm}$ and -25 C° → ~~P~~ $T_2 = 248K$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{1 \times 15}{273} = \frac{2 \times V_2}{248}$$

$V_2 = 6,8$ atm

Ex: How many grams of CH_4 needed at STP to obtain 11,2L CH_4?

↳ T = 273

P = 1atm

1 mole gas = 22,4L

$$11{,}2\cancel{L} \times \frac{1\,\cancel{\text{mole } CH_4}}{22{,}4\,\cancel{L}} \times \frac{16g}{1\,\cancel{\text{mole } CH_4}}$$

$$\boxed{8g}$$

Ex: Cylinder contain 2g He, How many grams of He were added to the cylinder if the volume was changed from 2L to 2,7L?

2g He
2L

?g
2,7L

$$\boxed{\frac{V_1}{n_1} = \frac{V_2}{n_2}}$$

$$\frac{2}{,5} = \frac{2{,}7}{n_2}$$

$$2g\,He \times \frac{1\,\text{mole}}{4g\,He} = \boxed{,5\,\text{mole } He}$$

$$n_2 = ,675$$

$$,675\,\cancel{\text{mole}} \times \frac{4g}{1\,\cancel{\text{mole}}}$$

Mass = ,7g

$\frac{\text{mass}}{\text{molar}}$

$V \alpha \frac{1}{P}$, $V \alpha T$, $V \alpha n$

$PV = nRT$
- molar mass.
- mass ✓
- Density

$\boxed{PV = RTn}$

$V \alpha \frac{Tn}{P}$

$V = \frac{RTn}{P}$

* mass of gas

Ex: $\overset{V}{5L}$ cylinder contain $\overset{32 \quad O_2}{\text{oxygen}}$ gas at $\overset{T}{20c°}$ and $\overset{P}{735}$ mmHg How many grams of O_2 are in the cylinder ,R=,0821

$20+273$

$R = 62,4$

$P * V = nRT$

$795 \times 5 = n\ 62,4 \times 293$

$n = n$

$n = \frac{\text{mass}}{32}$

mass = 6,4g

Ex: what is the molar mass of gas if $\overset{\text{mass}}{,25g}$ of the gas 215ml at ,813atm and 30c° ,R = ,0821

215×10^{-3}

$30+273$

303

$PV = nRT$

$,813 \times ,215 = n\ ,0821 \times 303$

$n = 7,02 \times 10^{-3}$

$7,02 \times 10^{-3} = \frac{,25}{M.M}$

M.M = 35,56

- Density of gas

$$PV = \overset{\curvearrowright \frac{m}{M.wt}}{n}RT$$

$$\boxed{d = \frac{M.wt\ P}{RT}}$$

$\hookrightarrow P = 1atm$

$T = 273$

Ex: calculate the density of O_2 at stp

$$d = \frac{32 \times 1}{10821 \times 273}$$

$d = 1,4 g/L$

~~Ex:~~ * Dalton's law

$$P_T = P_1 + P_2 + P_3 \text{ ------}$$

$$P_T = P_{He} + P_{O_2}$$

He, O_2

$P_{He} = n_{He}\frac{RT}{V}$

$P_{O_2} = n_{O_2}\frac{RT}{V}$

$P_T = (n_{He} + n_{O_2}) \times \frac{RT}{V}$

$P_T = n_{He}\frac{RT}{V} + n_{O_2}\frac{RT}{V}$

25+273

Ex: 5L cylinder contain ,05 mole of O_2 and ,418 mole of H_2 at 25 C° $\boxed{8}$
what partial pressure for each gas (The total pressure, R = ,0821)

$$P_{O_2} = \frac{nRT}{V} \rightarrow P_{O_2} = \frac{,05 \times ,0821 \times (25+273)}{5}$$

$$= \cancel{8,10}\ 5,6 \text{ atm}$$

$$P_{H_2} = \frac{,418 \times ,0821 \times (25+273)}{5}$$

$$= 2,04 \text{ atm}$$

$$P_T = 5,6 + 2,04$$

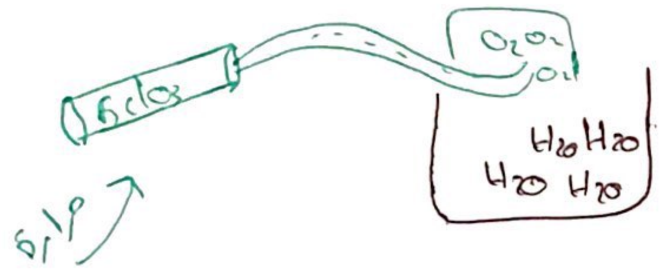
$$= 7,64 \text{ atm}$$

Ex: NH_3 decomposes to N_2 and H_2 ($2NH_3 \rightarrow N_2 + 3H_2$)
If 4 atm of NH_3 decompounes calculate the total pesser when the Reaction finished

$$\frac{P_1}{P_T} = \frac{n_1 \cancel{\frac{RT}{V}}}{n_T \cancel{\frac{RT}{V}}} \qquad \frac{4}{P_T} = \frac{2}{4}$$

$$P_T = 8 \text{ atm}$$

* collecting gas over water



$$2KClO_{3(s)} \xrightarrow{\Delta} 2KCl_{(s)} + 3O_{2(g)}$$

$$P_T = P_{O_2} + P_{H_2O}$$

$$P_T = P_{gas} + P_{H_2O}$$

Ex: An unknown gas was collected over water at $\overset{300K}{27C°}$, the total pressure was 750 atm and volume 37,5 mL and the gas mass ,0873g. if the water pressure 26,98 atm what is the molar mass of the gass ! R = ,0821

$$P_T = P_{gas} + P_{H_2O}$$

$$750 = P_{gas} + 26,98$$

$$P_{gas} = 723,02$$

$$PV = \frac{mass}{M.M} RT$$

$$M.M = \frac{m RT}{PV}$$

$$= \frac{,0873 \times ,0821 \times 300}{723,02 \times ,0375}$$

$$M.M = ,07$$

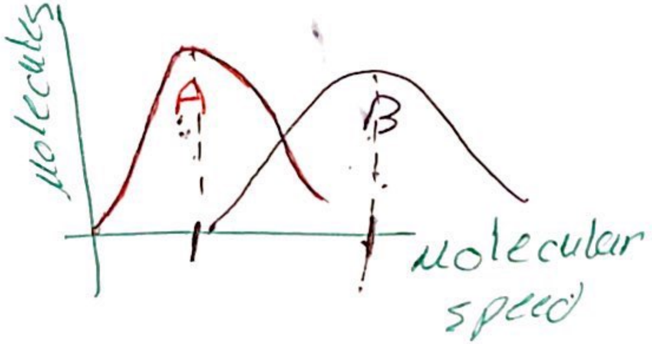
* kinetic - Molecular theory

He , H_2 , O_2 , Ne , Cl_2 , CH_4

M.M → 4 , 2 , 32 , 28 , 71 , 16

$H_2 > He > CH_4 > Ne > O_2 > Cl_2$

* which gases will effuses Faster



B

Molar Mas A > M.MB

tempB > tempA

درجة الحرارة ← كلما زادة درجة الحرارة تزداد سرعة الغاز ,

الكتلة المولية ← كلما زادت الكتلة المولية قلت سرعة الغاز ;

* speed of gass
rate of effusion $\Rightarrow$ $\mu = \sqrt{\frac{3RT}{M.M}}$

Ex: calculate the speed of gas (sample of helium gas) at 25 C°

M.M = 4

25+273
= 298

R = 8,314.

$$\mu = \sqrt{\frac{3RT}{M.M.}}$$

$$= \sqrt{\frac{3 \times 8{,}314 \times 298}{4 \times 10^{-3}}} = 1360 \, m/s$$

* graham's law → $\frac{\mu_1}{\mu_2} = \sqrt{\frac{M.M_2}{M.M_1}}$

$$\frac{\mu_1}{\mu_2} = \frac{\sqrt{\frac{\cancel{3RT}}{M.M_1}}}{\sqrt{\frac{\cancel{3RT}}{M.M_2}}} \rightarrow \frac{\mu_1}{\mu_2} = \sqrt{\frac{M.M_2}{M.M_1}}$$

NH_3

* which gases will effuses Faster ammonia (NH_3) or carbon dioxide (CO_2)

what are their relative rate of effusion

$M.M = 17$ $M.M = 44$

$$\frac{M_1}{M_2} = \sqrt{\frac{M.M_2}{M.M_1}}$$

$$\frac{M_{NH_3}}{N_{CO_2}} = \sqrt{\frac{44}{17}} = 1{,}6$$

* An unknown gas composed (X_2) molecules effuses at a rate that is only ,855 times than O_2 at the same temp, what is the of unknown gas

$$\frac{M_{X_2}}{M_{O_2}} = \sqrt{\frac{M.M_2}{M.M_1}}$$

$$,855 = \sqrt{\frac{32}{X_2}} \Rightarrow X_2 = 254$$

$$X = 127$$

CH5 *اسئلة شاشات

1- A balloon filled withe helium gas at $\overset{T_1}{20c}$, $\overset{V}{6,91L}$ at $\overset{P_1}{1}$ atm, The balloon is immersed in liquid nitrogen at $\overset{T_2}{-196c}$ raising the ~~pre~~ pressure to $\overset{P_2}{5,2}$ atm, what is the volume of the balloon in the liquid nitrogen.

$\boxed{1-}$,35L

2. 9,41

3- 140L

4- 5,11

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$T_1 = 293K$

$T_2 = 77$

$$\frac{1 \times 6,91}{293} = \frac{5,2 \times V_2}{77}$$

2- $CaH_{2(s)} + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)} + 2H_{2(g)}$

How many grams of CaH_2 are needed to generat 48L of H_2 gas at a pressure ,811 atm and a temp of 32°c?

$\downarrow$ 305

1- 65,4

$\boxed{2}$ 32,1

3- 46,3

4- ,718

$PV = nRT$

$,811 \times 48 = n \; ,0821 \times 305$

$n = 1,55 \text{ mol } H_2$

$$1,55 \text{ mole } H_2 \times \frac{1 \text{ mole } CaH_2}{2 \text{ mole } H_2} \times \frac{42,08 \text{ g}}{1 \text{ mole } CaH_2}$$

3- A mixture of 22 grams of $H_{2(g)}$ and 10,4 g of CH_4 If the total pressure is measured at 2,98 atm, the partial pressure of $H_{2(g)}$ must be ___ atm

M.M [$H_2 = 2$, $CH_4 = 16$]

$$P_{H_2} = X_{H_2} * P_T$$

1- 31,9

$\boxed{2-}$ 2,76

3- ,164

4- 33,8

$$X_{H_2} = \frac{\text{Mole } H_2}{\text{Mole } H_2 + \text{Mole } CH_4}$$

$$P_{H_2} = ,94 \times 2,98$$

$$= \frac{11}{11 + ,65}$$

$$= ,94$$

4- A mixture of 20.6 grams of $He_{(g)}$ and 12 grams of CH_4 if the total pressure is measured at 3,21 atm. The partial pressure of H_2 must be ---atm.

M.M [$H_2 = 2$ $CH_4 = 16$]

$$P_{H_2} = X_{H_2} \times P_T$$

$$,93 \times 3,21$$

1- 35,2

2- 6,03

3- ,219

$\boxed{4}$- 2,99

$$X_{H_2} = \frac{10,3}{10,3 + ,75} = ,93$$

5. which of the following would have density of 1,21 g/L at 7c° and ,987 atm? given MolarMass

[Ar=40, O=16, N=14, Ne=20, R=,0821)

1-O_2 = 32

$\boxed{2}$- N_2 = 28

3 - Nc = 20

4 - Ar = 40

$$D = \frac{M.MP}{RT}$$

$$\frac{DRT}{P} = M.M$$

6- Calculate the Molar Mass of unknown gas, if oxygen gas(O_2) effuses at rate equal to three times that of unknown gas (M.M O=16)

1-96

2-4

3.55

$\boxed{4}$-288

$$\frac{M_{1O_2}}{M_{2x}} = \sqrt{\frac{M.M_{2x}}{M.M_{1O_2}}}$$

$$3 = \sqrt{\frac{X}{32}}$$

$$9 = \frac{\overset{M.M}{X}}{32}$$

* CH11: InterMolcular forces and liquids and solids.

