New
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Civilittee

اللجنة الأكاديمية للهندسة المدنية

دفتر

اساسيات الكيمياء العامة

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الحسابات الكيميائية.

Mole

Dozen = 12

دزدينة ← 12 ← تريليار

التعريف الأول للمول في هذه الصفحة وهو عن طريق العد.

Mole: $6.02 * 10^{23}$

= 602 تريليار

→ Atom (عنصر): Na, H, O, C, Li ....

→ Molecule (جزيء (مركب)): 2 atome and more

∴ NaCl, H_2O, $C_6H_{12}O_6$

1 mole C atom = $6.02 * 10^{23}$ C atom

* Example: ① 1 mole of H_2 equals:

a) $6.02 * 10^{-23}$ **b) $6.02 * 10^{23}$** c) $6.02 * 10^{20}$

② How many atoms of carbon are in 0.5 mole of carbon atom?

$$0.5 \text{ mole of carbon} \times \frac{6.02 * 10^{23} \text{ C atom}}{\text{mole of C}}$$

$= 0.5 * 6.02 * 10^{23}$ C atom

$= 3.01 * 10^{23}$ C atom.

يتبع ...

eg:③ How many mole of carbon atom fore $6.02 * 10^5$ c atom?

$1 mole \longrightarrow 6.02 * 10^{23}$ catom

$X \longrightarrow 6.02 * 10^5$ catom

$$X = \frac{6.02 * 10^5 \text{ catom}}{6.02 * 10^{23}}$$

$$= 1 * 10^5 * 10^{-23}$$

$$= \boxed{1 * 10^{-18}} \text{ mole of C}$$

$$\text{mole} = \text{molar Mass}$$

هنا التعريف الذي يتعلق بالوزن.

1 mole Na = 23 g Na = 6.02 تريليار Atom.

2 mole Na = 46 g Na = 12.04 تريليار Atom.

eg: How many mole of Na atom are in 46g Na?

$$\frac{46\text{g Na}}{23\text{g Na}} * \frac{1 \text{ mole Na}}{} = \boxed{2 \text{ mole Na}}$$

$$* \boxed{\frac{1 \text{ mole Na}}{23 \text{ g Na}}} \equiv \boxed{\frac{23 \text{ g Na}}{1 \text{ mole Na}}} \equiv 1 \text{ mole Na} = 23 \text{ g Na}$$

eg: How many mole cule of H_2O in 9g H_2O ?

1 mole H_2O = $6.02 * 10^{23}$ mole cule H_2O = 18 g H_2O

X = 9g H_2O

= $3.01 * 10^{23}$ molecule

molar mass H_2O = $2*1 + 1*16$ = 18

طريقة الحل الثانية

$$0.5 \text{ 9g } H_2O \times \frac{1 \text{ mole}}{18 \text{ g } H_2O} = 0.5 \text{ mole}$$

$$0.5 \text{ mole} \times \frac{6.02 * 10^{23} \text{ mole cule}}{1 \text{ mole}}$$

$$= \boxed{3.01 * 10^{23} \text{ mole cule } H_2O}.$$

---

eg: How many Hydrogen atom in 9g H_2O ?

1 mole cule H_2O = 2 H atom

$3.01 * 10^{23}$ mole cule H_2O = ??

$$0.5 \text{ 9g } H_2O \times \frac{1 \text{ mole } H_2O}{18 \text{ g } H_2O} \times \frac{6.02 * 10^{23} \text{ mole cule } H_2O}{1 \text{ mole } H_2O} \times \frac{2 \text{ atom H}}{1 \text{ mole cule } H_2O}$$

$0.5 * 6.02 * 10^{23} * 2$

$= 6.02 * 10^{23}$ atom of H

H.w: ① How many of oxygen atom in 6g O_3 molecule ? $2.25 * 10^{23}$

② " " " " " " " " O_2 molecule ? $1.50 * 10^{23}$

③ " " ~~oxygen~~ atoms are in 6g CO_2 molecule ?

$2.46 * 10^{23}$ atoms

$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$

4 mole 3 mole 2 mole

$2*(4Fe) + 6O_2 \longrightarrow 2(2Fe_2O_3)$

$8Fe + 6O_2 \longrightarrow 4Fe_2O_3$

---

eg: How many mole of Fe_2O_3 are produced From reaction of 6 mole O_2 ?

$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$

$3\ O_2 \longrightarrow 2\ Fe_2O_3$

$6\ O_2 \longrightarrow X$

$3O_2 X = 6 * 2\ O_2 * Fe_2O_3$

$X = \frac{12\ O_2 * Fe_2O_3}{3O_2}$

$= \boxed{4\ Fe_2O_3 \text{ mole}}$

How mang gram of Fe_2O_3 are produced From Reation of 6 mole of O_2 ? molar mass $Fe_2O_3 = 160g$

$6\ mole\ O_2 \times \frac{2\ mole\ Fe_2O_3}{3\ mole\ O_2} \times \frac{160g\ Fe_2O_3}{1\ mole\ Fe_2O_3}$

$4\ mole\ Fe_2O_3 * \frac{160\ Fe_2O_3}{1\ mole}$

$= \boxed{640g\ Fe_2O_3}$

eg: How many gram of Fe_2O_3 are produced from Reaction of 192 g of O_2 ?

Sol:

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

$$= \frac{192 * 2\,mole\,Fe_2O_3 \times 160\,g\,Fe_2O_3}{32 * 3 * 1\,mole\,Fe_2O_3}$$

$$= \frac{192 * 2 * 160\,g\,Fe_2O_3}{32 * 3} = 640\,g\,Fe_2O_3$$

$$2H_2 + O_2 \longrightarrow 2H_2O$$

M.m H_2O = 18g

?? g ?? mole ?? mole — 1800g H_2O

eg: How many gram of oxygen are reacted to produced 1800g H_2O ?

$$1800\,g\,H_2O \times \frac{1\,mole\,H_2O}{18\,g\,H_2O} \times \frac{1\,mole\,O_2}{2\,mole\,H_2O} \times \frac{32\,g\,O_2}{1\,mole\,O_2}$$

$$= 1600\,g\,O_2$$

YASSIN

الأحد ٤/٢ Limiting Reagting

العادة المحددة للتفاعل.

$2H_2 + O_2 \longrightarrow 2H_2O$

10 mole H_2 7 mole O_2 10 mole H_2O

يتفاعل 5 mole O_2

2 mole O_2 فائض.

L.R

تعريف ① Reactant that consumed completely (استهلاك المادة)

تعريف ② Reactant that limit the product.

Ex: 12g Zn react with 6.5g S to produce ZnS

M.m
Zn = 65.5
S = 32.06

$Zn(s) + S(s) \longrightarrow ZnS(s)$ (اسود)

1) Determine L.R
2) how many gram of exces reactant ?
3) how many gram of ZnS is produced ?
4) percent yeild (الإنتاجية) IF you obtain 8g of ZnS are actual yeild? (عمليا)

عمليا اذا حصلت على 8g من ZnS.

1) أول خطوة التحويل إلى مولات

$12g\ Zn \times \frac{1 mole\ Zn}{65.5 g\ Zn}$

$= 0.122 mole\ Zn$

$6.5 g S \times \frac{1 mole}{32.06 S}$

$= 0.2 moles$

يتبع

$$\overset{12}{Zn} + \overset{6}{S} \longrightarrow ZnS$$

0.182 mole, 0.202 mole

1) Zn = L.R

2) 0.182 moles $\times \frac{1\text{mole}}{\cancel{32.06}\ 1\text{m}} \frac{32.06\,g}{1\text{moles}}$

$= (0.64\,g\ \text{selver})$

3) ~~1mol~~ 0.182 mole Zn $\times \frac{65.5\,g\,Zn}{1\text{mole Zn}} \times \frac{1\text{mole Zn}}{1\text{mole ZnS}} \times$

0.182 mole Zn $\times \frac{1\text{mole ZnS}}{1\text{mole Zn}} \times \frac{97.56}{1\text{mole ZnS}} = 17.759\,g_{ZnS}$

$12 + 6 - 0.64 = 17.75\,g\ ZnS$

4) Percent yield $= \frac{\text{Actual yield ZnS}}{\text{Theogirical yield ZnS}} \times 100\,\%$

$= \frac{8}{17.75} = 45\,\%$

YASSIN

الثاني ٦/١١

٤٧:

Al = 27g
O = 16

① 5g AL react With 5g O2 to produce Al2O3 According to the Following Reaction: How many grams of Al2O3 produced?

$$4\,AL + 3O_2 \longrightarrow 2Al_2O_3$$
5g 5g 5g — 95 غرام

a) 10g. b) 100g. c) 1000g d) 9.44

كتلة صغيرة فاعل فيجب أن تكون أقل من 10g

Sol: $5g\,AL \times \frac{1\,mole\,AL}{27g\,AL} = 0.185\,mole\,AL$

$5g\,O_2 \times \frac{1\,mole\,O_2}{32g\,O_2} = 0.156$

4 mole AL = 1 mole O2
0.185 mole AL = ?? X

$$0.185\,mole\,AL \times \frac{3\,mole\,O_2}{4\,mole\,AL} = 0.138\,mole\,O_2$$

L.R → AL
0.156 الفائض
0.138
0.018 mole O2

$$0.185\,mole\,AL \times \frac{2\,mole\,Al_2O_3}{4\,mole\,Al} \times \frac{102g\,Al_2O_3}{1\,mole\,Al_2O_3} = 9.435\,g\,Al_2O_3$$

* 5g AL X 5g O2 — طريقة أخرى هي 9Al2O3 ونأخذ الأقل.

* percent of element in compound :-
نسبة العنصر في المركب

$$n = \frac{\text{عدد مولات العنصر} \times \text{الكتلة المولية للعنصر}}{\text{الكتلة المولية للمركب}} \times 100\%$$

- $C_6H_{12}O_6$ احسب نسبة الـ C

$$n = \frac{6 * 12}{180} * 100\% = \boxed{40\% \ C}$$

احسب لـ H

$$n = \frac{12 * 1}{180} * 100\% = 6.66\% \ H$$

احسب لـ O

$$n = \frac{16 * 6}{180} \times 100\% = 53.34\% \ O$$

* يجب أن يكون مجموعهم 100%

... يتبع

Determination Empirical Formula and Molecular formula
الجزيئية

Ex: White powder contain 40% C and 6.66% H by. Determine the Empirical Formula and Molecular formula. such that, C, O, H, M.M = 180g

* 3 steps

تحويل النسبة لجرامات

[1] 40g C × $\frac{1 \text{ mole C}}{12 \text{g C}}$ = $\frac{3.33 \text{ mole C}}{3.33}$

6.66g H × $\frac{1 \text{ mole H}}{1 \text{g H}}$ = $\frac{6.66 \text{ mole H}}{3.33}$

53.34g O × $\frac{1 \text{ mole O}}{16 \text{g O}}$ = $\frac{3.33 \text{ mole O}}{3.33}$

[2] تحويل لـ mole

[3] بنشوف أصغر عدد و بنقسم عليه

1C → 2H → 1O

نحسب الـ m.m

1*12 + 2*1 + 1*16
= 30

نقسم M.M المركب على M.M اللي طلع

= $\frac{180}{30}$ = 6

← نضرب المركب الناتج بالعدد اللي بطلع لاستخراج المطلوب.

= CH_2O * 6
= $C_6H_{12}O_6$

Ex: White powder is analyzed and found to contain 43.64% P and 56.36% O by mass

[1] Empirical Formula ?

[2] molecular Formula? M.m = 283.88 g/mole

$$56.36\,g \times \frac{1\,mole\,O}{16} = \frac{3.5}{1.4}\,mole\ O = 2.50 \times 2$$

$$43.64\,g \times \frac{1\,mole\,P}{31\,g} = \frac{1.4}{1.41}\,mole\ P = P_2P_5 \times 2$$

$$= P_2O_5$$

[2] $P_2O_5 = 142$

$$n = \frac{283.88}{142} = [2]$$

$2 \rightarrow P_2O_5 \times 2$

$= \boxed{P_4O_{10}}$

Ex: When 0.1156 g of unknown compound contain (C, H, N) react with oxygen, 0.1638 g CO_2 and 0.1676 of H_2O what is the Empirical formula ?

compound $\xrightarrow{O_2}$ $CO_2 + H_2O$

0.1156 g → 0.1638 g, 0.1676 g

0.1638 g → %C → 9C

0.1676 g → %H → 9H

CH_5N

الخميس ١١/٨ ch5:- Gases.

Matter المادة لها ثلاث حالات

1) Solid
2) Liqued
3) gase
   - AL Hwa → O2, N2, H2O, CO2, CO, Ar
   - Noble gases → He, Ne, Ar, Kr, Rn
   - NH3, CH4, H2S

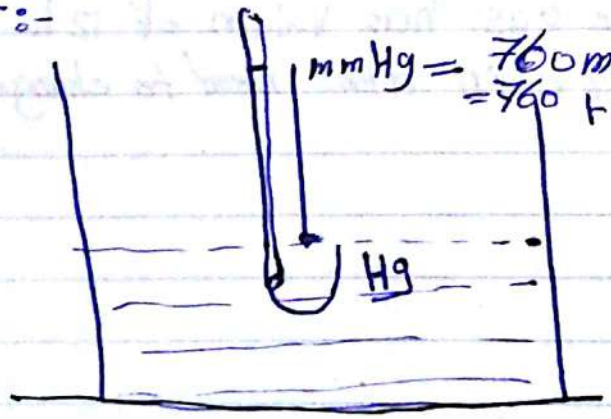
الأحد ١٤/١١

* خصائص الغازات *

1. يأخذ شكل الوعاء

2. Density (الكثافة) → 2g/L = الكتلة / الحجم

*Barometer :-



مستوى سطح البحر.

1 atmoosphere = 760 mmHg = 760 tore

كلما نزلنا للأسفل يزيد ويقل كلما ارتفعنا.

760 tore → 1013 kpa

يتبع ...

Ex: Convert 460 mmHg to 1) atm 2) kpa

* Boly law :- P, V

	P (atm)	V (L)	P*V
1	16	1	16
2	8	2	16
3	4	4	16

$P_1V_1 = P_2V_2$ at constant temp

Ex: Sample of He gass has volum of 12 L at 600 mmHg. What new pressure in atm need to change the volume to 36 ?

= 0.26 atm

Charlies law

$K = C + 273$

$T \propto V$

$T = 273\ k$
$V = 250\ mL$

$T = 546\ k$
$V = 500\ mL$

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

بشرط ثبات P=constant

Ex: Sample of oxygen gass has volume of 420mL at temperature of 18c° what temeprature (in c°) is needed to change the volume to (640mL) ?

ممنوع استخدام ت بالفاوت

$= 170\ c°$

YASSIN

تذكر طنجرة الضغط

الأحد 1/11 Gay-Lussacs law P,T

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \rightarrow V = \text{constant}$$

EX:

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* Combined gas law *

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$ — مهم جداً

Ex :- Sample of Ne gass has avolume of 0.18 L, apressure of 0.8 atm and temp of 29C what is the new temp . C° of the gass at volume of 90 mL and 3.20 atm ?

= 331 C°

Avogadros law:

$\frac{V_1}{n_1} = \frac{V_2}{n_2}$ ← العلاقة بين الحجم وعدد المولات طردية

EX:- Cylinder with movable piston contain 2g He at room temp More He was added and the volume was adjusted so that the gas pressure remained the same.
How many grams of He were added to the cylinder IF the Volume of gass changed from 2L to 2.7L

$n_1 = 2g \times \frac{1 mole He}{4g He} = 1/2 mole He$

$n_2 = ??$

$V_1 = 2L$

$V_2 = 2.7L$

$\frac{V_1}{n_1} = \frac{V_2}{n_2} \rightarrow \frac{2}{1/2} = \frac{2.7}{X}$

$n = X = 0.675$

$0.675g \times \frac{4g}{1mole} = 2.7g He$

$\Delta g = 2.7 - 2 = 0.7g$ ← الاضافة

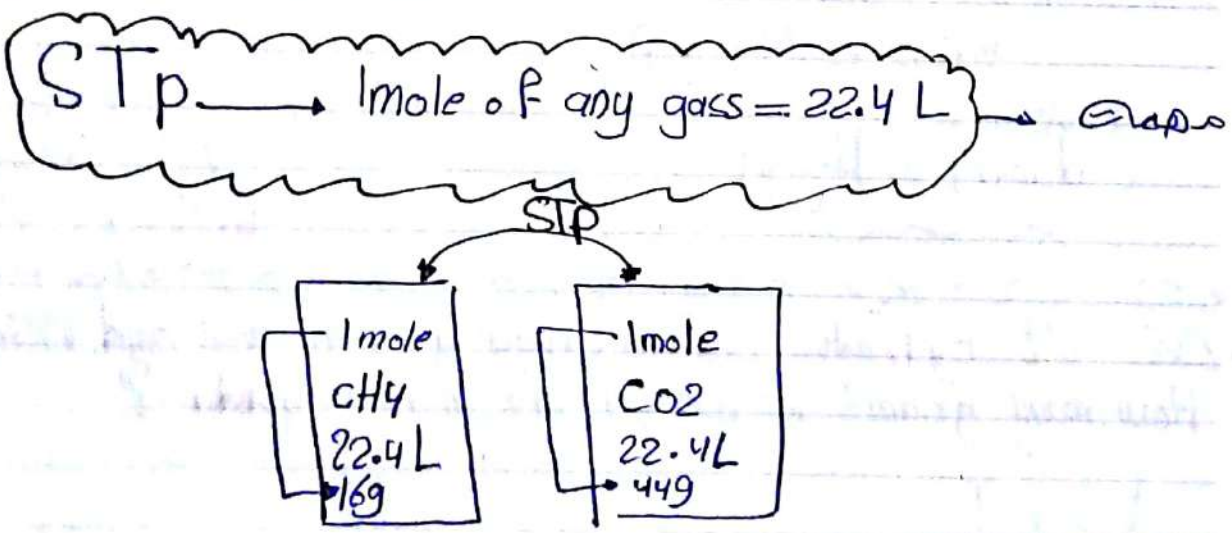
Stande Tempreture Pregure (STP)

273 K

1 atm = 760 mm

Ex: Sample of neon gas has volume of 15L at STP
What is new volume (L) ~~Find~~ on the gass at 2atm and -25C° ?

cool
$V_2 = 6.8L$



Ex: How many (L) of 4g of cH4 at STP?

$$4g\ cH_4 * \frac{1\ mole}{16g} = \frac{1}{4}\ mole\ cH_4 \times \frac{22.4}{1\ mole} = 5.6L\ cH_4$$

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الخميس 2/15 * Ideal gas law

- Charly → $V \propto T$ (constant P)
- Bouly → $V \propto \frac{1}{P}$
- Allogadro → $V \propto n$

$V \propto \frac{nT}{P} \rightarrow V = \frac{RnT}{P}$

$R = 0.0821 \frac{atm \times L}{mole \times k}$

$R = 62.4 \frac{mmHg \times L}{mole \times k}$

$PV = nRT$

$M.m = \frac{mass \times RT}{V \times P}$

$\frac{mass}{V} = \frac{M.m \cdot P}{R.T}$

density $= \frac{M.m \times P}{R.T}$

(mass) Ex: 5L cylinder contain oxygen gass at 20c° and 735 mmHg, How many grams of oxygen are in the cylinder?