- IntraMoleculor forces

1- Ionic bond (فلز - لافلز)

Na⊖Cl

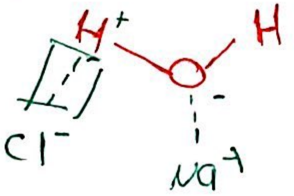
2- Covalent bond (لافلز - لافلز)

H⊖Cl

- InterMolecular forces

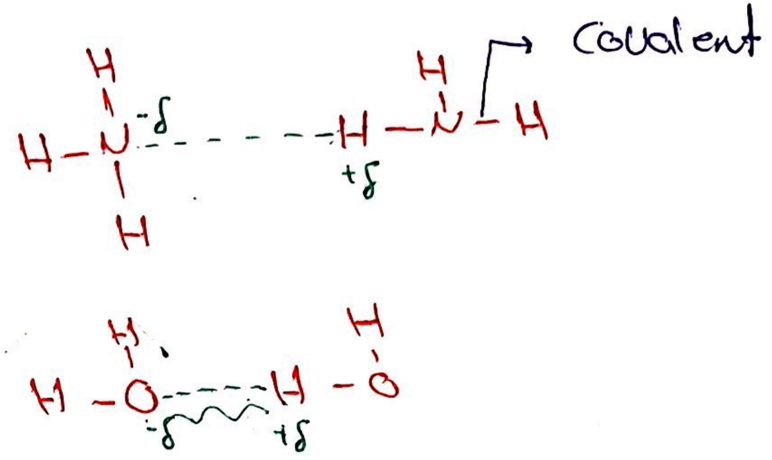
1- Ion-dipole

NaCl



2- Hydrogen bond

- N---H
- O---H
- F---H



* which of the following have hydrogen bond

A) H_2

B) CH_4

[✓ C)] NH_3

D) PH_3

3- Dipols - Dipols

$H-\overset{-\delta}{Cl}\cdots\overset{+\delta}{H}-Cl$

$C\equiv\overset{-\delta}{O}\cdots\overset{+\delta}{C}\equiv O$

4. london Froces

- X_2 $(H_2, O_2, Cl_2, F_2 -)$ $H_2 \cdots H_2$
- Nobel gass $Ne \cdots Ne$
- C, H $((CH_4, C_2H_2, C_2H_4)$
- محصلة القوى صفر $O \cancel{=} C \cancel{=} O$

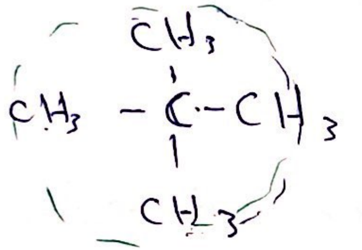
[١] الرابطة ← [٢] القطبية ← [٣] التشكل

1

CH_4 london $\quad$ C_2H_4 london

$16 < 28$ → B.P $\boxed{CH_4 < C_2H_4}$

2



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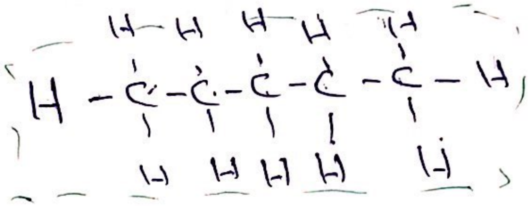


* list the substance

Ion $\quad$ london $\quad$ dipols $\quad$ hydrogen $\quad$ london

BCl_2, H_2, CO, HF and Ne in order increasing (B.P.)

$\quad$ 2 $\quad\quad\quad\quad$ 40

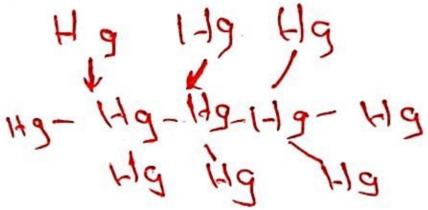
$BCl_2 > HF > CO > Ne > H_2$

* some properties of liquids

- * Viscosity
  - decreasing with increasing temp
  - depend on the attractive forces

* surface tension.

properties that measure the energy we need to expand the surface erea of Liquid

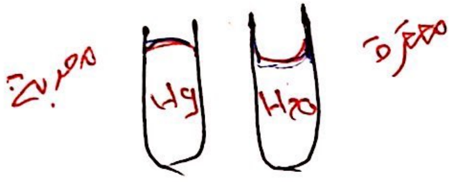


* Cohesive forces

bind molecule of
the same type together

* Adhesive forces

bind substance to surface



H_2O

Adhesive foces > Cohesive forces

Hg

Cohesive forces > Adhesive forces

* Capillary action

The rise of liquid up in very narrow tubes

↳ Adhesive forces

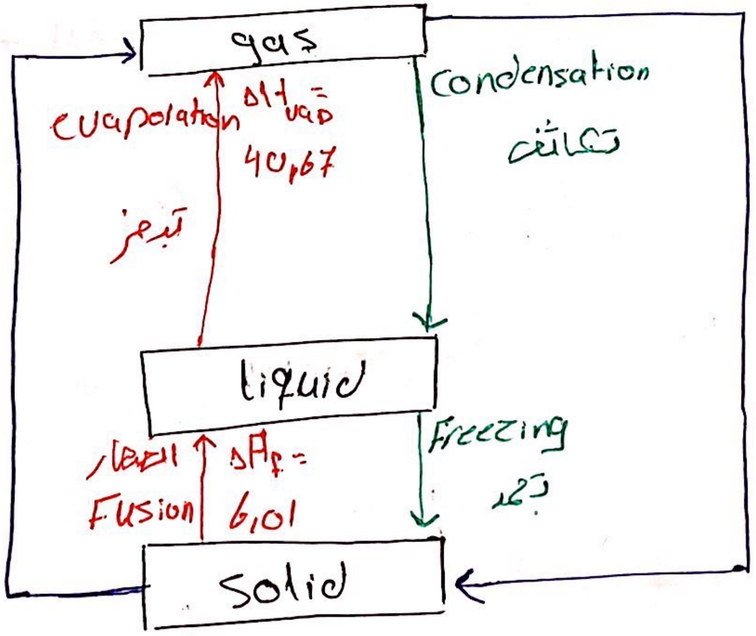
* phase change (Transformation from (solid - liquid - gas))

- The heat of fusion   كمية الحرارة التي يحتاجها (المول) من المادة ليتحول من (صلب ← سائل)

$\Delta H_{F(H_2O)} = 6{,}01$ KJ/mol

- The heat of evaporation   كمية الحرارة التي يحتاجها (المول) من المادة ليتحول من (سائل ← غاز)

$\Delta H_{vap} = 40{,}67$ KJ/mol



sublimation
تسامي

$\Delta H_S = \Delta H_{vap} + \Delta H_F$

$\Delta H_S = 46{,}68$

Deposition
ترسب

$\Delta H_{Dep} = -\Delta H_S$

$= -46{,}68$

* vapor pressure

- vapor pressure increase with increase temperature
- The stronger attractive forces $\rightarrow$ lower the vapor pressure

$$\boxed{\ln \frac{P_1}{P_2} = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}$$

Ex: The vapor pressure of water at 25C° is 238 mmHg (P_1) and the heat of vaporization of water is 43,9 KJ/mol, calculate the vapor pressure of water at 50c° (R = 62,4)

$$\ln \frac{P_1}{P_2} = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln \frac{238}{P_2} = \frac{43,9 \times 10^3}{62,4}\left(\frac{1}{50+273} - \frac{1}{25+273}\right)$$

$$P_2 = 93,7 \text{ mmHg}$$

$\Delta H_{vap} = 43,9\ kJ/mol$

↳ $T = 100C°$

↳ $P = 1atm$

Ex: If ΔH_{vap} for water is 40,7 kJ/mol what is the vapor pressure at 73C°

$$\ln \frac{1}{P_2} = \frac{40,7 \times 10^3}{8,314} \left(\frac{1}{73+273} - \frac{1}{100+273} \right)$$

$$P_2 = ,35\ atm$$

اسئلة تشابتر CH11 :.

Q1:- which one of the following should have the lowest boiling point

1- NH_3 H-bond

$\boxed{2-}$ cH_4 London-force

3- Hcl Inic -

4. H_2O H-bond

Q2:- place the following compounds in order of increasing strength of intermolecular for CO_2, He, NH_2CH_3

molar mass are ($CO_2 = 44$, $He = 4$, $NH_2CH_3 = 31$]

1- $He < NH_2CH_3 < CO_2$

2- $NH_2CH_3 < He < CO_2$

3- $NH_2CH_3 < CO_2 < He$

4- $CO_2 < NH_2CH_3 < He$

$\boxed{5-}$ $\underline{\underline{He}} < CO_2 < NH_2CH_3$

$\underline{CO_2}$ London

He London

* NH_2CH_3 H-bond

$NH_2CH_3 > CO_2 \cancel{>} He$

Q3: which of the ~~follow~~ following would you expect to have the lowest boiling point? molar masses are ($F = 19,$ $Cl = 35,5,$ $Br = 79,9,$ $I = 126,9.$)

$\boxed{1}$- F_2

2- Cl_2

3- Br_2

4- I_2

Q4: when a nonpolar liquid displays a convex meniscus in a Glass tube, which of the follwing explains this behavior?

1- It has alow surfacetension, and therefore adheres to the glass

2- The adhesive forces stronger than the cohesive forces

3- The liquid's viscosity is low.

$\boxed{4}$- The cohesive forces are stronger than adhesive forces

5- none of these

Q5:- The vapor pressure of a liquid in a closed container depends upon

[✓ 1- The temperature]

2. The surface area of the liquid

3- The volume of the container

4- all of the above

Q6: The vapor pressure of benzene is 100 mmHg at 26C° (299) calculate it's vapor pressure at 61°C (334K) & ΔH_{vap} = 31 KJ/Mol R=8,31

1- 27 mmHg

[✓ 2- 369 mmHg]

3- 100 mmHg

4- 34 mmHg

$$\ln \frac{P_1}{P_2} = \frac{\Delta H vap}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\ln \frac{100}{P_2} = \frac{31 \times 10^3}{8,314} \left(\frac{1}{334} - \frac{1}{299} \right)$$

$$\frac{100}{P_2} = ,27$$

$$P_2 = \frac{100}{,27}$$

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CH 12 :- physical properties of solution

$\boxed{1}$

* Solution { → solvent (مذيب) اكبر
→ solute (مذاب) اقل

$\underline{90\text{ g } H_2O}$ solvent — 10 g Na solute

80 g Na solvent — $\underline{20\text{ g}}$ H_2O solute

$\boxed{1}$ $\underline{\text{Molarity}}$ (M) $= \dfrac{\text{mole solut}}{V\,(\text{solution})}$

$(V_{\text{solvent}} + V_{\text{solute}})$

$3M\ HCl = \dfrac{3\text{ mole } HCl}{1L\ \text{solution}} =$ [illegible] $\overset{?}{=}$

$\underline{\underline{12M\ HCl}} = \dfrac{12\text{ mole } HCl}{1L(\text{solution})}$

$\underline{(H_2O)}$

[2]

[2] Molality = $\frac{\text{mole of solute}}{\text{mass solvent}}$ $\xrightarrow{}$ Kg

(m)

$,1m\ HCl = \frac{,1\ \text{mole HCl}}{1\text{kg } H_2O}$

$M = \frac{\text{mole solute}}{\text{volume (solution}}$

[3] Mole factor (الكسر المولي)

A = 3 mol

B = 2 mol

$X_A = \frac{\text{Mole } A}{\text{Mole } A + \text{Mole } B}$

X_A , X_B

$\boxed{X_A = \frac{3}{5}}$ $\boxed{X_B = \frac{2}{5}}$

$X_A + X_B =$

$\frac{3}{5} + \frac{2}{5} = \frac{5}{5} = \boxed{1}$

(A, B, C, D)

$X_A + X_B + X_C + X_D = \boxed{1}$

* physical proparcties of solution:-

↳(propartics that depend on mol of solute)

[I] Elevation for Boiling point

$\Delta T = K_b \cdot \underline{m} \curvearrowright \frac{\text{mole solute}}{\text{Kg solvent}} \curvearrowright \frac{\text{mass solute}}{\text{M.M}}$

$\swarrow$

$T_{\text{solution}} - T_{\text{solvent pure}}$

Ex: calculate the Boiling point (c°) of solution made by dissolving 30 g of sucrose ($C_{12}H_{22}O_{12}$ → MM = 342) in 200 g of H_2O (K_b = ,51) ($T_{B.p}(H_2O)$ = 100 c°)

$\Delta T = K_b \cdot m$

$\Delta T = ,51 * \frac{\frac{30}{342}}{,2}$

$m = \frac{\text{mole solute}}{\text{Kg solvent}}$

↓ ,2

$m = \frac{\frac{30}{342}}{,2}$

$\underline{\Delta T} = ,22$

$T_{(s)} - 100 = ,22 \rightarrow T_{\text{solution}} = 100,22$ (c°)

$\boxed{2}$ Depression in freezing point :-

$\Delta T_f = \boxed{-} K_f \cdot m \curvearrowright \frac{\text{mole solute}}{\text{kg solvent}} \curvearrowright \frac{\text{mass solute}}{\text{M.M.}}$

$\swarrow$

$T_{solution} - T_{\substack{solvent \\ pure}}$

Ex:- what mass of ethylene gly (c°) (anti freezing) ($HCOCH_2OH \rightarrow M.M = 62,1$)
add to 10kg ↓ to produce solution that freezes at (-23,3 c°)
(H_2O)

$T_{f\ H_2O} = 0$ $\quad K_f = 1,86$

$\Delta T_f = -K_f \cdot m$

$\cancel{-}23,3 - 0 = \cancel{-}1,86 * \frac{\text{mole solut}}{10kg}$

mole solut = 124,73 ⟶

$\frac{\text{mass}}{\text{M.M}} = 124,73$

mass = 124,73 X 62,1

mass = 7745,8

$\boxed{3}$ depression in vapor pressure solution :-

1 atm = 760 torr

* Raoul's law

$$P_A = \underset{\downarrow}{x_A}\, P_A^{\circ} \rightarrow \text{vapor pressur solvent}$$

P_A ← vapor pressure solution

$$x_A = \frac{\text{mole solvent}}{\text{mole solvent} + \text{mole solute}}$$

*- Ex :- solution was made by mixing 20g ethanol (solute) (M.M = 46) with 100g H_2O (solvent) (M.M = 18) , calculate the vapor pressure of this solution at 70 c°
(vapor pressure of pure water at 70°c = 233,7 torr ~~atm~~)

$$x_A = \frac{\text{mole solvent}}{\text{mole solute} + \text{mole solvent}}$$

$$\frac{\frac{100}{18}}{\frac{100}{18} + \frac{20}{46}}$$

$x_A = ,927$

$P_A = x_A * P_A^{\circ}$

$P_A = ,927 * 233,7$

$P_A = 216,73$ torr

1atm → 760torr
? → 216,73
= ,285atm

Ex : calculate the mass of $C_3H_8O_2$ that must be add to ,5 kg H_2O [6]
to ~~reduce~~ decrease the vapor pressure of H_2O 4,6 torr at 40°C ($P^\circ H_2O = 55,3$ torr)

(m.m → C = 12 , O = 16 , H = 1

$P_A = X_A \cdot P_A^\circ$

$50,7 = \underline{X_A} \cdot 55,3$

$X = ,916$

$$,916 = \frac{\frac{500}{18}}{\frac{500}{18} + \frac{m}{64}}$$

$$\boxed{m = 191,5 \text{ g}}$$

vaper pressure = 55, 3
H_2O pure

Vaper pressure = 55, 3 - 4,6
solution = 50,7

$\frac{m}{m.m}$

$$X_A = \frac{\text{mole solvent}}{\text{molesolvent} + \text{mole solut}}$$

$\frac{m}{m.m}$ $\frac{m}{m.m}$

m.m H_2O → 18

m.m $C_3H_8O_2$ → 64

4 Osmatic pressure :-

الخاصية الاسموزية :- انتقال الماء من التراكيز الأقل إلى التراكيز الأعلى

$\cancel{P}V = nRT$

$\pi V = nRT$

$\pi = \underbrace{\frac{n}{V}}_{M} RT \qquad n \rightarrow \frac{mass}{M.M}$

* Calculate M.M. of proteen mass = 1×10^{-3} g in 1 mL solution. the osmatic.

$V = 1 \times 10^{-3} L$

pressure = 1,12 , $T = 25c°$, $R = 0,0821$

$T = 25 + 273$

$= 298 K$

$\pi V = nRT$

$\pi V = \frac{mass}{M.M} RT$

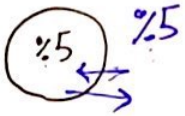
$1,12 \times 1 \times 10^{-3} = \frac{1 \times 10^{-3}}{M.M.} * ,0821 * 298$

$M.M = \underline{1,66 \times 10^{4}}$ g/mol

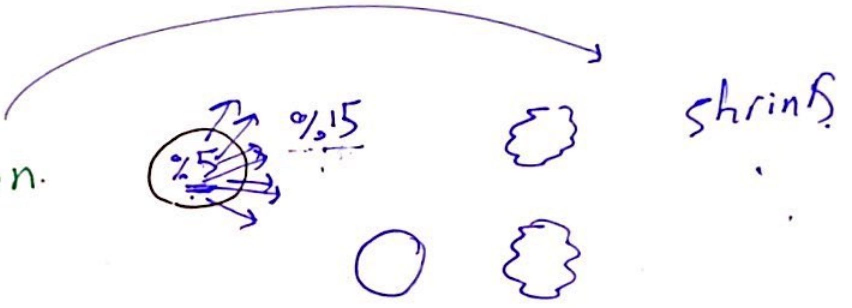
%5 جلوكوز

Nacl %9

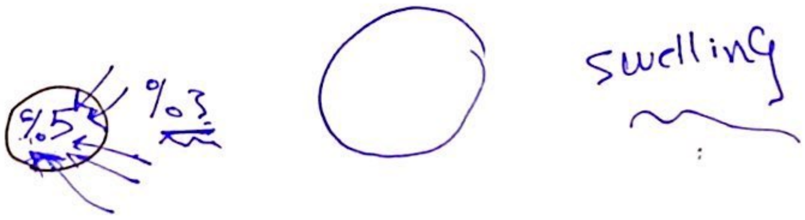
[1] Isotonic solution



[2] hypotonic solution.



[3] hyprtonic solution



* colligative properties for electrolyte solution

$C_6H_{12}O_6 \xrightarrow{H_2O} \underline{C_6H_{12}O_6}$

$NaCl \xrightarrow{H_2O} Na^+ + Cl^-$

- Vant hoff $i = 2$

$\underline{Fe}\,\underline{Cl}_3 \rightarrow i = 4$

$HCl \rightarrow i = 2$

$\overset{+1}{Na}\,\overset{-1}{OH} \rightarrow i = \underline{2}$

$\boxed{\overset{+2}{Mg}}\boxed{\overset{-2}{SO_4}} \rightarrow i = 2$

$Mg^{+2} + SO_4^{-2}$

$MgCl_2 \rightarrow i = 3$

$C_6H_{12}O_6 \rightarrow i = 1$

$\overset{+1}{\underline{Na}}\,\boxed{\overset{-1}{NO_3}} \Rightarrow i = 1$

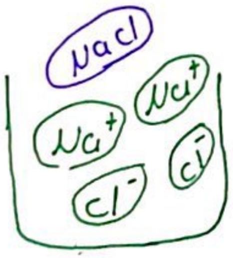
$\underline{NO_3^{-1}}$

$\underline{OH^{-1}}$

SO_4^{-2}

- ion - pairing

NaCl



i (expected)

$\underline{\underline{i = 2}}$

i (experimental)

$i = 1,9$

$\underline{\underline{i \neq 1}}$

1- elevation for boiling point

$\Delta T_b = K_b \cdot m \rightarrow \frac{(i)\,\text{Mole solute}}{\text{kg solvent}}$

$\Delta T_b = i K_b \cdot m$

2- Depression in freezing point

$i \neq 1$

$\text{NaCl} \rightarrow \underline{\underline{i = 2}}$

$\Delta T_f = -K_f \cdot m \rightarrow \frac{(i)\,\text{Mole solute}}{\text{kg solvent}}$

$\Delta T_f = -i K_f \cdot m$

3- depression in Vapor pressure:-

$$\underline{\underline{P_A}} = x_A * P_A^\circ$$

$\hookrightarrow \dfrac{\text{mole solvent}}{\text{mole solvent} + (i)\,\text{mole solute}}$

4- osmotic pressure:-

$$\pi V = nRT\,(i) \rightarrow \underline{\underline{\pi = iMRT}}$$

Ex:- predict the vapor pressure of solution producsed by mixing 35 g solid (solute) Na_2SO_4 (M.M = 172) with 175 g H_2O (solvent) (M.M = 18) at 25°C ($P^\circ_{H_2O}$ = 23.7 torr)

$\boxed{i = 3}$

$$P_A = x_A * P_A^\circ$$

$$P_A = \frac{\frac{175}{18}}{\frac{175}{18} + (3)\frac{35}{172}} * 23.7$$

$$P_A = 22 \text{ torr}$$

Ex:- The osmatic pressure of ,1 M. solution of $Fe(NH_4)_2(SO_4)_2$ at 25 C° is 10,8 atom , compare the expected and experimental for (i) ↘ $i=5$

$\pi = MRT(i)$

$10,8 = ,1 \times ,0821 \times (25 + 273) \times (i)$

$i = 4,4$

Ex:- wich one of the following solution have hair osmatic pressure:-

$\uparrow \pi = \uparrow \boxed{i} MRT$

1) ,2 Molar NaCl $i=2$

2) ,2 Molar $C_6H_{12}O_6$ $i=1$

$\boxed{3)}$,2 Molor $FeCl_3$ $i=4$

4) ,2 Molar Na_2SO_4 $i=3$

* physical properties of solution

CH 18

* تلخيص

* elevation for Boiling point

$$\Delta T_b = i k_b m \rightarrow \frac{\text{mole solute}}{\text{kg solvent}}$$

$$\Delta T_b \downarrow T_{solution} - T_{pure\ solvent}$$

* Depression in freezing point

$$\Delta T_f = - i k_f m \rightarrow \frac{\text{mole solute}}{\text{kg solvent}}$$

$$\Delta T_f \downarrow T_{solution} - T_{pure\ solvent}$$

* Depression in vapor pressure

$$P_A = \chi_A P_A^{\circ}$$

$$\chi_A \rightarrow \frac{\text{mole solvent}}{\text{mole solvent} + \underline{\underline{i}}\ \text{mole solut}}$$

* Osmatic pressure

$$\pi V = i n R T$$

* اسئلة شاشات CH 12

Q1:- When 2.36g of a nonvolatil solute is dissolved in 100g of solvent, the largest change in freezing point will achived when the solvent is:-

$\Delta T_f = -i K_f m$

$\boxed{1-}$ tret-butnol, $K_f = 9,1$

2- acetic acid, $K_f = 3,9$

3- $K_f = 5,12$, benzene

4- All are expected to have the same freezing point

Q2:- calculate the freezing point of a solution containing 20g of KCl (solut, i=2) and 2200g H2O (solvent), (M.M KCl = 74.55) The Molal freezing point depression constant ($K_f = 1,86$)

1) +,23 °C

2- -0,23 °C

$\boxed{3-\ -0.45\ °C}$

4- 1,23 °C

5- +,45 °C

$\Delta T_f = -i K_f m$

$T_{solution} - 0 = -2 \times 1,86 \times \frac{\frac{20}{74,55}}{2,2}$

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Q38- An aqueous solution has normal boiling point 102°C, what is the freezing point of this solution

[for water $K_b = ,51$ $K_f = 1,86$]

1- −3,6 °C

$\boxed{2.\ -7,3\ °C}$

3- 0,55 °C

4- −2,0

~~Kf~~ = -

$\Delta T_f = -K_f\, m$

$T_{solution} - 0 = -1,86 \cdot \underline{m}$

$T_{soluton} = -1,86 \times 3,92$

$\Delta T_b = K_b\, \underline{m}$

$102 - 100 = ,51\, m$

$m = 3,92$

$T_{b\,solution} = 102$

$T_b = 100$

$K_b = ,51$

$T_{f\,solution} = ?$

$K_f = 1,86$

$\boxed{i=1}$

Q4°- When ,5g (solut) of unkown non-electrolyte compound is dissolved in 10g (solvent) of camphor ($K_f = 40$) freezing point of the solution ~~[illegible]~~ lower than that of pure camphor if $\Delta T = 4,43$, calculate the unkown compound M.M

1- 55,4 g/Mol

2- ,451 g/Mol

3- 3,54 g/Mol

$\boxed{4-}$ 454,5 g/Mol

$\Delta T = -4,43$

$\Delta T = T_{solution} - T_{pure\,camphor}$

$\Delta T = -i\, K_f\, m$

$-4,43 = -40 \times m$

$m = ,11$

$,11 = \frac{\text{mole solute}}{,01}$

$\text{mole}_{\text{solute}} = 1,1 \times 10^{-3}$

$1,1 \times 10^{-3} = \frac{,5}{M.M}$

M.M =

Q5:- At a given temperature the vapor pressure of benzene and toluene are 183 mmHg and 59,2 mmHg. Calculate the totel pressure over a solution of benzeen and toluene ($X_{benzene}$ = ,56)

1- 102 mmHg

2- 242 mmHg

3- 121 mmHg

[✓ 3- 129 mmHg]

$$V_{total} = V_b + V_t$$

~~V_b~~

$$V_b = ,56 \times 183$$

$$= \underbrace{102,48}$$

$$V_t = ,44 \times 59,2$$

$$= 26,048$$

$$,56 + X_t = 1$$

$$X_t = ,44$$

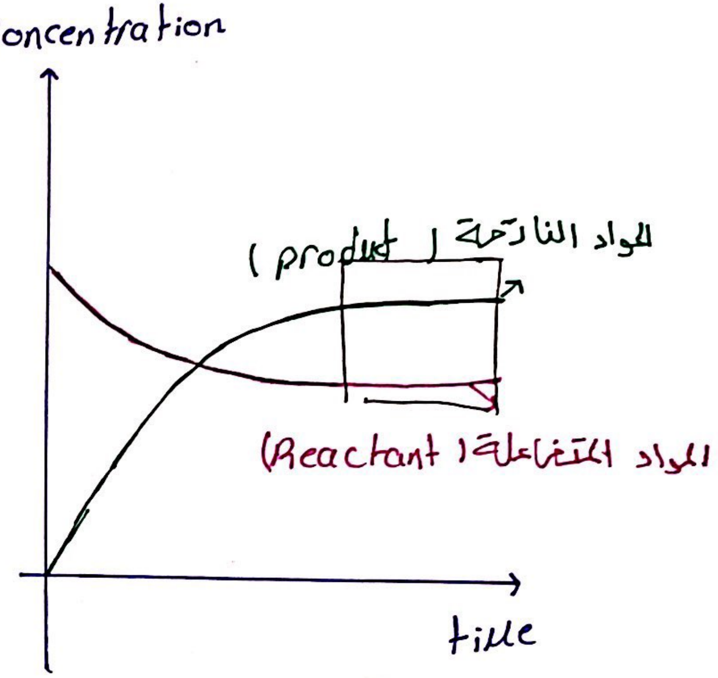
* CH4:- Chemical Equilibrium

- Concept of equilibrium:-

$$A + B \rightleftharpoons C + D$$

$t = 0$ A , B

$t = t_1$ A - x, B - x / C , D



* equilibrium → its the point at which no change on concentration within time

↳ rate of product = rate of Reactant

لـ(سرعة التفاعل الامامي = سرعة التفاعل الخلفي)

* The equilibrium constant (ثابت الاتزان)

$$A + B \leftrightharpoons C + D$$

$$K_c = \frac{[C] * [D]}{[A] * [B]}$$

$$aA + bB \leftrightharpoons cC + dD$$

$$K_c = \frac{[C]^c \cdot [D]^d}{[A]^a [B]^b}$$

Ex: Write the equilibrium constant for the Reaction

1- $2O_3 \leftrightharpoons 3O_2$

$$K_c = \frac{[O_2]^3}{[O_3]^2}$$

2- $\textcircled{2}NO + Cl_2 \leftrightharpoons \boxed{2}NOCl$

$$K_c = \frac{[NOCl]^2}{[NO]^2 [Cl_2]}$$

3- $CH_3COOH_{(aq)} + H_2O_{(L)} \leftrightharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$

$$K_c = \frac{[H_3O]^+ [CH_3COO]^-}{[H_2O] [CH_3COOH]}$$

Ex°: The following equilibrium hast been studied at 230c°

$$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$$

If $[NO] = ,0542\ M$

$[O_2] = ,127\ M$ → calculat the equilibrium constant (K_c)

$[NO_2] = 15,5\ M$

$$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$$

$$= \frac{(15,5)^2}{(,0542)^2(,127)} = 6,44 \times 10^5$$

* The equilibrium constant :-

$$aA_{(g)} + bB_{(g)} \rightleftharpoons cC_{(g)} + dD_{(g)}$$

$$K_P = \frac{P_D^d * P_C^c}{P_A^a * P_B^b}$$

Ex:- prideet the Kp for the following rxn:-

1- $3PCl_{3(g)} + O_2 \rightleftharpoons 2POCl_{3(g)}$

$$K_{P_1} = \frac{P^2_{POCl_3}}{P_{O_2} * P^3_{PCl_3}}$$

2- $2POCl_{3(g)} \rightleftharpoons 2PCl_{3(g)} + O_{2(g)}$

$$K_{P_2} = \frac{P_{O_2} * P^2_{PCl_3}}{P^2_{POCl_3}} \qquad K_{P_2} = \frac{1}{K_{P_1}}$$

3- $4POCl_{3(g)} \rightleftharpoons 4PCl_{3(g)} + 2O_{2(g)}$

$$K_{P_3} = \frac{P^2_{O_2} * P^4_{PCl_3}}{P^4_{POCl_3}} \qquad K_{P_3} = \frac{1}{(K_{P_1})^2}$$

4- $PCl_{3(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons POCl_{3(g)}$

$$K_{P_4} = \frac{P_{POCl_3}}{P^{1/2}_{O_2} * P_{PCl_3}}$$

$$K_{P_4} = K_{P_1}$$

Ex:- If (Kp) the following rxn is 1,05 and the partial pressure of PCl_5 and PCl_3 are 0,875 and 0,463 (atm), what is the partial pressure of Cl_2?