$V = 5L$

$T = 293k$

$P = 735\ mmHg$

$R = 62.4$

$M.M = 32$

$m = \frac{PV.M.M}{R.T} =$

6.4g O2

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(molar mass) Ex: What is the Molar Mass of a gass if 0.25g of the gass occupy (يحتوي) 215 mL at ~~2.8~~ 0.813 atm and 30°C?

$m = 0.25g$ $\quad R = 0.0821$

$V = 215 mL \rightarrow 0.215 L$

$P = 0.813 atm$

$T = 303 K$

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

$$M.M = \frac{mRT}{PV} =$$

$$= 35.6 \frac{g}{mole}$$

(Density) ex: Calculate the density of oxygen gas at STP?

$V = 22.4$

$n = 1 mole \rightarrow$ $\quad 1 mole \rightarrow 32g$

$P = 1 atm$

$T = 273 K$

$R = 0.082$

$$D = \frac{mass}{V} = \frac{32}{22.4} = 1.4$$

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2/18 *Using equation in gases*

Ex: $Fe(s) + H_2SO_4 \longrightarrow H_2(g)\uparrow + FeSO_4$

(grams) → (n)

→ 453.6 * 10^3 g of iron added to H_2SO_4 to produce H_2

$Fe(s) + H_2SO_4 \longrightarrow Fe(s) + H_2(g)$

AT STP, How many liter of H_2 were generated? (R = 0.821)

$PV = nRT$

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

Sol = 181440

Ex: How many liter of O_2 to react 28g NH_3 at 24° and 0.95 atm

$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

52.5 L

4 → 5
2 → x
2.5

الأحد 2/18 *Dalton's law*

$P_t = P_1 + P_2 + P_3 + \dots$ → قانون دالتون

Total pressure — Partial pressure

$PV = nRT$

$P_1 V_{\text{كلي}} = n_1 R T$ → يكون لجميع الغازات في نفس الوعاء يتساوى (V, T, R)

$$P_T = n_1 \frac{RT}{V} + n_2 \frac{RT}{V} + n_3 \frac{RT}{V} + \dots$$

$$= \left(\frac{RT}{V}\right)(n_1 + n_2 + n_3 + \dots)$$

Ex: 5L scuba tank contain 1.05 mole of O_2 and 0.418 mole of He at 25C°:

1) what is partial pressure of each gas?

$$P_{O_2} = \frac{1.05 * 0.0821 * 298}{5} = 5.13$$

$$P_{He} = \frac{0.418 * 0.0821 * 298}{5} = 2.04$$

2) what is the total pressure?

$= 7.17$ atm.

YASSIN

$$\frac{P_1}{P_T} = \frac{n_1 RT}{n_{tot} RT}$$

$$= \boxed{\frac{P_1}{P_T} = \frac{n_1}{n_T}}$$ ← هذا قانون

$\frac{n_1}{n_T}$ = mole Fraction = X (الكسر المولي)

$$\boxed{\frac{P_1}{P_T} = X}$$ ← قانون الكسر المولي

EX: NH_3 decomposed to N_2 and H_2 as

$n_1 = n_{N_2} + n_{H_2} = 3+1 = 4$

$$\underbrace{2NH_{3(g)}}_{P_1} \longrightarrow N_{2(g)} + \underbrace{3H_{2(g)}}_{P_T}$$

If 4 atm of NH_3 was decomposed what is Total pressure?

$$\frac{P_1}{P_T} = \frac{n_1}{n_{total}}$$

$$= \frac{4}{P_T} = \frac{2}{4} \Rightarrow P_T = 8\,atm$$

EX: 3.31 g $Pb(NO_3)_{2(s)}$ (M.m = 331 g/mole) is heated in 1.38 L cylinder. The sold decomposes.

$$2Pb(NO_3)_{2(s)} \rightarrow 2PbO_{(s)} + 4NO_{2(g)} + O_{2(g)}$$

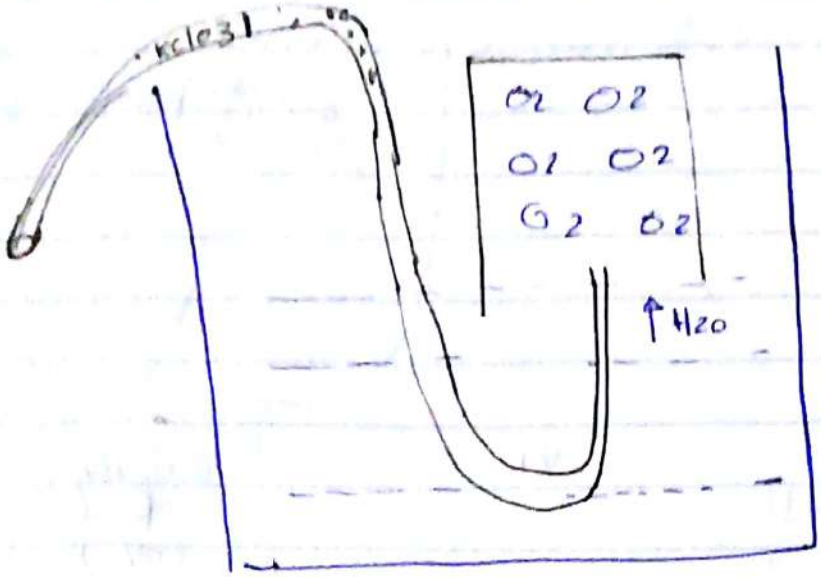
What is the Pressure in acylinder After decomposition (T = 300 k)

0.446 atm YASSIN

* collecting gass over H2O(water)

$2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

(grams) (s) (s) (g)



Ex: Sample of kclo3 is decomposed producing O2 gas That is collected over water

$2KClO_3(s) \xrightarrow{\Delta} 2KCl_{(s)} + 3O_2(g)$

and 765 mmHg as total pressure with volume of gas is 0.25L at 26c° (P_{H_2O} = 25 mmHg, at 26 c°)

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

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

$= 765 - 25 = 740 mmHg$

1) How many mole of O2 are collected?

$P_{O_2} = 740 mmH$

$T = 299K$

$V = 0.25 L$

$R = 62.4$

$n = \frac{PV}{RT} = 0.01 mole$

b) How many grams of kclo3 were decomposed?

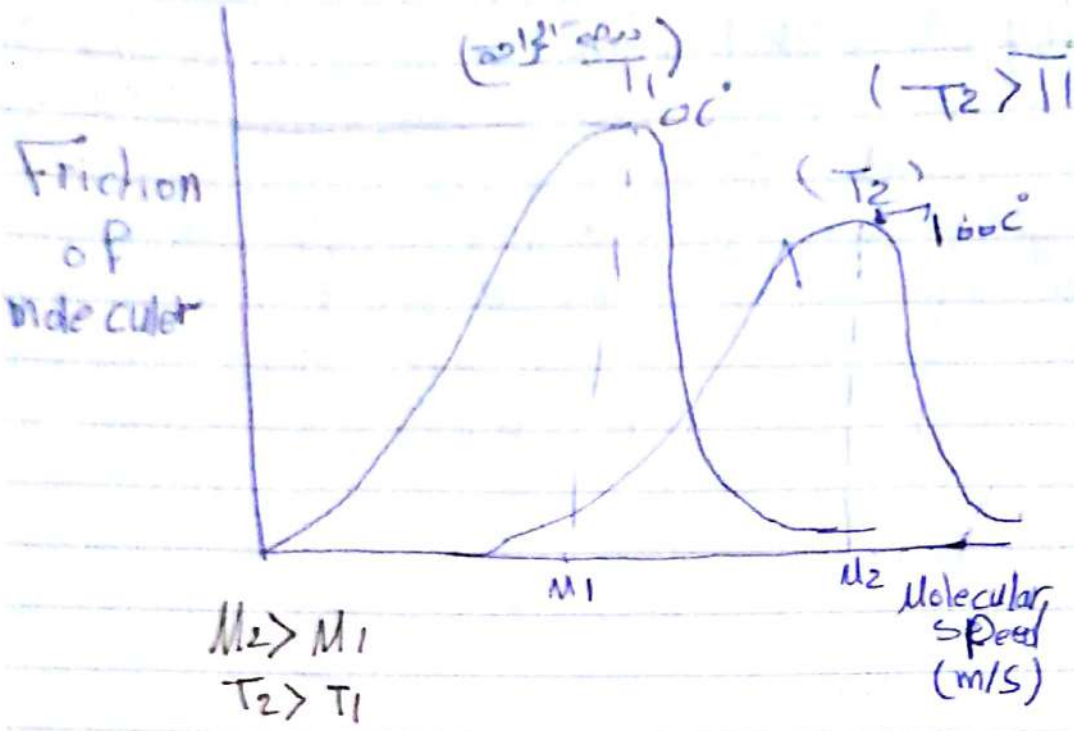
2 : 3 → $X = 0.13 mole\ KClO_3$

X : 0.01

$0.13 \text{ mole} \times \frac{122.6 g}{1 mole} = 0.13 g$ kclo3 M.m

2/20

Kinetic-Molecular Theory



$M_2 > M_1$
$T_2 > T_1$

→ The curve shows that fraction of moleculy moving at each speed.