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

$$Kp = \frac{P_{Cl_2} * P_{PCl_3}}{P_{PCl_5}}$$

$$1,05 = \frac{P_{Cl_2} * ,463}{,875}$$

$$P_{Cl_2} = 1,98 \text{ atm}$$

$\cancel{2NO} + O_2 \rightleftharpoons 2NO_2 \rightarrow Kc_1 = \frac{[NO_2]^2}{[O_2][NO]^2}$

$+$

$N_2 + O_2 \rightleftharpoons \cancel{2NO} \rightarrow Kc_2 = \frac{[NO]^2}{[O_2][N_2]}$

$N_2 + 2O_2 \rightleftharpoons 2NO_2$

$\rightarrow Kc = ?$

$\boxed{Kc = \frac{[NO_2]^2}{[O_2]^2[N_2]}}$

$\boxed{Kc = Kc_1 * Kc_2}$

$Kc_1 * Kc_2$

$\frac{[NO_2]^2}{[O_2]\cancel{[NO]^2}} * \frac{\cancel{[NO]^2}}{[O_2][N_2]} = \frac{[NO_2]^2}{[O_2]^2[N_2]}$

Ex.: ⊕

$H_2CO_{3(aq)} \rightleftharpoons H^+_{(aq)} + HCO^-_{3(aq)} \rightarrow Kc_1 = 4,2 \times 10^{-7}$

$HCO_3^-{}_{(aq)} \rightleftharpoons H^+_{(aq)} + CO^{-2}_{3(aq)} \rightarrow Kc_2 = 4,8 \times 10^{-11}$

$H_2CO_{3(aq)} \rightleftharpoons 2H^+_{(aq)} + CO^{-2}_{3(aq)} \rightarrow Kc = ??$

$Kc = Kc_1 * Kc_2$

$11,76 \times 10^{-18}$

* Relationship between Kp and Kc

$$K_p = K_c\,(\overset{\uparrow\,0.0821}{R}T)^{\boxed{\Delta n}\rightarrow} \quad \underset{\hookrightarrow\,\underline{K}}{}$$

مولات المواد الناتجة بالحالة الغازية - مولات المواد المتفاعلة بالحالة الغازية

→ $2SO_{3(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ → $\Delta n = ?$ $\quad \Delta n = 2 - 3$

$= -1$

Ex:- $CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$

The equilibrium constant (Kc) for the reaction is 10,5 at 220 c°, what is the value of Kp at this temperature?

220 ↓ + 273

493 K

$\Delta n = 1 - 3$

$= -2$

$$K_p = K_c\,(RT)^{\Delta n}$$

$$= 10{,}5\,(0{,}0821 * 493)^{-2}$$

$$K_p = 6{,}4 \times 10^{-3}$$

* Heterogeneous equilibrium:- (الاتزان غير المتجانس)

- $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ Homogeneous equilibrium

- $2NaHCO_{3(s)} \rightleftharpoons Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$
  - $K_p = P_{H_2O} * P_{CO_2}$
  - $K_c = \frac{[H_2O][CO_2]}{-\,///}$

△1 $H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

$K_p = P_{H_2O}$

$K_c = [H_2O]$

△2 $CO_{2(g)} + H_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(l)}$

$K_p = \frac{P_{CO}}{P_{CO_2} * P_{H_2}}$ $K_c = \frac{[CO]}{[H_2][CO_2]}$

△3 $SnO_{2(s)} + 2CO_{(g)} \rightleftharpoons Sn_{(s)} + 2CO_{2(g)}$

$K_p = \frac{P_{CO_2}^2}{P_{CO}^2}$

$K_c = \frac{[CO_2]^2}{[CO]^2}$

* Calculating equilibrium concentration.

Ex:- 2L flask with 4Mol NH_3 As in Reactin ($2NH_3 \rightleftharpoons N_2 + 2H_2$).

At equilibrium it remain 1M of NH_3 what is Kc?

$$2NH_3 \rightleftharpoons N_2 + 2H_2$$

$$\begin{array}{ccc} 2 & 0 & 0 \\ 2-2x & +x & +2x \end{array}$$

$M = \frac{4}{2} = 2$

$[NH_3] = 1 \qquad [N_2] = \frac{1}{2} \qquad [H_2] = 1$

$2 - 2x = 1$

$x = \frac{1}{2}$

$$Kc = \frac{[H_2]\,[N_2]}{[.NH_3]}$$

$$\boxed{Kc = \frac{1}{2}}$$

Ex 8- 10L flask is filled with ,2Mol of H_2 and ,2Mol I_2 at 778c°

The value of (K_c) is 49,5 for the Reaction ($H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

what are the concentration of H_2, I_2 in the flask at equilibrium.

$[H_2]\ \frac{,2}{10} = ,02$

$[I_2] = \frac{,2}{10} = ,02$

$$H_2 + I_2 \rightleftharpoons 2HI$$

$$,02 \qquad ,02 \qquad 0$$

$$+2x$$

$$,02 - x \qquad ,02 - x$$

$$K_c = \frac{[HI]^2}{[H_2]\,[I_2]}$$

$$49,5 = \frac{4x^2}{(,02 - x)^2}$$

$$x = 0,0156$$

$[H_2] = ,02 - ,0156$

$= 4,5 \times 10^{-3} = [I_2]$

* predicting direction for the Reaction :-

Ex:- suppose we place mix

$$\left.\begin{array}{l} 2\,\text{Mol}\ H_2 \\ 1\,\text{Mol}\ N_2 \\ 2\,\text{Mol}\ NH_3 \end{array}\right] \rightarrow \text{in (1L) at } 472C^{\circ}$$

will N_2 and H_2 react to give NH_3 knowing $K_c = .105$, predict direction for the rxn

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

$[H_2] = 2M$

$[N_2] = 1M$

$[NH_3] = 2M$

$$Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$= \frac{(2)^{\cancel{2}}}{1 \times (2)^{\cancel{3}}}$$

$$\boxed{Q = .5}$$

$Q > K_c$

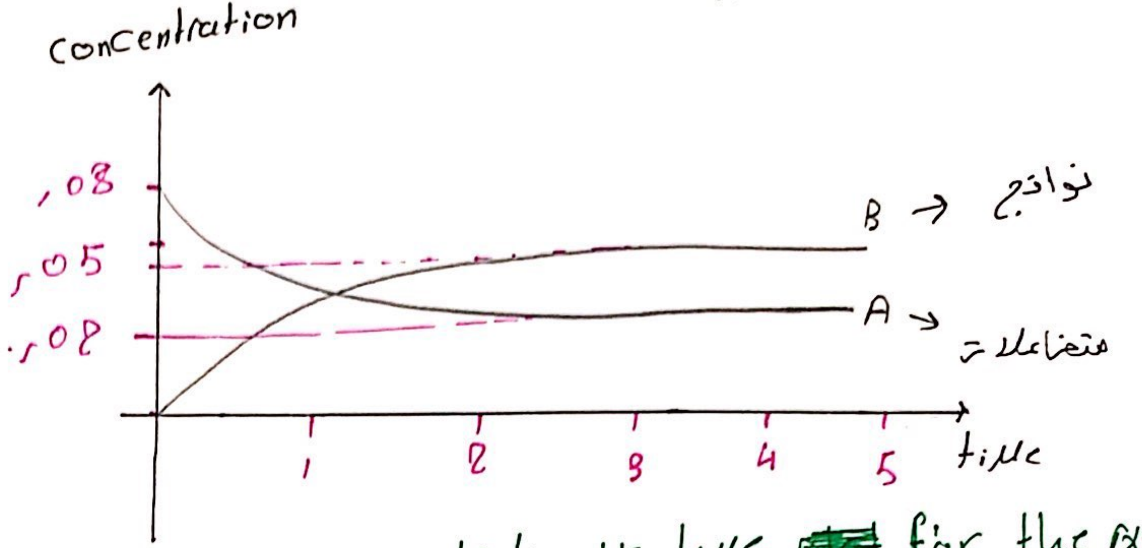
$\longleftarrow$

$Q > K_c$ shift t
left

$Q < K_c$ shift t
Right

* اسئلة تشاشات CH 14

Q1:-



shown below is a concentration vs time for the rxn $A \rightleftharpoons 2B$, for this reaction the value for the equilibrium constant is:-

$$K_c = \frac{[B]^2}{[A]}$$

1- $K_c > 1$

$\boxed{2.}$ $K_c < 1$

3- $K_c = 0$

4- $K_c = 1$

$[A] = ,02$

$[B] = ,05$

$$K_c = \frac{(,05)^2}{,02}$$

$K_c = ,125$

Q2:- $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ $K_{c_1} = 1,7 \times 10^6$

$SO_{3(g)} \rightleftharpoons \frac{1}{2} O_{2(g)} + SO_{2(g)}$ $K_c = ??$

$\boxed{1-}$ $7,7 \times 10^{-4}$

2- $3,4 \times 10^2$

3. $1,2 \times 10^{-6}$

4- $8,5$

$$K_c = \frac{1}{(K_{c_1})^{\frac{1}{2}}}$$

$$K_c = \frac{1}{(1,7 \times 10^6)^{\frac{1}{2}}}$$

Q38- For the reaction $(N_{2(g)} + 2O_{2(g)} \rightleftharpoons 2NO_{2(g)})$

$K_c = 8,3 \times 10^{-10}$ at 25 c°, what is the concentration of N_2 if NO_2 is twice The concentration of O_2 gas?

1- $2,4 \times 10^{9}$ M

2- $4,8 \times 10^{-10}$ M

3- $2,1 \times 10^{-16}$ M

$\boxed{4-}$ 4.18×10^{9} M.

$K_c = 8,3 \times 10^{-10}$

$[NO_2] = 2[O_2]$

$$K_c = \frac{[NO_2]^2}{[O_2][N_2]}$$

$$8,3 \times 10^{-10} = \frac{\cancel{4[O_2]^2}}{\cancel{[O_2]^2}[N_2]}$$

$$8,3 \times 10^{-10} = \frac{4}{[N_2]} \rightarrow ,481 \times 10^{10}$$

$4,8 \times 10^{9}$

Q48- 1 L flask filled with ,35 mol CO and ,4 mol H_2O if you know that concentration of CO at equilibraim = ,22 M.

calculate K_c

1- 3,5

2- 1

$\boxed{3-}$,28

4- 5,5

5- ,75

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

$,35 \quad ,4 \quad 0 \quad 0$

$,35 - X \quad ,4 - X \quad +X \quad +X$

$[CO] = ,22$

$[H_2O] = ,27$

$[CO_2] = ,13$

$[H_2] = ,13$

$$K_c = \frac{(,13)^2}{,22 \times ,27}$$

$,35 - X = ,22$

$X = ,13$

Q5:- $2COF_{2(g)} \rightleftharpoons CO_{2(g)} + CF_{4(g)}$

The equilibrium constant (Kc) is (2) at 1000c° for the rxn.

If ,43 mol co$_2$ and ,43 mol CF$_4$ are into 1L flask

what will be the concentration of coF$_2$ at equilibruim

1- ,31M

2. ,15M

$\boxed{3.}$,22M

4, 1M

$$2COF_2 \rightleftharpoons CO_2 + CF_4$$

$$=0 \quad ,43 \quad ,43$$

$$+\underline{\underline{2x}} \quad ,43-x \quad ,43-x$$

$$Kc = \frac{[CO_2][CF_4]}{[COF_2]^2}$$

$$2 = \frac{(,43-x)^2}{4x^2}$$

$$8x^2 = (,43-x)^2$$

$$x = ,11$$

$$[COF_2] = 2 \times ,11$$

$$= ,22\ M$$

CH 15:- Acid - Base equilibrium -

* Arhenius

Acid:- substan give H^+ in H_2O

Base: substan give OH^- in H_2O

Ex :- $HCl \xrightarrow{H_2O} \boxed{H^+} + Cl^-$ Acid

$NaOH \xrightarrow{H_2O} \underline{\underline{OH^-}} + Na^+$ Base

* Bronsted - lowry

Acid : substanc donate H^+

Base ; substabe accept H^+

Ex: $HCl + \underline{\underline{HSO_3^-}} \longrightarrow H_2SO_3 + Cl^-$

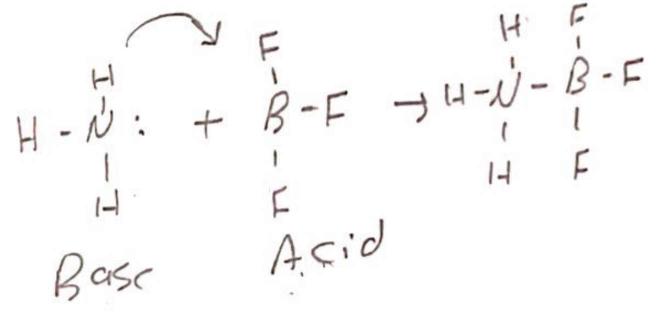
Acid Base

* lewis

Acid: substane accept $2e^-$

Base :- substane donate $2e^-$

Ex:.



Acid - $H^+ \longrightarrow$ conjugate Base

Base + $H^+ \longrightarrow$ conjugate Acid

* what is conjugate base of each Acid ?

Acid	$PH_4^{\boxed{+}}$	H_2S	$HClO_4$
↓	↓	↓	↓
conjugate base	PH_3^{0}	HS^{-}	ClO_4^{-}

* what is cojugate Acid of each Base?

Base	$CN^{\boxed{-}}$	$SO_4^{\boxed{=}}$	H_2O	NH_3
↓	↓	↓	↓	↓
Conjugate Acid.	HCN	HSO_4	H_3O^+	NH_4^+

* autotiouzation of water

H^+ ~~H_2O~~

$$H_2O + H_2O \rightleftarrows OH^- + H_3O^+$$

$$Kw = [OH]^- \cancel{[H_3O]^+} [H]^+$$

$$\cancel{[H_2O]^2}$$

$$[Kw \text{ at } 25c° = 1 \times 10^{-14}]$$

$[OH]^- = [H_3O]^+ = 1 \times 10^{-7}$ nutral

$1 \times 10^{-2} > 1 \times 10^{-12}$

$[OH]^- > [H]^+ \rightarrow$ Base →

$1 \times 10^{-6} > 1 \times 10^{-8}$

$[H]^+ > [OH]^- \rightarrow$ Acid

* Indicate wetheir each of the following (neutral , acid , base)

$Kw = [OH]^- [H]^+ = 10^{-14}$

- $[H]^+ = 2 \times 10^{-5}$ M $> [OH]^- = \frac{1}{2} \times 10^{-9}$
  Acid
- $[OH]^- = 3 \times 10^{-9}$ M   Acid
  $[H]^+ > [OH]^-$
- $[OH]^- = 1 \times 10^{-7}$ M neutral
- $[H]^+ = 1 \times 10^{-11}$ M   Base
  $[OH]^- > [H]^+$

* calculate concentration of H^+ in solution in ~~which~~ which $[OH]^- = ,01$ M

$Kw = 1 \times 10^{-14}$

$1 \times 10^{-14} = 1 \times 10^{-2} \times [H]^+$

$$\boxed{[H]^+ = 1 \times 10^{-12}}$$

* pH (power of Hydrogen)

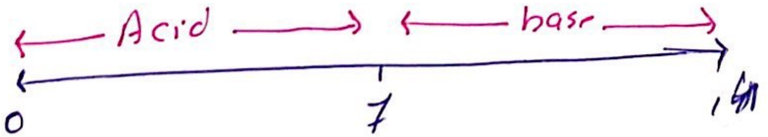
$pH = -\log_{10} [H]^+ \rightarrow \underline{[H]^+ = 10^{-pH}}$ $\quad$ $K_w = [H]^+ [OH]^-$

10

$pH = 5 \longrightarrow [H]^+ = 10^{-5} \rightarrow [OH]^- = 1 \times 10^{-9}$ Acid

$pH = 7 \longrightarrow [H]^+ = 1 \times 10^{-7} \rightarrow [OH]^- = 1 \times 10^{-7}$ neutral

$pH = 9 \rightarrow [H]^+ = 10^{-9} \rightarrow [OH]^- = 10^{-5}$ Base



* Strong Acid :-

↳ (HCl, HBr, HI, HNO_3, $HClO_4$, H_2SO_4)

↲ ماعدا ذلك حمض ضعيف

$$HCl \xrightarrow{H_2O} H^+ + Cl^-$$

$$\begin{array}{ccc} \underline{\underline{100\,mol}} & 0 & 0 \\ 0 & 100\,mol & \underline{100\,mol} \end{array}$$

HCl

$$100\,mol\ \cancel{HCl} * \frac{1\,mol\ Cl}{\cancel{1\,mol\ HCl}}$$

$100\,mol\ Cl$

* what is pH of $\underline{\underline{,2\,M}}$ solution H_2SO_4 ?

$$H_{\underline{2}}SO_4 \xrightarrow{H_2O} 2H^+ + SO_4^{-2}$$

$$\begin{array}{ccc} ,2\,M & 0 & 0 \\ & \underline{\underline{2(,2)}} & ,2 \end{array}$$

$[H]^+ = ,4\,M$

$pH = -\log(,4)$

$$\frac{,2\,mol}{1L} \rightarrow \frac{,2}{1L} = ,2M$$

$$,2\,\cancel{M\ H_2SO_4} \times \frac{2M\,H^+}{\cancel{1M\,H_2SO_4}}$$

$$\boxed{,4\,M\,H^+}$$

* strong Base

↳(NaOH, KOH, LiOH, BrOH, Ca(OH)$_2$, Ba(OH)$_2$, Sr(OH)$_2$, CsOH)

$$NaOH \xrightarrow{H_2O} Na^+ + OH^-$$

50M　　0　　0

$\underline{\underline{0}}$　　50M　　50M

* what is $\underline{\underline{pH}}$ of ,011 M solution of Ca(OH)$_2$?

$$Ca(OH)_{\underline{\underline{2}}} \xrightarrow{H_2O} Ca^{+2} + \underline{\underline{2}}OH^-$$

,011　　0　　0

0　　,011　　(,011)2

$[OH]^- = ,011\ M$

$$[H]^+ = \frac{1\times10^{-14}}{11\times10^{-3}}$$

$[H]^+ = ,09\times10^{-11}$

$pH = -\log(,09\times10^{-11})$

← $pH = -\log[H]^+$

- strong base (Inic Metal oxide) :-

Na_2O , CaO

$$Na_2O + H_2O \rightarrow 2Na(OH)_2$$

Ex: ,01 Mol Na_2O react with water (H_2O) in 1L solution

calculate pH!

$\frac{,01}{1} = ,01\ M$

$$Na_2O + H_2O \rightarrow \underline{\underline{2NaOH}}$$

$$2NaOH \xrightarrow{H_2O} 2Na^+ + 2OH^-$$

$2(,01)$ 0 0

0 ,02 ,02

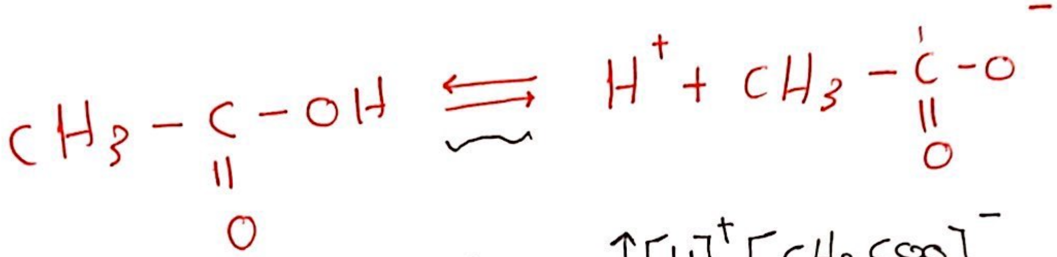
$[OH]^- = ,02$

$[H]^+ = \frac{1\times10^{-14}}{2\times10^{-2}}$

$[H]^+ = ,5\times10^{-12}$

$pH = -\log(,5\times10^{-12})$

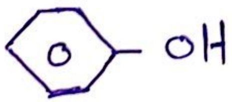
* Weak Acid



$$CH_3-\underset{\underset{O}{||}}{C}-OH \underset{\sim}{\rightleftharpoons} H^+ + CH_3-\underset{\underset{O}{||}}{\overset{|}{C}}-O^-$$

$$\uparrow \underline{K_a} = \frac{\uparrow[H]^+[CH_3COO]^-}{[CH_3COOH]}$$

$$K_a \propto [H]^+$$
$$\propto \frac{1}{[OH]^+}$$

Acid/Base	$\underline{K_a}$	
$\boxed{HF}$	68×10^{-4}	اقوى منا حيث وجود تركيز H^+
$CH_3-\overset{\overset{O}{||}}{C}-OH$	$6,3 \times 10^{-5}$	
HNO_2	$4,5 \times 10^{-5}$	
	$1,3 \times 10^{-10}$	اضعفه منا حيث تراكيز H^+

Ex: ,1 M $H-\underset{\underset{O}{\|}}{C}-OH$ has $\underline{\underline{pH = 2,32}}$

$\rightleftarrows$

10

[A] calculate Ka :-

$$\frac{H\,COOH}{,1\,M} \rightleftarrows H^{+} + H\,COO^{-}$$

H^{+}: 0, +x

$H\,COO^{-}$: 0, +x

$H\,COOH$: ,1 − x

$[H]^{+} = 10^{-pH}$

$[H]^{+} = 10^{-2,32}$

$[H]^{+} = 4,2 \times 10^{-3}$

$$\underline{Ka} = \frac{[H]^{+}[H\,COO]^{-}}{[H\,COOH]}$$

$$Ka = \frac{(4,2\times10^{-3})^{2}}{,1} \rightarrow \underline{\underline{Ka}} = 1,8 \times 10^{-4}$$

[B] percent ionization:-

$$\frac{[H]^{+}}{[H\,COOH]} \times 100\% \longrightarrow \frac{4,2\times10^{-3}}{,1} * 100\%$$

$$= 4,2\%$$

Ex:- Calculate pH of ,3 M of $(CH_3-\underset{\underset{O}{\parallel}}{C}-OH)$, $(K_a = 1{,}8 \times 10^{-5})$

$$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$$

$$\begin{array}{ccc} & 0 & 0 \\ ,3 & & \\ & +x & +x \\ ,3-\cancel{x} & & \end{array}$$

$$K_a = \frac{[H]^+[CH_3COO]^-}{[CH_3COOH]}$$

$$1{,}8 \times 10^{-5} = \frac{x^2}{,3} \rightarrow x^2 = 5{,}4 \times 10^{-6}$$

$$[H]^+ = \underbrace{2{,}3}\times 10^{-3}\ M$$

$$pH = -\log [H]^+$$

$$\underbrace{pH = 2{,}64}$$

* persent ionizotion

$$\frac{[H]^+}{[CH_3COOH]} \times 100\%$$

$$\frac{2{,}3 \times 10^{-3}}{,3} \times 100\% = 0{,}77\%$$

* Weak Base

$$\hookrightarrow NH_3 \xrightleftharpoons[H^+ \quad OH^-]{H_2O} OH^- + NH_4^+$$

$$\uparrow \underline{\underline{K_b}} = \frac{\uparrow [OH]^- \, [NH_4]^+}{[NH_3]}$$

$$K_b \propto [OH]^-$$

$$\propto \frac{1}{[H]^+}$$

Base / Acid	K_b	
NH_3	$1{,}8 \times 10^{-5}$	
$H-\underset{\underset{H}{\vert}}{N}-OH$	$\boxed{1{,}1 \times 10^{-8}}$	اضعف من حيث تراكيز $\underline{[OH]^-}$
$H-\underset{\underset{H}{\vert}}{N}-CH_3$	$\boxed{4{,}4 \times 10^{-4}}$	→ أقوى من حيث تراكيز $\underline{[OH]^-}$
ClO^-	$3{,}3 \times 10^{-7}$	

Ex:- calculate concentration of OH^- in ,15 M NH_3 $Kb = 1,8 \times 10^{-5}$

$$NH_3 \leftrightharpoons OH^- + NH_4^+$$

$$\begin{array}{ccc} ,15 & 0 & 0 \\ & +x & +x \\ ,15 - x & & \end{array}$$

$$K_b = \frac{[OH]^- [NH_4]^+}{[NH_3]}$$

$$1,8 \times 10^{-5} = \frac{x^2}{,15} \rightarrow x = [OH]^- = 1,6 \times 10^{-6} M$$

* Relationship between Kb and Ka

$$\boxed{Ka * Kb = 1 \times 10^{-14}} \rightarrow [H]^+ * [OH]^- = 1 \times 10^{-14}$$

$$Ka * Kb = 1 \times 10^{-14}$$

$$6,8 \times 10^{-4} * Kb = 1 \times 10^{-14}$$

$$Kb = 1,47 \times 10^{-11}$$

Acid	Ka	base	Kb
HF	$(6,8 \times 10^{-4})$	F^-	$1,47 \times 10^{-11}$?
NH_4^+	$H^+ (5,6 \times 10^{-10}) \downarrow$ $OH^- \downarrow$	NH_3	$1,78 \times 10^{-5}$? $\uparrow$ OH^-
HCO_3^-	$5,55 \times 10^{-11}$?	CO_3^{-2}	$(1,8 \times 10^{-4}$

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* Acid - Base properties of salt solution :-

NH_4OH

$\underline{NH_3} + H \rightarrow NH_4^+$

[1]

H^+ OH^-

- $\underline{NaCl} \begin{cases} \rightarrow Na^{\pm} \rightarrow NaOH \\ \rightarrow Cl^{-} \rightarrow \underline{HCl} \end{cases}$

strong Base + strong Acid

- $Ca(NO_3)_2 \begin{cases} \rightarrow Ca^{+2} \\ \rightarrow NO_3^{-1} \end{cases}$

$\underline{Ca(OH)_2}$ HNO_3

strong Base + strong Acid

salt from strong acid and strong Base

$pH = 7$

[2]