* At higher tempreture atrgs fraction of moleculy is moving at greter speed.

	H_2	He
M	2	4

Speed of H_2 > speed He

* speed of gas ≡ root-mean square ≡ rate Effusion of gas

$$\equiv u_s \equiv \boxed{u}$$

$$u = \sqrt{\frac{3RT}{M}}$$

$$R = \frac{kg \cdot m^2}{mol \cdot K \cdot s^2} \quad J$$

8.314

$$u \equiv \sqrt{\frac{kg \cdot m^2}{s^2}} \equiv \sqrt{\frac{m^2}{s^2}} \equiv m/s$$

2/22 الخميس

* نتائج *

EX: Calculate the root-mean square sample of Helium gas at 25C° (R=8.314)

* يجب تحويل من درجة سلزيوس لكلفن .

*Graham law :-

$$\frac{M_1}{M_2} = \frac{\sqrt{\frac{3RT}{M.m1}}}{\sqrt{\frac{3RT}{M.m2}}} = \sqrt{\frac{M.m2}{M.m1}}$$

① EX: Which gas will effuse faster, NH_3 or CO_2. مين اسرع

$M.m\ NH_3 = 14+3 = 17$
$M.m\ CO_2 = 32 + 12 = 44$
$\therefore NH_3$ faster than CO_2

② what are their relative rate of effussion?
شو نسبة سرعتهم لبعض اي السؤال اللي بتذكر أول هو البسط)

$$\frac{U_{NH3}}{U_{CO2}} = \sqrt{\frac{U.MCO2}{U.MNH3}} = \sqrt{\frac{44}{17}} = 1.6$$

YASSIN

Ex: An unknown gas (X_2) effuse at arate that is only 0.355 times that of O_2 what is the idenstiy of the unknown gas?

$M = 0.355$ speed of O_2

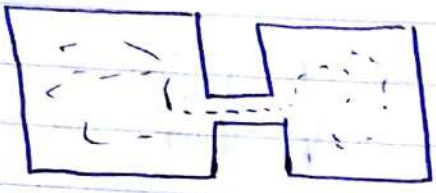
$$\frac{M_{X_2}}{M_{O_2}} = \sqrt{\frac{M.m_{O_2}}{M.m_{X_2}}}$$

$$0.355 = \sqrt{\frac{32}{M.m_{X_2}}}$$

$$M.m\ X_2 = 253.4$$

1) Cl_2
2) N_2
3) F_2
4) I_2
5) Br_2

* Effusion → تدفق (انتقال من مكان لمكان)



* Diffusion → انتشار (التوزع في نفس المكان والحيز)

الأحد 2/25 ch11 الإمتحان 2-3 / 11-12

Inter molecular forces . Liquid and Solid.

1. Intra molecular forces
الروابط في نفس الجزيء

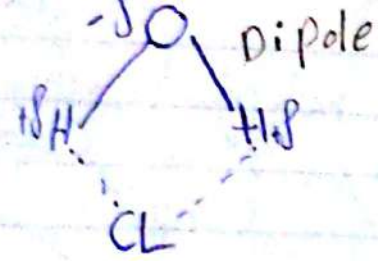
2. Inter molecular forces.
الروابط بين جزيء وجزيء آخر

1
① ionic bond (Metal + non metal) غاز - معدن أيونية. (أقوى الروابط) 1
NaCL

② Covalent bond (تساهمية) (أضعف) 2
(non metal + non metal) غاز - غاز
HCL

2 ① Ion - dipole. (أضعف) 3 وهي الأقوى في الـ Inter
Na^+ أيون موجب يجذب شحنة Cl^- أيون سالب
جزيء ذو قطبين ⊕ و ⊖ مع بعضهم (قطبي)

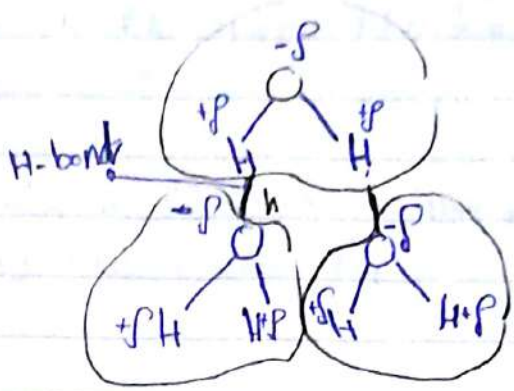
Na^+ Ion

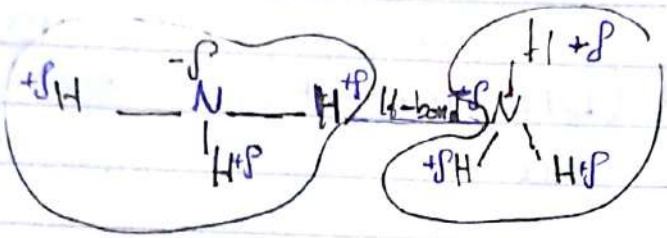


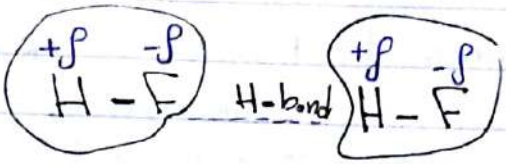
2/25

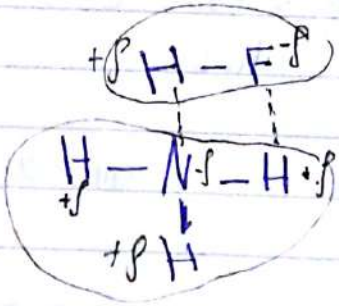
② Hydrogen bond الرابطة الهيدروجينية (٨ صفحة) [٧]

الشروط
- N – H
- O – H
- F – H

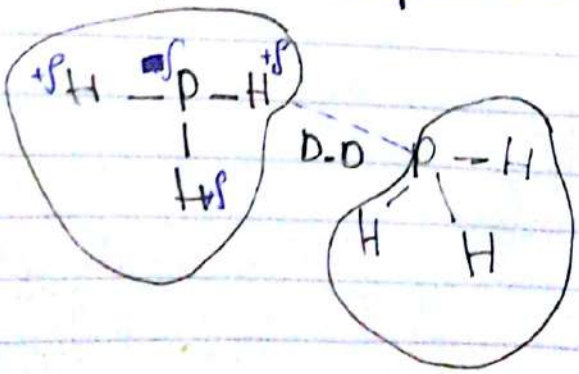




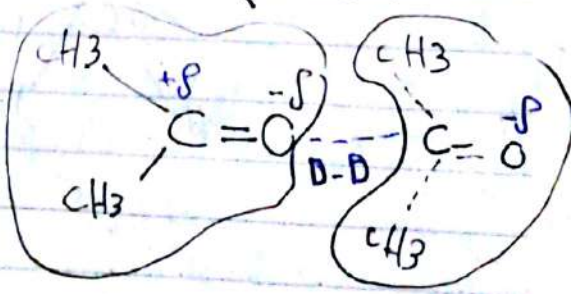




③ Dipole _ Dipole.



⑤ (٨ صفحة)
(نفس ③ ولكن عناصرها غير)
(N, O, F)



YASSIN

④ london - dispersion forces

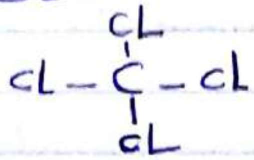
→ non polar (غير قطبية)

1) $H_2, N_2, F_2, F_2, Cl_2, X_2$ ....
2) Noble gases (grop 8)
3) جميع المركبات التي تحتوي فقط C و H
(مستحيلة التوضيح) 4) جميع المركبات التي تكون linear (خطي) $^{-\delta}O = C^{+\delta} = O^{-\delta}$

H-bond

1) H_2. 2) HCl. 3) NH_3. 4) PH_3

(مهم) ⑤ AX4 على صيغة



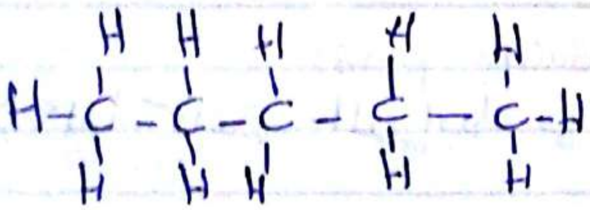
من حيث M.M ⑧ H_2 — Ne : bonding

B.P اللي عنده M.M أكبر هو الأقوى

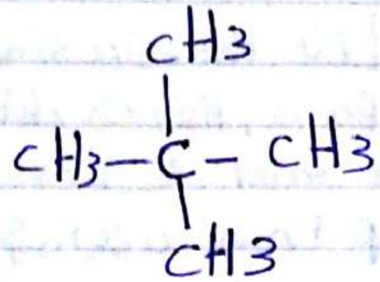
$2 < 20$

∴ $B.P\ H_2 < B.P\ Ne$.