- $NaClO \begin{cases} \rightarrow Na^+ \rightarrow NaOH \\ ClO^- \rightarrow \underline{HClO} \end{cases}$

strong Base — weak Acid

- $Ba(CH_3-\overset{O}{\overset{\|}{C}}-O)_2$

Ba^{+2} CH_3COO^-

$Ba(OH)_2$ strong Base — CH_3COOH weak Acid

$\boxed{pH > 7}$

* salt from strong Base and weak Acid

[3]

- NH_4Cl

NH_4^+ — Cl^-

NH_3 weak base — HCl strong Acid

- $Al(NO_3)_3$

Al^{+3} — NO_3^{-1}

$Al(OH)_3$ weak Base — HNO_3 strong Acid

$\boxed{pH < 7}$

* salt from strong Acid and weak Base

[4]

- NH_4CN

NH_4^+ — CN^-

NH_3 weak base — HCN weak acid

- CH_3COONH_4

CH_3COO^- — NH_4^+

CH_3COOH weak Acid — NH_3 weak Base

$K_a > K_b \rightarrow$

$pH < 7$

$K_b > K_a$

$pH > 7$

Example:-

clalculate $\underline{\underline{pH}}$ of ,3M solution of NH4Cl

(Kb of NH_3 = $1,8 \times 10^{-5}$)

$\underline{\underline{Ka}}$

$Kb = 1,8 \times 10^{-5}$

$Kb * Ka = 1 \times 10^{-14}$

$1,8 \times 10^{-5} \times Ka = 1 \times 10^{-14}$

$Ka = 5,6 \times 10^{-10}$

$$NH_4Cl \longrightarrow CH_4OH + \boxed{H^+}$$

,3	0	0
	$+\alpha$	$+\alpha$
,3 $\cancel{\alpha}$		

$\underline{\underline{Ka}} = \dfrac{x^2}{,3}$

$5,6 \times 10^{-10} \times ,3 = x^2$

$x = [H]^+ = 1,3 \times 10^{-5}$

$pH = -\log [H]^+$

$= -\log (1,3 \times 10^{-5})$

$$\boxed{pH = 4,88}$$

* اسئلة شاشاته ..CH15

Q1:- what is conjugate base of the Bronsted-lowry acid HPO_4^{-2}

acid $-H^+ \rightarrow$ conjugate base

1) $H_2PO_4^-$

$\boxed{2)\ \underline{PO_4^{-3}}}$

PO_4^{-3}

3) HPO_4^{-2}

4) H_3PO_4

Q2:- Indicate all the Bronsted lowry acids in the following chemical reaction

$$\underset{\text{Acid}}{\underline{HI}_{(aq)}} \overset{H^+}{\curvearrowright} + \underset{\underline{\text{Base}}}{H_2O_{(aq)}} \rightleftharpoons \underset{\text{Acid}}{H_3O^+_{(aq)}} + \underset{\text{Base}}{I^-_{(aq)}}$$

1) HI , I

2) HI , H_2O

$\boxed{3)\ \underline{HI}\ ,\ \underline{H_3O^+}}$

4) HI, H_2O, H_3O^+

Q3:- given the following substances in order off increasing acid strength

$\overset{ocl^-}{\underline{HOcl}} < \overset{C_2H_3O_2^-}{HC_2H_3O_2} < HC_2O_4^- < HNO_2 < \underline{Hcl}$

which is the stongest base of thate set ?

1) Cl^-

$\boxed{2)\ C_2H_3O_2^-}$

3) $C_2O_4^{-2}$

4) NO_2^-

$HOcl \uparrow ocl^-$

$\underline{Ka} = 1\times10^{-2}$ $\quad \underline{Kb = 1\times10^{-6}}$

$Ka * Kb = 1\times10^{-14}$

Q4:- An aqueous مائي solution of ..... will produce abasic solution

1) CsBr α

2) $Mg(clo_4)^2$ α

3) NH_4NO_3 α

$\boxed{4)\ NaNO_2}$

5) KNO_3

$$\begin{tikzcd} & CsBr \arrow[dl] \arrow[dr] & \\ Cs^+ & & Br^- \\ \underset{\sim\sim}{CsOH} & & HBr \end{tikzcd}$$

$$\begin{tikzcd} & Mg(clo_4)_2 \arrow[dl] \arrow[dr] & \\ Mg^{+2} & & clo_4^- \\ Mg(OH)_2\ ✓ & & Hclo_4\ ✓ \end{tikzcd}$$

~~NaOH~~

$$\begin{tikzcd} & NaNO_2 \arrow[dl] \arrow[dr] & \\ NaOH \arrow[d] & & HNO_2 \arrow[d] \\ \boxed{\text{strong Base}} & & \boxed{\text{weak Acid}} \end{tikzcd}$$

$$\begin{tikzcd} & NH_4NO_3 \arrow[dl] \arrow[dr] & \\ NH_4^+ & & NO_3^- \\ NH_3 & & HNO_3 \end{tikzcd}$$

Q5:- The Ka of hydrozoic acid (HN_3^-) is $1,9 \times 10^{-5}$ at 25°C, what is the pH of ,15 M solution of (NH_3)

1) 1,95

[✓ 2) 2,77]

3) -3,46

4) 5,23

$NH_3^- \rightleftharpoons NH_2^{-2} + H^+$

,15 — —

$,15 - x \quad +x \quad +x$

$Ka = 1,9 \times 10^{-5}$

$1,9 \times 10^{-5} = \frac{x^2}{,15}$

$x = 1,68 \times 10^{-3}$

$pH = -\log[H^+]$

$= -\log(1,68 \times 10^{-3}$

$pH = 2,77$

Q6:- What is the hydronium in $(H_3O)^+$ concentration of a ,4 M acid (CH_3CO_2H), solution with ($Ka = 1,8 \times 10^{-5}$)

1) $4,2 \times 10^{-2}$ M

2) $2,7 \times 10^{-2}$ M

3) $4,2 \times 10^{-3}$ M

[✓ 4) $2,7 \times 10^{-3}$ M]

$CH_3CO_2H \rightleftharpoons CH_3CO_2^- + H^+$

,4 — —

$,4 - x \quad +x \quad +x$

$Ka = 1,8 \times 10^{-5}$

$1,8 \times 10^{-5} = \frac{x^2}{4 \times 10^{-1}}$

$[H_3O]^+ = [H]^+$

H_2O H^+

m

$\sqrt{1,8 \times 4 \times 10^{-6}}$

$2,68 \times 10^{-3}$

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Q7:- Determine the pH of ,15 M equcous solution of CaF_2 : ($Ka_{HF} = 7 \times 10^{-4}$)

1) 1,32

2) 5,68

$\boxed{3)\ 8,32}$

4) ,52

5) 5,01

$$CaF_2 \longrightarrow 2F^- + Ca^{+2}$$

$$,15 \qquad 2 \times (,15) \qquad ,15$$

$[F]^- = ,3$

$$F^- \longrightarrow HF + OH^-$$

$$,3 \qquad - \qquad -$$

$$,3 - x \qquad x \qquad x$$

Kb

$Ka * Kb = 1 \times 10^{-14}$

$7 \times 10^{-4} * Kb = 1 \times 10^{-14}$

$\boxed{,14 \times 10^{-10} = Kb}$

$$Kb = \frac{[OH]^-[HF]}{[F]^-}$$

$,14 \times 10^{-10} \times ,3 = x^2$

$x = ,2 \times 10^{-5} = [OH]^- \rightarrow [H]^+ = \frac{1 \times 10^{-14}}{2 \times 10^{-6}}$

$[H^+] = 5 \times 10^{-8}$

OH^- → H^+ → pH

Q8:- Determine pH of a weak base that has $Kb = 3,78 \times 10^{-18}$

$\boxed{1)\ 9,26}$

2) 7,00 ✗

3) 4,73 ✗

4) 3,42 ✗

5) 1,59 ✗

$$Kb = \frac{[OH]^-[\ ]^+}{[\text{قاعدة}]}$$

1

Q9:- calculate the pH of a 1,6 M KBrO solution

$(K_{a\,HBrO} = 2,0\times10^{-9})$, $K_W = 1\times10^{-14}$

$$KBrO \longrightarrow K^+ + \boxed{Br O^-}$$

1,6   1,0 $\boxed{1,6}$

$\boxed{1)\ 11,45}$

2) 2,55

3) 9,75

4) 4,85

$$BrO^- \rightleftarrows HBrO + OH^-$$

H_2O

H^+ OH^-

1,6   x   x

1,6 - x

$$K_b = \frac{[OH]^-[HBrO]}{[BrO]^-}$$

$K_a * K_b = 1\times10^{-14}$

$2\times10^{-9} \times K_b = 1\times10^{-14}$

$K_b = ,5\times10^{-5}$ ←

$$5\times10^{-6} = \frac{x^2}{1,6}$$

$2,82\times10^{-3}$

$x = \cancel{2,82\times10^{-3}} = [OH]^-$

$$[H]^+ = \frac{1\times10^{-14}}{2,82\times10^{-3}}$$

$[H]^+ = ,35\times10^{-11}$

$pH = -\log[H]^+$

Q10:- If an acid HA is 10% in 1M solution. what is the Ka for the acid

$[HA] = 1M$

$$K_a = \frac{[H]^+[A]^-}{[HA]}$$ ✓

10%

$$10\% = \frac{[H]^+}{[HA]} \times 100\%$$

$$K_a = \frac{(,1)^2}{1}$$

$\boxed{K_a = ,01}$

$$[H]^+ = \frac{10}{100} = \boxed{,1}$$

$\cancel{10\%} \; [H]^+ \times 100\% \; \frac{100}{100}$

CH6:- Thermochemistry

→ The Relationship between chemical Reaction and energy

- unite of energy:- Jules = J

1cal = 4,184J

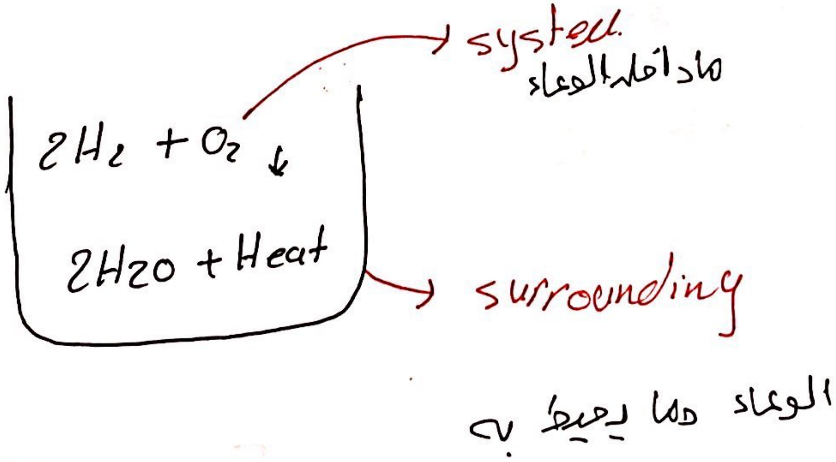
Ex:- 23cal in J ?

1cal → 4,184J

23 cal → ??

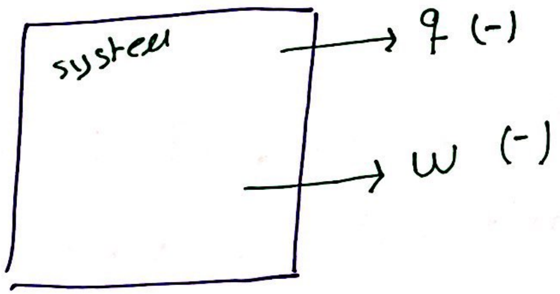
= 96,23 J

* system and surrounding
(النظام) (المحيط)



* Internal energy

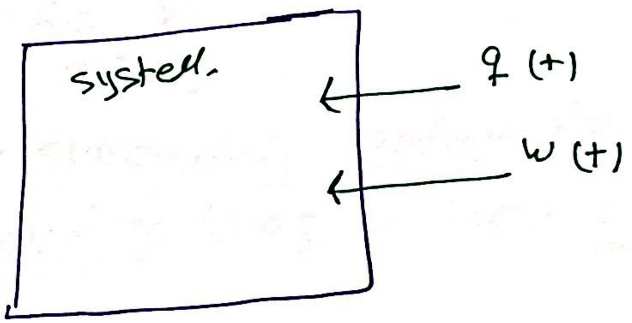
$\Delta E = w + q$



$\Delta E = -q - w$

$\Delta E = (-)$

Exothermic (طارد)



$\Delta E = q + w$

$\Delta E = (+)$

Endothermic (ماص)

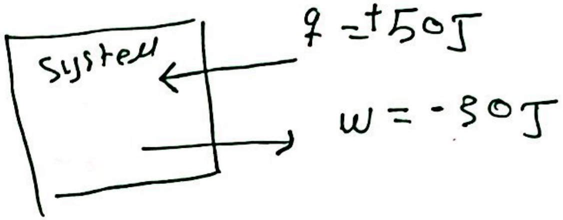
Example:- system absorb 50J as heat and does 30J as work

$\Delta E \rightarrow$ A) -20J

$\boxed{\text{B)}}$ 20J

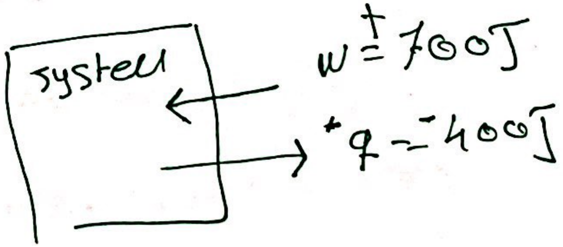
C) 80J

D) -80J



$$\Delta E = q - w$$
$$50 - 30$$
$$= 20J$$

Example: In particular process. the surrounding perform 700J of work upon the system, while the system evolves 400J of heat to surrounding



$$\Delta E = w - q$$
$$700 - 400$$
$$= 300 J$$

does]-
evolves

absorb →

perform →

$\Delta E = q + w$ → نظام مغلق

$\Delta H = q$ → نظام مفتوح (P = 1atm)

ΔH (enthalpy): the amount of the heat absorb or released by a system at constant pressure (1 atm)

$\Delta H = H_{final} - H_{initial}$

$\Delta H = (-)$ → exothermic Reaction. (طارد)

$\Delta H = (+)$ → endothermic Reaction (ماص)

- Enthalpy of reaction :-

↳ $2H_2 + O_2 \longrightarrow 2H_2O$

$\Delta H = H_{product} - H_{reactant}$

* Some properties for enthalpy

$\boxed{1}$ enthalpy is extensive

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ $(\Delta H = -802\ KJ)$

$2CH_4 + 4O_2 \longrightarrow 2CO_2 + 4H_2O$ $(\Delta H ? = -802 \times 2 = -1604\ KJ$

Ex:- How much heat is released when 4,5 g of CH_4 is burned in constant pressure system?