من حيث الشكل ⑧



C_5H_{12}
$MM = 72$



C_5H_{12}
$MM = 72$

linear > circle
B.P B.P

2/27

درجة الغليان B.P

CH_3CH_2OH H-bond $OHCH_2CH_3$ — $78C^\circ$

$HoCH_3\ CH_2OH$ ——— $200\ C^\circ$

* كلما زاد عدد OH تزيد قوة الرابطة.

كل ما زادت نقاط الإرتباط في H-bond زادت قوة الرابطة ✅
وبالتالي Bop سوف تزداد (درجة الغليان)

EX: In which of the following substance is Hydrogen bonding posibble.?

a) CH_4	a) CH_4
b) H_2S	b) H_2S
c) CH_3F	(c) $NH_2\ NH_2$
(d) HF	d) PH_3

2 List the substace :-
$BaCl_2$, H_2, Co, HF, Ne
in order increasing Boling point
← (كلما كانت الروابط قوية يكون عندها B.p عالي)

> > > .

أعلى

a) $HF > Co > Ne > H_2 > BaCl_2$
b) $HF > BaCl_2 > CO > Ne > H_2$
(c) $BaCl_2 > HF > co > Ne > H_2$

✅ كل ما H-bond فيه D.D وكل المركبات في الكون فيها قوى london

Some properties of liquids
خصائص السوائل

① Viscosity (اللزوجة)

Def: Resistance (مقاومة) of liquid to flow

1. Viscosity ↓ (تقل) with ↑ (ازداد) temp.

2. viscosity depend on Inter molecular forces.
(الروابط بين الجزيئ وأخوه وهي طردية)

② Surface Tension (التوتر السطحي)

Def: properties that measure the energy required to expand the surface area of liquid by unit amount of area.

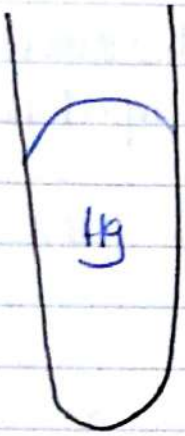
الخميس 3/2021 * Cohesive and Adhesive Forces. *

تماسك

- Cohesive forces → جزيئات مع جزيئات
  - H-bond in water bind similar to onether
- Adhesive Force → جزيئات مع السطح
  - Inter moleculer forces that Forces that bind substance to surface.

→ Adhesive force > cohisive force

H2O Concave (مقعر)



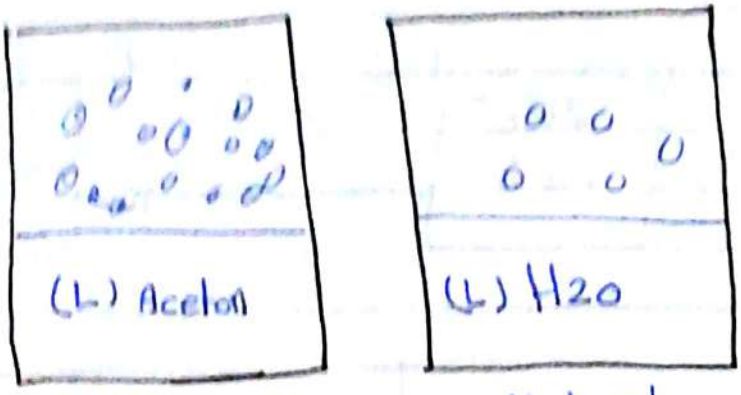
→ Cohesive Forces > Adhesive Forces

(محدب) convex

(الخاصية الشعرية)

- capillary action :- The rise of liquid up in avery narrow tubes.

* vaper pressure * الضغط البخاري



Dipole - Dipole
الروابط الضعف

H- bond

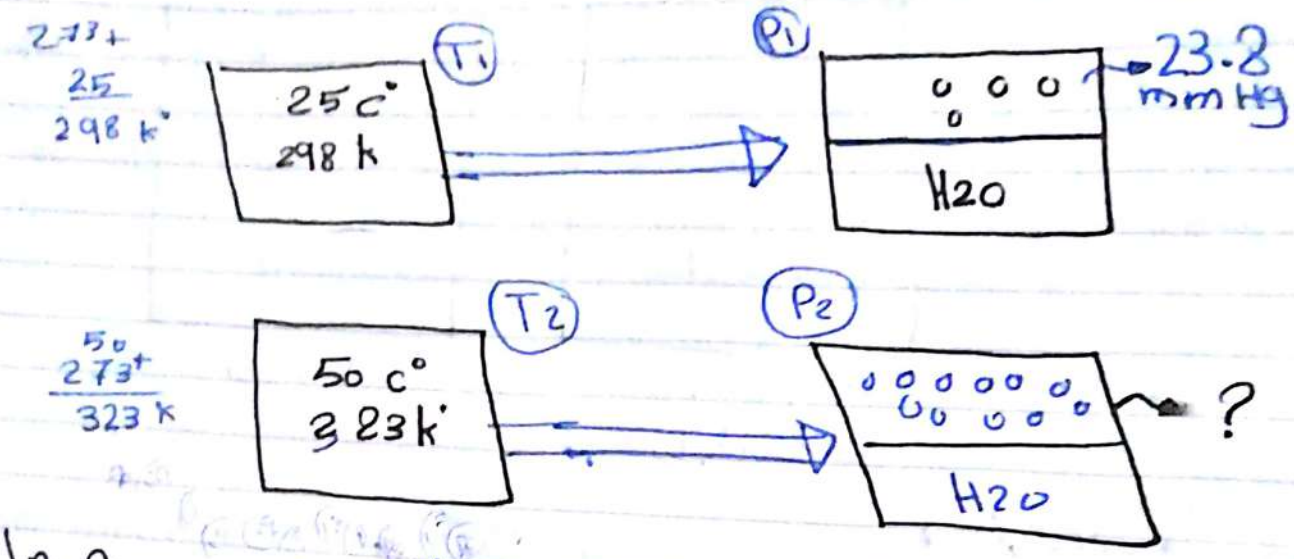
زيادة ↑ temp ↑ veper pressure ↓ strength inter mole ↓ الانخفاض

Ex: Which one of liquides have highest veper pressure

	B.P
1) $CH_3CH_2OCH_2CH_3$	34.5 c°
2) CH_3CH_2OH	78.5 c°
3) H - OH	100. c°
4) $HOCH_2$	200 c°

* Boiling point : درجة الغليان هي مؤشر على قوة الروابط بين الجزيئات .

(كلما قلت الـ B.P يزداد الـ Vaper pressure)



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

قانون حفظ

$\therefore$ $R = 8.3145 \frac{J}{mol.k}$

ΔH_{vap} للماء $= 43.9 \frac{kg \times 10^3}{mole}$

حل

$$\ln \frac{23.8}{P_2} = \frac{43.9 \times 10^3}{8.3145} \left(\frac{1}{323} - \frac{1}{298} \right)$$

$$P_2 = 93.79 \text{ mm Hg}$$

Ex: If ΔH_{vap} for water is 40.7 kJ/mol then the vaper pressure of pure water at 73 c° is:

a) 0.35 atm.
b) 0.53 atm.
c) 273 atm.

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

$$\ln \frac{1}{P_2} = \frac{40.7 \times 10^3}{8.314}\left(\frac{1}{346} - \frac{1}{373}\right)$$

$$0 - \ln P_2 = \text{- - - - - -}$$

* معلومة مهمة :-
ΔH = الحرارة التي تلزمنا لتحويل امول من الحالة السائلة الى الحالة الغازية

$T_b = 100 c°$ ← $P = 1 atm = 760 mmHg$

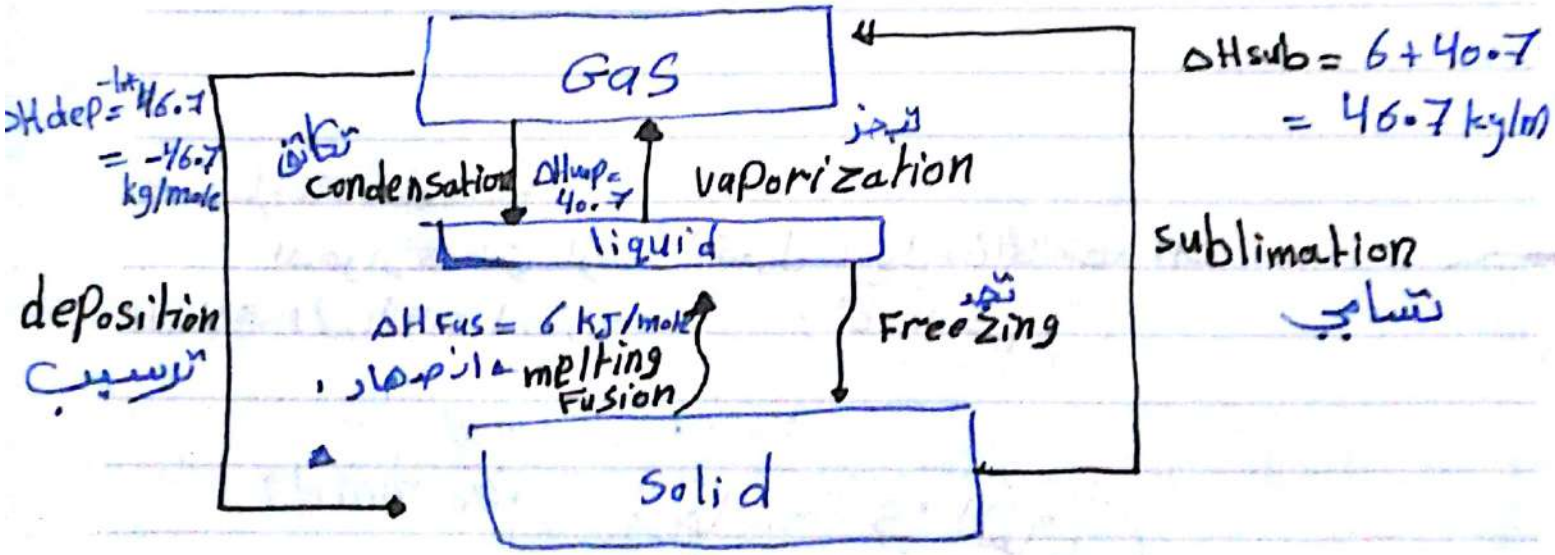
خاصة في الماء

Ex: CCl4 has at 40 c° vaper pressure = 313mmHg
80c° , at vaper pressure = 512 mmHg. What is the normal B.P of CCl4 ?

ΔH = ??
R = 8.3141
نجد ΔH أولاً من المعطيات ومن ثم نجد B.P.

---

* phase change تغير حالة المادة



الخميس

4/8 * Ch12 physical properties of solution *

Solutions:-

1- Solvent (المذيب) ← كمية أكبر
2- Solute (المذاب) ← كمية أقل

* 90 mL Aceton → solvent
10 mL H2O → solute

* 90 mL H2O → Solvent
10 mL Aceto → solute

[1]

* molarity (المولارية) = $\frac{\text{mole solute}}{V(L): \text{solution}}$ ← (Vsolvent + V solute)

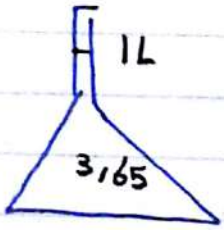
* 12 M HCl = $\frac{12 \text{ mole HCl}}{1 \text{ L}}$ ← تركيزه أكبر

1 M HCl = $\frac{1 \text{ mole HCl}}{1 \text{ L}}$ = [1]

molarity ← (M)

* 1 mole HCl * $\frac{3.5}{1 \text{ mole HCl}}$ = 3.65 g HCl

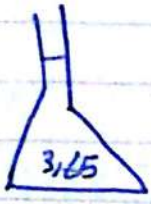
1 L = 1000 g



1000 g - 3,65 = 996.35

* [2] molality = $\frac{\text{mole solute}}{\text{kg solvent}}$

1 m HCl → $\frac{1 \text{ mole HCl}}{1 \text{ kg H2O}}$



M → molarity (mole/L) مول لكل لتر
m → molality (mole / kg)

* ③ mole Fraction $= \frac{nA}{n_{total}}$
$X_{For\ A}$

A = 3 mole (Solute)
B = 12 mole (Solvent)

$X_A = \frac{3}{15} = \frac{1}{5} = 0.2$

$X_B = \frac{12}{15} = \frac{4}{5}$

$\frac{1}{5} + \frac{4}{5} = 1$

* mole $= \frac{mass}{molar\ mass}$

3/11

* electrolyte :

$NaCl \xrightarrow{H_2O} Na^+ + Cl^-$ ($i = 2$)

لـ عدد المولات

$H_2SO_4 \xrightarrow{H_2O} 2H^+ + SO_4^{2-}$ ($i = 3$)

* non electrolyte :

$C_6H_{12}O_3 \xrightarrow{H_2O} C_6H_{12}O_6$ ($i = 1$)

solution :

① solute المذاب

② solvent المذيب

* Colligative properities for solution

properities depend on mole of solute المذاب

1. Boiling point elevation (الإرتفاع في درجة الغليان) (تزايد) بعديد الثاني
2. Depression in Freezing point (الإنخفاض في) (انخفاض) الأمينيوم
3. Vapor pressure (Raoult law) (انخفاض) الأسيتون والعسل
4. Osmatic pressure (الضغط الإسموزي) فلتر الماء

1 Boiling Point elevation :

$\Delta T = i\, k_b\, m$

- ΔT : التغير في درجة الغليان ($T - T^\circ$) — T: solution, T°: solvent
- i : mole ions (mole cules)
- m : molality

$$\text{molality} = \frac{\text{mole solute}}{\text{kg solvent}} = \frac{\frac{\text{mass}}{\text{M.M}}}{\text{kg solvent}}$$

EX :- Calculate the Boiling point (C°) of solution made by desolving 30g sucrose ($C_{12}H_{22}O_{11}$, M.M = 342) in 200g H_2O ($k_b = 0.51$), $T^\circ H_2O = 100^\circ C$

$$\Delta T = i\, k_b\, m$$

$$T - 100 = 1 * 0.51 * \frac{\frac{30}{342}}{200 * 10^{-3}}$$

$$\boxed{T = 100.22^\circ C}$$

⬇ How

EX: mass نفس السؤال ولكن المطلوب الـ

[2] Depression in freezing point :

$\Delta T_F = -i K_F (m)$ ← فيها كل المصايب.

$T - T^{\circ}$
درجة تجمد

(i طلع Na_2SO_4 مركب) اعطوا

anti Freez

EX :- What mass of ethylene glycol ($OHCH_2CH_2OH$, $M=62$) must added to 10kg H_2O to produce solution that Freezes at (-23.3 C°), $T^{\circ}_{H_2O} = 0°C$, $K_F = 1.86$.

$m = 7.76$ kg

[3] Raoults law (vaper pressure). دائماً يقل الـ vaper p للمحلول

$$P_A = X_A \cdot P_A^\circ$$

- X_A → mole fraction للـ solvent
- P_A → vaper pressure للـ solution
- P_A° → vaper pressure للـ pure solvent

$$P_A = \frac{\text{mole solvent}}{\text{total moles solution (الكلي)}} \cdot P_A^\circ$$

** اذا كان مول الـ solute لا يتفكك نضرب mole solute في 1 اذا كان يتفكك نضرب mole solute في عدد المولات الناتجة من التفكك

$$P_A = \frac{\text{mole solvent}}{\text{mole solvent} + i \cdot \text{mole solute}} \cdot P_A^\circ$$

i ← عدد المولات

مثلها لحالك. (Na_2SO_4)

Ex:- calculate The mass of ~~CH3H~~ $C_3H_8O_2$ that must be added to 0.5kg H_2O to reduce the vaper pressure of H_2O by 4.6 mmHg at 40°C

(P_{H_2O} = 55.3 mmHg at 40°C). (At. wt, C=12, H=1, O=16)

تنخفض بمقدار 4.6

mole solute = 2.52

mass = 191.52g

Ex: The vaper pressure of H_2O at $20°C$ is $17.5\ mmHg$ If 20% sucrose was added. what is the Resulting vaper ~~pre~~ pressure of H_2O?

20g X

$P_A = X_{solvent} \cdot P_{H_2O}$

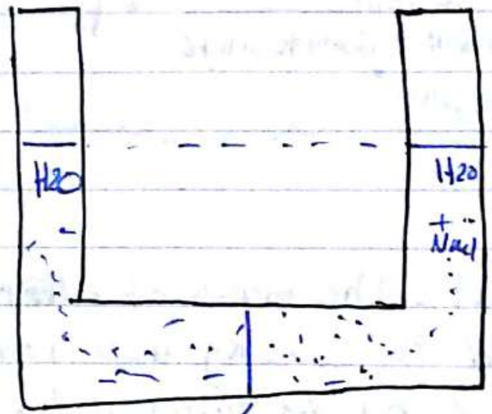
$= \frac{80}{20+80} \cdot 17.5 =$

$\frac{80}{100} * 17.5$

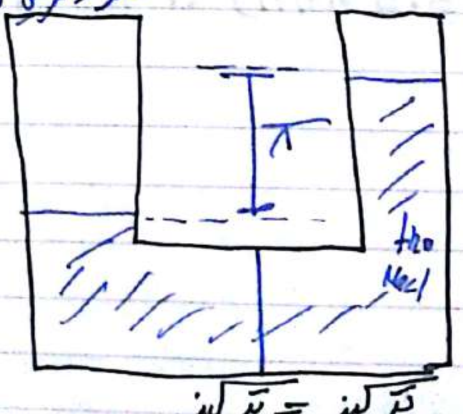
$= \boxed{14\ mmHg}$

4 Osmatic pressure : فلتر الماء

t=0 الزمن .