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ $(\Delta H = -802\ KJ)$

$(M.M\ (CH_4) = 16)$

$mol = \boxed{\frac{4,5\,g}{16}}$

$\frac{4,5}{16} \times -802$

$= -226\ KJ$

6

2 اذا عكسنا التفاعل بنعكس اشارة (ΔH)

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O \quad (\Delta H = -802\ KJ)$

$CO_2 + 2H_2O \rightarrow CH_4 + 2O_2 \quad (\Delta H = ?\ 802\ KJ$

3 اذا جمعنا معادلتين أو اكثر نجمع ΔH

$CH_4 + 2O_2 \longrightarrow CO_2 + \cancel{2H_2O} \quad (\Delta H = -802\ KJ)$

$+ \quad \underset{(g)}{\cancel{2H_2O}} \longrightarrow \underset{(L)}{2H_2O} \quad (\Delta H = -88)$

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \quad (\Delta H = \ ?)$

$-802 + -88 = -890K$

* Instrument used to calculate (ΔH) → (calorimetry)

- heat capacity and specific heat

- heat capacity: (السعة الحرارية), the amount of heat needed for the object to raise its temperature 1 C° or K

- specific heat: (الحرارة النوعية) the amount of heat needed for 1 gram of object to raise its temperature 1C° or 1K

$$\text{specific heat} = \frac{q}{m \times \Delta t} = \frac{J}{g \times C/K}$$

Ex:- calculate the specific heat of water if $\underset{q}{209\,J}$ is needed to increase the temperature of $\underset{m}{50\,g}$ of water by $\underset{\Delta t}{1K}$

$$\text{specific heat} = \frac{q}{m \times \Delta t} = \frac{209}{50 * 1} = 4,18 \ J / g \cdot K$$

Ex: The specific heat of iron is ,452 if 240J of heat is added to 7,05g of iron at 25c°, what would be the final temperture

specific heat = ,452

$q = 240\,J$

$m = 7,05\,g$

$t_{(i)} = 25c°$

- **A) 100c°**
- B) 75c°
- C) -100c°
- D) -75c°

$$\text{specific heat} = \frac{q}{m \times (t_f - t_{(i)})}$$

$$,452 = \frac{240}{7,05 * (t_f - 25c°)}$$

$$t_f = 100c°$$

Ex: [A] How much <u>heat</u> needed to $\underset{m}{\underset{\downarrow}{\underline{250g}}}$ of $\underset{\text{specific heat}}{\underset{\downarrow}{H_2O}}$ from 22 c° to it's boiling point (98 c°)

specific heat = 4,18

$\Delta t = 98 - 22 = \underline{76}$ c°

$$4{,}18 = \frac{q}{250 \times 76} \qquad q = 7{,}942 \times 10^{3}\ J$$

[B] what is molar heat capasity

$$4{,}18 \times \frac{18\ g\ H_2O}{1\ mole} = 75{,}24$$

* Calorimetry

$\Delta H_{rxn} = \ominus \Delta H_{H_2O}$ → $q_{rxn} = \ominus q_{H_2O}$

$q_{rxn} = - s.h * m \times \Delta t$

$$\text{specfic heat} = \frac{q}{m \times \Delta t}$$

$q_{H_2O} = s.h * m \times \Delta t$

$$\begin{cases} q = -C * \Delta t \\ w = -P \Delta V \end{cases}$$

\boxed{111}

* Hess's law

Ex: Using the information below

2x/ عكس $MnO_{2(s)} \longrightarrow MnO_{(s)} + \frac{1}{2}O_{2(g)}$ $\Delta H_1 = 136$ kJ

$MnO_{2(s)} + Mn_{(s)} \longrightarrow 2MnO_{(s)}$ $\Delta H = -249$ kJ

calculate ΔH for $\boxed{Mn_{(s)} + O_{2(g)} \longrightarrow MnO_{2(s)}}$

$O_2 + \cancel{2MnO} \rightarrow \overset{1}{\cancel{2}}MnO_2$ $\Delta H_1 = -(2 \times 136)$

$+$

$1\,\cancel{MnO_2} + Mn \longrightarrow \cancel{2MnO}$ $\Delta H_1 = -249$

$O_2 + Mn \longrightarrow MnO_2$ $\Delta H = -249 + (-2 \times 136)$

$= -521$ kJ

$$\Delta H_{rxn} = H_{product} - H_{reactant}$$

* standared enthalpy of rxn:-

$$\Delta H^{\circ} = \sum n \times \Delta H_{(product)} \ominus \sum n \times \Delta H_{reactant}$$

* $\Delta H^{\circ} = 0$] → element. in the standerd state (Al, N_2, O_2, H_2, Fe)

Ex: ΔH° for this reaction is -2816, what is ΔH for ($C_6H_{12}O_6$)

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_{2(g)} + 6H_2O_{(l)}$$

ΔH ? ∴ $-393,5$ $-285,8$

$$-2816 = ((6 \times -393,5) + (6 \times -285,8)) - (0 + 1 \times \Delta H)$$

$$\Delta H = -1259,8$$

Ex: Using the information below

$2 \times \quad Cu + \frac{1}{2}O_2 \rightarrow CuO \qquad \Delta H = -398\ kJ$

$\Delta H = -221\ kJ$

نعكس: $2Cu + \frac{1}{2}O_2 \rightarrow Cu_2O$

Calculate the ΔH for $Cu_2O + \frac{1}{2}O_2 \rightarrow 2CuO$

$\cancel{2Cu} + 1O_2 \rightarrow 2CuO \qquad \Delta H = -398 \times 2\ kJ$

$\Delta H = 221\ kJ$

$Cu_2O \longrightarrow \cancel{\frac{1}{2}O_2} + \cancel{2Cu}$

$\Delta H = 221 + (-2 \times 398)$

$\frac{1}{2}O_2 + Cu_2O \rightarrow 2CuO$

$\Delta H = -575\ kJ$

* اسئلة شاشات (CH6)

Q1: During compresstion of goseous system, the absorbed work was 420J, while a heat of 185J was released from the gas to surrounding, The net energy is:-

1- -210J

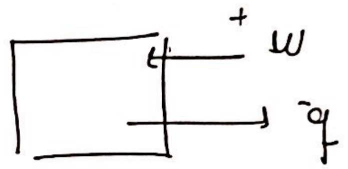
2- -235J

3- +210J

$\boxed{4}$ 235 J

$w = +420J$

$q = -185J$



$\Delta E = 420 - 185$

Q2: calculate the work (kJ) done during a reaction in which the internal volume contracte from 88L to 16L The pressure is 5,8 atm

$\Delta V = 16 - 88$

$\boxed{1}$ 42kJ

2. -24kJ

3- 61kJ

4. -61kJ

$w = -P\Delta V$

$w = -5{,}8 * (16-88)$

$w = 417{,}6\ (atm \cdot L)$

$1 atm \cdot L \longrightarrow 101{,}3J$

$417{,}6 \rightarrow ?J$

$\frac{42302{,}88}{1000} J$

42kJ

Q3:- Exactly 235,4 J will rais the tellprature of. 10g of a metal from 25,0C° to 60,C what is the spesific heat?

$\Delta t = 60 - 25$

$sp = \frac{q}{m \times \Delta t}$ $\frac{J}{g \cdot C}$

$sp = \frac{235,4}{10(60-25)}$

1- 1,49 J/gC

2- 13,1 J/g.C

$\boxed{3-}$,673 J/g.C

4. 56,3 J/g.C

5- none of these

Q4:- $2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(L)}$ $\Delta H = -285\ kJ$

The heat evolved when 10 mol H_2 was reacted is?

$\Delta H = -285 \times 5$

1- 570kJ

2- 235 J

3- 855 J

$\boxed{4-}$ 1425 J

5- -1425 kJ

Q5: What is enthalpy change of chemical reaction that raises the temp of 250mL of solution having a density of 1,25 g/ml by $\underset{\Delta t}{6,91}$ K? (The specific heat of solution is 3,74 J/g.K)

$\Delta H_{rxn} = -\Delta H_{solution}$

$q_{rxn} = -q_{solution}$

$= -s p m \Delta t$

$= -3,74 \times 312,5 \times 6,91$

$= -8076 J \times 10^{-3}$

$= 8,078$

1- -12,51 KJ

2- -7,43 KJ

3- 6,5 KJ

$\boxed{4-}$ -8,08 KJ

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

$1,25 = \frac{m}{250}$ $m = 312,5$

Q6: A $\underset{m}{,1375}$ g sample of solid Mg (M.M = 24,31) has heat capacity of $(\overset{C}{3024} J/C°)$ if the temp increasing by $\underset{\Delta t}{1,13}$ C° calculate the molar heat of Mg?

1- 604 KJ/mol

2- -3,42 KJ/mol

3- +3,42 KJ/mol

$\boxed{4-}$ -604 KJ/mol

$\Delta H = -C * \Delta t$

$= -3024 \times 1,13$

$= -3417,12$ J

$-3,417$ KJ

$\frac{\Delta H}{n} = \frac{-3,417 KJ}{5,6 \times 10^{-3} mol}$

-604 KJ/mol

$n = \frac{,1375}{24,31} = 5,6 \times 10^{-3}$

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* CH17: Entropy . free energy and equilibrium:-

- Entropy: It is Measure of randomness

ل(ΔS) / J/K

$$\Delta S = S_f - S_i$$

* $\boxed{S_{(g)} > S_{(aq)} > S_{(L)} > S_{(s)}}$

غاز محاليل سوائل صلب

- $Ag^+_{aq} + Cl^-_{aq} \longrightarrow AgCl_{(s)}$

$\Delta S = -$

- $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

$\Delta S = (-)$

- $4Fe_{(s)} + 3O_{2(g)} \longrightarrow 2Fe_2O_{3(s)}$

$\Delta S = (-)$

- $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$

$\Delta S \approx 0$

* Calculate of entropy change (ΔS)

$$\Delta S^\circ = S_f - S_i$$

$$\Delta S^\circ = \sum n \times S^\circ_{product} - \sum n \times S^\circ_{reactant}$$

* Calculate ΔS°

$$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$$

	S°
N_2	191,5
H_2	130,6
NH_3	192,5

$$(2 \times 192,5) - ((1 \times 191,5) + (3 \times 130,6)$$

$$= \ominus 198,3 \ J/K$$

* free energy / useful work (ΔG)

ΔH, ΔG]→ element = zero

ΔS element ≠ zero

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\underset{J}{\downarrow} \qquad J \quad \cancel{K} \times \frac{J}{\cancel{K}}$$

ΔH	ΔS	$\overset{-}{\Delta G} = \overset{-}{\Delta H} - \overset{+}{T\Delta S}$	changes
(-)	(+)	ΔG(-)	spont Rxn
(+)	(-)	+ ++ ΔG(+)	non-spont Rxn
(+)	(+)	+ - ↑T * + ΔG(-)	spont if (T) is very high
(-)	(-)	- + ↓T ΔS ΔG(-)	spont if (T) is very low

* Calculate free energy change

$$\Delta G^\circ = G_f - G_i$$

$$\Delta G^\circ = \sum \mu \times G^\circ_{product} - \sum \mu \times G^\circ_{reactant}$$

Ex:- calculate (ΔG°) for :- ($\Delta G(NH_3) = -16,66$)

[1] $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

$\Delta G^\circ = 2 \times -16,66$

$= -33,32$ J

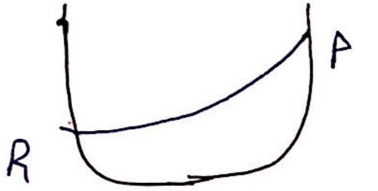
[2] $2NH_{3(g)} \longrightarrow 3H_{2(g)} + N_{2(g)}$

$\Delta G^\circ = 0 - 2 \times +16,66$

$= 33,32$ J

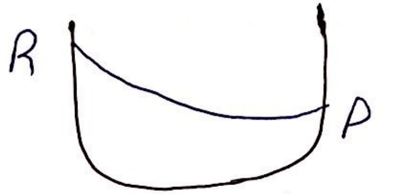
* free energy and equilibrium:-

$R \rightleftarrows P$



$\Delta G = G_P - G_R$

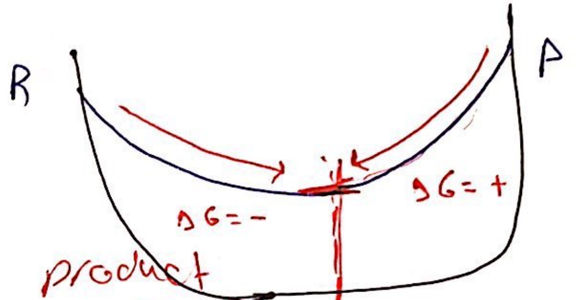
$\Delta G = (+)$ (reactant)



$\Delta G = G_P - G_R$

$\Delta G = (-)$

(product)



product

$Q < K$

$\Delta G = 0$

$Q = K$

reactant

$Q > K$

$$\Delta G = \Delta G^{\circ} + RT\ln(Q)$$

عند الاتزان $\Delta G^{\circ} = -RT\ln(K)$

$$\boxed{K = e^{-\Delta G^{\circ}/RT}}$$

Ex: calculate ΔG at 298 K for a Rxn. $\left[G^\circ_f(NH_3) = -16{,}66 \right.$ $R = 8{,}314 \times 10^{-3}$

.1 atm (N_2)

3 atm $(H_2$ .5 atm (NH_3)

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_3$

$\Delta G = \Delta G^\circ + RT\ln Q$

$\Delta G^\circ = 2 \times -16{,}66$

$= -33{,}32$ J

$\Delta G = 9{,}23 \times 10^{-3} + 8{,}314 \times 10^{-3} \times 298 \times \ln 9{,}23 \times 10^{-3}$

$\boxed{= -44{,}9}$

$$Q = \frac{(.5)^2}{(3)^3 \times (.1)}$$

$= 9{,}23 \times 10^{-3}$

Ex: for the rxn ($2NO_2 \rightleftarrows N_2O_4$)

* $R = 8,134$

$\Delta H^\circ = 56,9\ KJ$

Calculate K_p at $\underline{\underline{100C^\circ}}$

373K

$\Delta S^\circ = -175\ J/K$

$-175 \times 10^{-3}\ KJ$

$\Delta G^\circ = 56,9 - 373 \times 175$

$\Delta G^\circ = 122,175\ KJ$

$K = e^{-\Delta G^\circ / R T}$

$= e^{-122,175 \times 10^{3} / \cancel{8,134} \times 373}$ 8,314

$= 7,8 \times 10^{-18}$

Ex:- one mole of $A_{(g)}$ and one mole of $B_{(g)}$ are placed in 1L flask and heat $\underline{\underline{400K}}$

~~The~~ At equilibrium ,78 mole of (C) are present . what is ΔG° for this Rxn.