فلتر ورقي (تسمح بمرور الماء فقط)



تركيز = تركيز

القانون ← $PV = nRT$

$\pi V = nRT$

$\pi = \left(\frac{n}{V}\right) \cdot RT$

solute لا

العوامل ريتي ← $\boxed{\pi = i * MRT}$

π – osmatic Pressure

Ex:- The observed osmatic pressure For 0.1 M solution of $Fe(NH_4)_2(SO_4)_2$ at 25c° is 10.8 atm. Compare the expected and experimental For (i).

$i = 5$ Theo

Exp. $i = \frac{\pi}{MRT} = \frac{10.8}{0.1 \times 0.0821 \times 298}$

$\therefore$ i expected $\neq$ i experimental.

* Electrolyte	(i) experimental	(i) expected
NaCl	1.9	2
$MgCl_2$	2.7	3
$MgSO_4$	1.3	2
$FeCl_3$	3.4	4
HCl	1.9	2

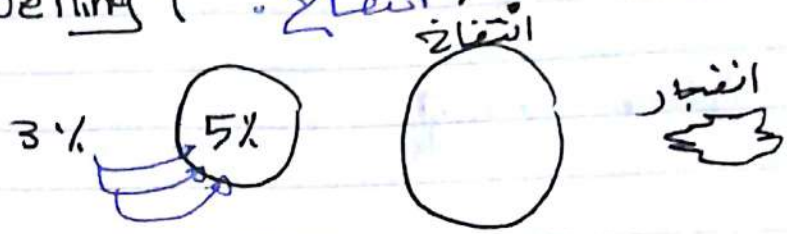
السبب هو (ion pairing (تزاوج الأيونات \
أن يعود الـ molecule كأصلو بعد تحليل جزء

* concentration of solution:

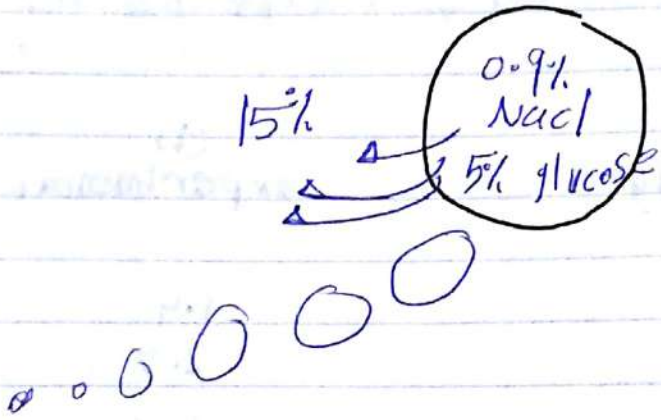
1) isotonic : have same concentration

5% → (5%)

2) hypotic :→ swelling (انتفاخ)



3) hyportonic :→ shrink (انكماش)



Ex: which of the following solutions have hieghest osmatic pressure at 25c°

a) 0.1 M $FeCl_3$ → $i = 4$
b) 0.1 M $MgCl_2$ → $i = 3$
c) 0.1 M NaCl → $i = 2$
d) 0.1 M glucose $i = 1$

$\pi = iMRT$ (ثابت ثابت ثابت)

∴ أعلى واحد هو أكبر i

الخميس 3/15 ch14 :- chemical equilibrium

* concept of equilibrium مفهوم الاتزان .

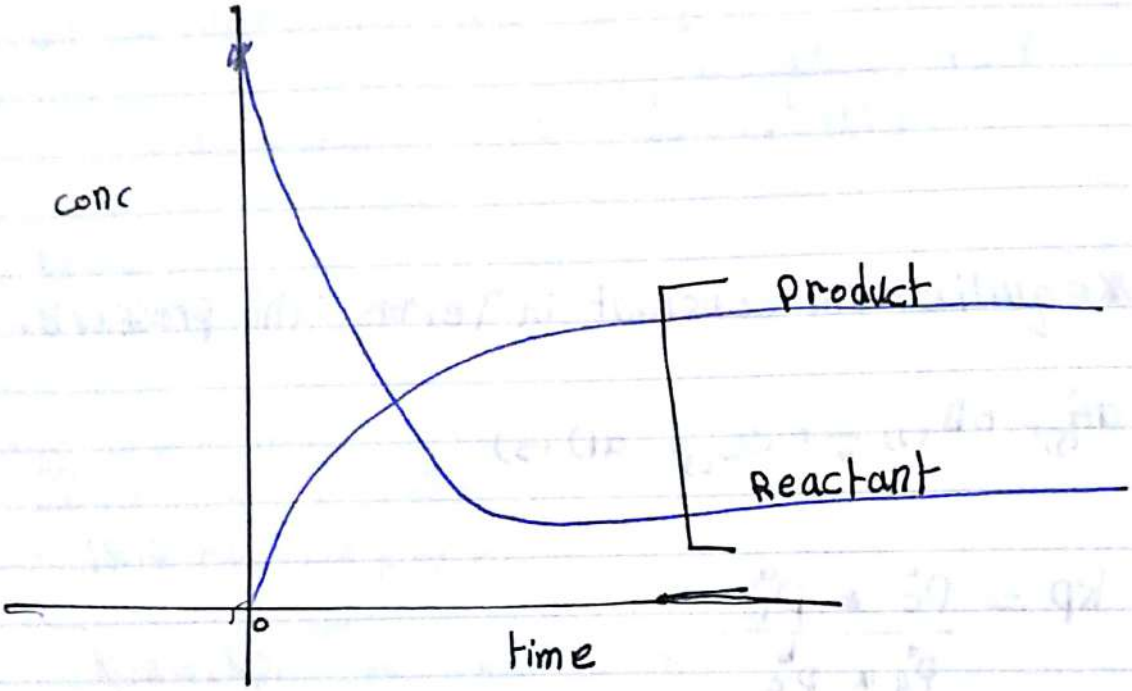
reactant product

$aA + bB \rightleftharpoons cC + dD$

t=0 A B 0 0

t = t A-X B-X ⇌ C D

يتناقص . يتزايد



تعريف
* It is The point at which No change on cancentration with time.

* Rate of product = Rate of Reactant

- سرعة التفاعل الأمامي = سرعة التفاعل العكسي

ثابت الإتزان .

* The equilibrium constant

$aA + bB \rightleftharpoons cC + dD$

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

YASSIN

Ex: Write the equilibrium constant For:-

a) $2O_{3(g)} \rightleftharpoons 3O_{2(g)}$

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

b) $2NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NaCl$

$$K_c = \frac{[NaCl]^2}{[No]^2 \cdot [Cl_2]}$$

*equilibrium constant in Terms The pressure.

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

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

Ex: $2PCl_{3(g)} + O_{2(g)} \rightleftharpoons 2POCl_3$

$$K_{p_1} = \frac{P^2_{POCl_3}}{P^2_{PCl_3} * P^1_{O_2}}$$

$$\therefore K_{p_2} = \frac{1}{K_{p_1}}$$

$$K_{c_1} = \frac{[POCl_3]^2}{[PCl_3]^2 * [O_2]}$$

$2POCl_3 \rightleftharpoons 2PCl_3 + O_2$

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

YASSIN

3/18

Ex: Calculate k_{p2} For: $2PCl_3 + O_2 \rightleftharpoons 2POCl_3$ $\quad k_{p1} = 1 * 10^{-20}$

$4POCl_3 \rightleftharpoons 4PCl_3 + 2O_2$

$$k_{p2} = \frac{1}{(k_{p1})^2} = \frac{1}{(1*10^{-20})^2} = 1*10^{40}$$

[2] calculate k_p FoR:

$POCl_3 \rightleftharpoons PCl_3 + 0.5O_2$

$$k_{p2} = \frac{1}{(k_{p1})^{1/2}} = \frac{1}{(1*10^{-20})^{0.5}} = 1*10^{10}$$

[3] // // // FoR:

$PCl_3 + 0.5O_2 \rightleftharpoons POCl_3$

$k_{p2} = (k_{p1})^{0.5} = 1*10^{-20} = 1*10^{-10}$

Hesse's law

1) $2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$ $\quad k_{c1} = 1*10^{10}$

2) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO$ $\quad k_{c2} = 1*10^{5}$

3) $N_2 + 2O_2 \rightleftharpoons 2NO_{2(g)}$ $\rightarrow k_{c3} = k_{c1} \times k_{c2} = 1*10^{15}$

الأحد 3/18 *تابع*

* Relation ship between kp and kc :-

$kp = kc(RT)^{\Delta n}$

R: 62.4 mmHg, 0.0821 atm — T: kelven

Δn = number of gases product − numbe of gases reactant

Ex: Find Δn For: $N_{2(g)} + 2O_{2(g)} \rightleftharpoons 2NO_{2(g)}$

$\Delta n = 2 - 3$

$= \boxed{-1}$

* اذا كان هناك مواد غير غازية لا نحسبها في ايجاد Δn .