$K = \dfrac{(,78)}{(,22)(,22)}$

$K = 16,12$

$A_{(g)} + B_{(g)} \rightleftarrows C_{(g)}$

1	1	0
1-x	1-x	,78
1-,78	1-,78	
,22		

$\Delta G^\circ = -RT\ln(K)$

$\Delta G^\circ = -8,314 \times 400 \times \ln(16,12)$

$\boxed{= 9,045\ KJ}$

Q1:- For the reaction $(A+B \rightarrow C+D)$, $\Delta H^\circ = 40KJ$ and $\Delta S^\circ = 50 J/K$. Therefore, the reaction under standard condition is?

1- spontaneous at all temperatures

~~2~~ spontaneous at temperatures less than 10K.

~~3~~- spontaneous anly at tempertuers between 10K and 800K

$\boxed{4-}$ spontaneous at all tempertuers greater than 800K.

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$\boxed{1}$ $= 40000 - 9 \times 50$

$= (+)$

$40000 - 100 \times 50$

$(+)$

$40000 - 1000 \times 50$

$(-)$

Q2:- For a reaction to be spontaneous under standard conditions at all temperatures, the signs of ΔH and ΔS (— and —), respectively

	ΔH	ΔS
1-	+	0
2-	+	+
$\boxed{3-}$	−	+
4.	+	−

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$- \quad - \quad \oplus$

$(-)$

Q3: $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

The resulting solution has a higher temperature than the water prior to the addition of sodium, what are the signs of ΔH° and ΔS° for this reaction.

$\Delta H = (+)$

$\Delta S = (+)$

1. ΔH° is negative and ΔS° is positive
2. ΔH° is negative and ΔS° is negative
[✓ 3.] ΔH° is positive and ΔS° is positive
4. ΔH° is positive and ΔS° is negative

Q4: $P_{2(g)} + 3Cl_{2(g)} \rightarrow 2PCl_{3(g)}$

ΔG° at 298K for this reaction is -642,9 kJ/mole, The value of ΔG at 298K for a reaction mixture that consists of 1,9 atm P_2, 2,5 atm Cl_2 and ,55 atm PCl_3 is ___ kJ

R = 8,314

$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$= -642,9 \times 10^3 + 8,314 \times 298 \times \ln \frac{(,55)^2}{(2,5)^3 \times (1,9)}$$

1. -6,6
[✓ 2.] $-1,20 \times 10^4$
3. -755,1
5. -654,3

$-1,20 \times 10^4$

Q5:- Determine the equilibrium constant for the following reaction at 549K $\left(\begin{array}{l} \Delta H° = -94,9 \text{ KJ/mol} \\ \Delta S° = -224,2 \text{ J/mol} \cdot K \end{array} \right)$

1- $1,07 \times 10^{9}$

2- 481

3- $1,94 \times 10^{-12}$

$\boxed{4-}$ $2,08 \times 10^{-3}$

$\Delta G° = \Delta H - T\Delta S$

$= -94,9 \times 10^{3} + 549 \times 224,2$

$\Delta G° = 28185,8$

$K = e^{-28185,8 / 8,314 \times 549}$

Q6: If $\Delta G°$ for a reaction is equal to zero, then

1- $K > 1$

2. $K < 1$

3- $K = 0$

$\boxed{4-}$ $K = 1$

$K = e^{-\frac{\Delta G°}{RT}}$

$K = e^{-\frac{0}{RT}}$

$K = e^{0}$

$\boxed{K = 1}$

* CH18:- Electrochemistry

- Electrolysis cells : generation of an chemical Rxn from electric current

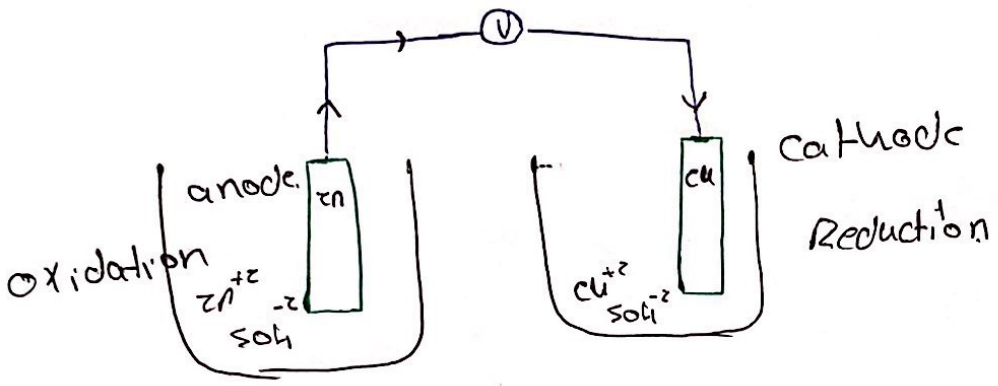
- Galvanic cells : generation of electric current from spontaneous chemical Rxn

* galvanic cells

oxidizing agent - Reduction : $Cu^{+2} + 2e^- \longrightarrow Cu$

Reduction agent - oxidation : $Zn \longrightarrow Zn^{+2} + 2e^-$

* cell potential



$Zn \longrightarrow Zn^{+2} + 2e^-$ $(E^\circ = ,76)$

$Cu^{+2} + 2e^- \longrightarrow Cu$ $(E^\circ = ,34)$

$,76 + ,34 = 1,1V$

* Standard Reduction potential (E°)

$2H^{+}_{(aq)} + Zn_{(s)} \longrightarrow Zn^{+2}_{aq} + H_{2(g)}$ $\quad$ $,76 + 0 = ,76V$

$Zn \rightarrow Zn^{+2} + 2e^{-}$ ($E^\circ = +,76$)

$2H^{+} + 2e^{-} \rightarrow H_2$ ($E^\circ =$ Zero)

Ex: Calculate E° cell for $Zn + Cu^{+2} \longrightarrow Zn^{+2} + Cu$

$Cu^{+2} + 2e^{-} \rightarrow Cu$ ($E^\circ = ,34$)

$Zn^{+2} + 2e^{-} \longrightarrow Zn$ ($E^\circ = -,76$)

$Zn \rightarrow Zn^{+2} + 2e^{-}$ ($E^\circ = ,76$)

$Cu^{+2} + 2e^{-} \rightarrow Cu$ ($E^\circ = ,34$)

$,76 + ,34 = 1,1V$

Ex: calculate E° cell for $Fe^{+3} + Cu \rightarrow Cu^{+2} + Fe^{+2}$

$2 \times (Fe^{+3} + e \rightarrow Fe^{+2})$ $(E^\circ = ,77V)$

$Cu^{+2} + 2e^- \rightarrow Cu$ $(E^\circ =$ [illegible] $,341)$ نعكس

$2Fe^{+3} + \cancel{2e^-} \rightarrow 2Fe^{+2}$ $(E^\circ = ,770)$

$Cu \rightarrow Cu^{+2} + \cancel{2e^-}$ $(E^\circ = -,34)$

$E^\circ cell = ,77 - ,34$

$= ,43V$

$\underline{\underline{n=2}}$

Ex: calculate E° cell for $Al^{+3} + Mg \rightarrow Al + Mg^{+2}$

$2 \times$ $Al^{+3} + 3e \rightarrow Al$ $(E^\circ = -1,66)$

$3 \times$ $Mg^{+2} + 2e^- \rightarrow Mg$ $(E^\circ = -2,37)$ نعكس

$2Al^{+3} + \cancel{6e^-} \rightarrow 2Al$ $(E^\circ = -1,66)$

$\boxed{n=6}$

~~3Mg~~

$3Mg \rightarrow 3Mg^{+2} + \cancel{6e^-}$ $(E^\circ = 2,37)$

$2Al^{+3} + 3Mg \rightarrow 2Al + 3Mg^{+2}$

$E^\circ cell = -1,66 + 2,37$

$= ,71V$

* Nernst equation:- → 96,485

$$\boxed{\Delta G^\circ = -nFE^\circ}$$

Ex: $2Fe^{+3} + Cu \rightarrow Cu^{+2} + 2Fe^{+3}$ → $\left[\begin{array}{ll} Fe^{+3} + e^- \rightarrow Fe^{+2} & (E^\circ = ,771 \\ Cu^{+2} + 2e^- \rightarrow Cu & (E^\circ = ,341 \end{array}\right.$

calculate ΔG $\Delta G^\circ = -2 \times 96,485 \times ,43$ $E^\circ = ,43V$

$= 82,977$

$$\boxed{E = E^\circ - \frac{,0591}{n} \log Q}$$

Ex: calculate E at concentration 3M Cu and 2M Zn

$Zn + Cu^{+2} \rightarrow Cu + Zn^{+2}$ $(E^\circ = 1,1$

$$E = 1,1 - \frac{0591}{2} \times \log \frac{2}{3}$$

$$= 1,015$$

* السئلة قناشات CH18

Q1: what is the shorthand notation that repesents the following galvanc cell reaction?

$$Zn_{(s)} + \overset{+2}{Cu}(NO_3)_{2\,aq} \longrightarrow \overset{+2}{Zn}(\overset{-2}{NO_3})_{2(aq)} + Cu_{(s)}$$

* $Zn_{(s)} | NO_{3\,(aq)}^{-} // NO_{3\,(aq)}^{-} | Cu_{(s)}$

~~2~~. $Cu_{(s)} | Cu(NO_3)_{2(aq)} // Zn(NO_3)_{2(aq)} | Zn_{(s)}$

~~3~~- $Cu_{(s)} | Cu^{+2}_{(aq)} // Zn^{+2}_{(aq)} | Zn_{(s)}$

$\boxed{4-}$ $Zn_{(s)} | Zn^{+2} // Cu^{+2}_{aq} | Cu_{(s)}$

Q2: Consider the following standard reduction potentials

The strongest oxidizing agent is :

1. $Cr^{+3}_{(aq)}$ 3- $Mn^{+2}_{(aq)}$ $\boxed{5.}$ $MnO_{4\,(aq)}^{-}$

2- $Cr_{(s)}$ 4. $Co_{(s)}$

~~1~~ $Cr^{+3}_{aq} + 3e \longrightarrow Cr_{(s)}$ $(E^\circ = ,073)$

$Co^{+2}_{(aq)} + 2e^- \longrightarrow Co_{(s)}$ $(E^\circ = ,2)$

$\underline{MnO_4^-}_{(aq)} + 8H^+ + 5e^- \longrightarrow Mn^{+2}_{aq} + 4H_2O_{(l)}$ $(E^\circ = +1,21$

Q3: Half-reaction $E^\circ(V)$

$Cr^{+3}_{(aq)} + 3e^- \rightarrow Cr_{(s)}$	$-,74$
$Fe^{+2}_{(aq)} + 2e^- \rightarrow Fe_{(s)}$	$-,44$
$Fe^{+3}_{(aq)} + e^- \rightarrow Fe^{+2}_{(aq)}$	$+,771$
$Sn^{+4}_{aq} + 2e^- \rightarrow Sn^{+2}_{(aq)}$	$,154$

$+,74$

Using the table above, the standard cell potentials ($E^\circ cell$) for the galvanic cell based on the reaction below

$$3Sn^{4+}_{aq} + 2Cr_{(s)} \rightarrow 2Cr^{+3}_{aq} + 3Sn^{+2}_{aq}$$

Sn
اختزال

1- $+2,53$

2- $-1,02$

$\boxed{3-}$ $+0,89$

4- $+1,94$

Q4: For the galvanic cell reaction, what half reaction accurs at the cathode? $Zn/Zn^{+2}//Fe^{+2}/Fe$

تأكسد

اختزال

1 $Zn_{(s)} \rightarrow Zn^{+2}_{(aq)} + 2e^-$

2- $Zn^{+2}_{aq} + 2e^- \rightarrow Zn_{(s)}$

$\boxed{3-}$ $Fe^{+2}_{aq} + 2e^- \rightarrow Fe_{(s)}$

4. $Fe_{(s)} \rightarrow Fe^{+2} + 2e^-$