Ex: In the synthesis of NH_3 From N_2 and H_2 $kc = 9.6$ at 300c

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

calculate kp For this React?

$kp = kc(RT)^{\Delta n}$

$kp = 9.6(0.0821 * 573)^{-2}$

$= \frac{9.6}{(0.0821*573)^2} = \boxed{4.34 * 10^{-3}}$

* عندما تكون $\Delta n = 0$ ∴ $kc = kp$

$kp = kc(RT)^{\Delta n}$

$= kc(RT)^0$

$kp = kc * 1$

$KP = Kc$ //

* Heterogeneous equilibrium: الاتزان غير المتجانس

$2NaHCO_{3(s)} \longrightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$

$$K_p = \frac{P_{CO_2} \times P_{H_2O}}{1}$$

$$K_c = [CO_2][H_2O]$$

* الذي يدخل في حساب Kc و Kp فقط الغازات والمحاليل .

HoW:- Write kp and kc For :

① $CO_{2(g)} + H_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(L)}$

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

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

$$\frac{P^2_{CO_2}}{P^2_{CO}}$$

3/20

Ex: What are the value of kp and kc FoR the reaction

$H_2O_{(L)} \rightleftharpoons H_2O_{(g)}$

Knowing that partial pressure of H_2O at 25°C is 23.8 ~~atm~~ torr ?

$k_p = p_{H_2O}$

$= 23.8$ torr

$k_p = k_c (RT)^{\Delta n}$

$23.8 = k_c (62.4 \times 298)^{1-0}$

$k_c = \frac{23.8}{62.4 \times 298} = 1.28 \times 10^{-3}$

ملاحظة * k (يوجد في الكتاب) $= k_c \; k_p$

$\Delta n =$ عدد المولات الغازية في النواتج − عدد المولات الغازية في المتفاعلات

3/20 *Application of equilibrium constant

a) calculate equilibrium concentration.

معرفة التراكيز عند الإتزان .

Ex: For the reaction

$K_p = 1.45 \times 10^{-5}$ $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_3$

In an equilibrium of the Three gases, the partial pressure of $H_2 = 0.928$ atm and for $N_2 = 0.432$ atm

What is partial pressure for NH_3 ?

$P_{H_2} = 0.928$ atm
$P_{N_2} = 0.432$ atm
$kp = 1.45 \times 10^{-5}$

$$kp = \frac{P^2_{NH_3}}{P_{N_2} \cdot P^3_{H_2}}$$

$$1.45 \times 10^{-5} = \frac{P^2 NH_3}{0.928 \times (0.432)^2}$$

$$P_{NH_3} = 2.24 \times 10^{-3} \text{ atm}$$

Ex: A 5 leter flask filled with 0.625 mole of N_2O_4 if you know that concentration N_2O_4 at equilibrium = 0.07 what is K_c for the Reaction?

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

$M = \frac{0.625}{5L} = 0.125 M$

1) Initial conc. 0 ⇌ 0.125 M

2) change +2X −X

at equilibrium

0 + 2X ⇌ 0.125 − X = 0.07 M

0 + 2(0.05) = 0.1 M X = 0.05

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} = \frac{0.075}{(0.1)^2} = 7.5$$

EX: 2L Flask contain 4mole NH_3. If you know that the remaining of NH_3 at equilibrium is 2 mole

Find k_c

$2\,NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_2$ calculate k_c.

4mole

$2-2X$

$\frac{2\text{mole}}{2\,L} = \boxed{1M}$

0 0

$+1X \quad +3X$

$\frac{1}{2}$ mol-M $\quad \frac{3}{2}M$

$2-2X=1$

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

$$k_c = \frac{(\frac{1}{2})^1 * (\frac{3}{2})^3}{(1)^2} = \frac{1}{2} * \frac{27}{2}$$

How

Q 10L Flask is filled with 0.2 mole H_2, 0.2 mole I the value of equilibrium $k_c = 49.5$

0.2 0.2 0

$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI$

What are conc of H_2, I_2, HI at equilibrium

$0.2-X \quad 0.2-X \quad 0+2X$

$\frac{0.2}{10} = 0.02M$

$$k_c = \frac{[HI]^2}{[H_2].[I_2]}$$

$$49.5 = \frac{(2X)^2}{(0.02-X)^2} = \frac{4X^2}{0.0002 - X^2}$$

$9.9*10^{-3} - X^2 = 4X^2$

$X =$

B) prediction Direction For a Reaction :-

Ex: suppose we place mixture of (افرض)
2mole H_2
2mole NH_3
1mole N_2
] in 1L flask

Will N_2 and H_2 react to form more NH_3 ?

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$
1M 2M 2M

(للإتزان $K_c = 0.105$)

$$Kc2 \equiv Q = \frac{[NH_3]^2}{[H_2]^3[N_2]} = \frac{(2)^2}{(1)(2)^3} = \frac{1}{2} = \boxed{0.5}$$

* $K_c = Q \Rightarrow$ equilibrium
$K_c < Q \Rightarrow$ ← الإتزان باتجاه المواد المتفاعلة.
$K_c > Q \Rightarrow$ → الإتزان باتجاه المواد الناتجة.

الحل ∵ $K_c < Q$ ∴ no

الخميس 3/22 ch15 Acid-Base equilibrium

Concept Acid → substance $\xrightarrow{H_2O}$ H^+

-Arhenious: Base → substance $\xrightarrow{H_2O}$ OH^-

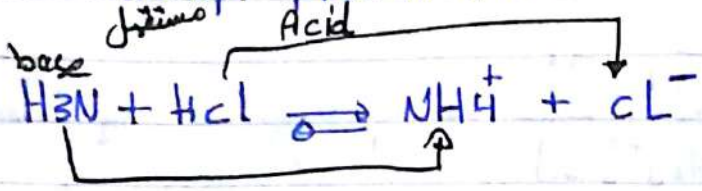
$NaOH \xrightarrow{H_2O} Na^+ + OH^-$

base

- Bronisted-lowry:

Acid: donate proton (H^+)

Base: Accept proton (H^+)



- lewis:

Acid: Accept 2ē

Base: donate 2ē

※ Amphoteric substance: مواد مزدوجة

→ Acting as either acid or Base.

EX: H_2O, HSO_3^-

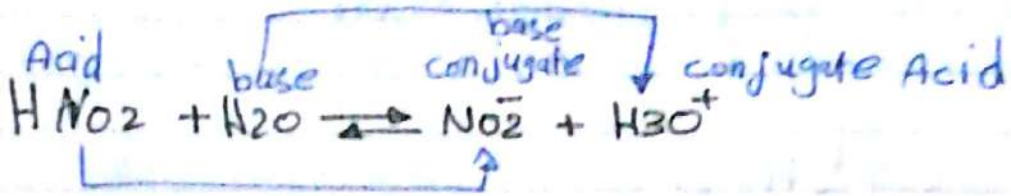
$HSO_3^- \xrightarrow{H_2O} SO_3^{-2} + H_3O^+$

Acid Base

$HSO_3^- \xrightarrow{H_2O} H_2SO_3 + OH^-$

base Acid

* conjugate Acid-Base pain :-



Ex : What is the conjugate base of each Acid

$HClO_4$, H_2S, PH_4^+ , HCO_3^-

Ex: // // // // Acid // // // // Base.

CN^-, SO_4^{2-}, H_2O, HCO_3^-

* Autoionization for water : التأين الذاتي للماء

$$\underset{\text{Acid}}{H_2O_{(l)}} + \underset{\text{base}}{H_2O_{(l)}} \rightleftharpoons OH^-_{(aq)} + H_3O^+_{(aq)}$$

$$K_w = [OH^-][H_3O^+]$$

at 25c° → $K_W = 1 * 10^{-14}$ → ثابت

$[OH^-] = [H_3O^+]$ naturale

$1*10^{-7} \quad 1*10^{-7}$

$[OH^-] > [H_3O^+]$ base

$1*10^{-5} \quad 1*10^{-9}$

$[OH^-] < [H_3O^+]$ acid

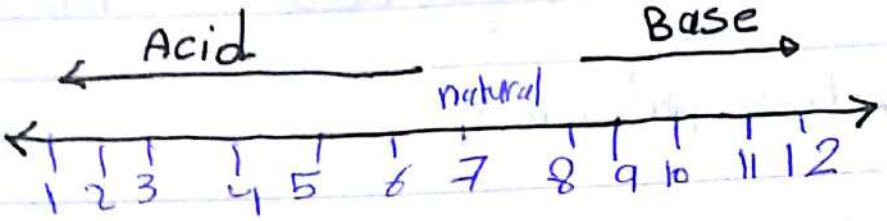
$1*10^{-9} \quad 1*10^{-5}$

3/25

PH : الرقم الهيدروجيني

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

↳ Power of hydrogen.



EX: sample of Freshly apple juice has PH of 3.76 calculate $[H^+]$.

3/25

* Strong acid & strong Base

* strong acids: %100 Ionised

HCL, HBr, HI, HNO_3, $HClO_3$, $HClO_4$, H_2SO_4

* يتأين كلياً في الماء.

EX: HNO_3 (0.2N)

$$HNO_3 \longrightarrow H^+ + NO_3^-$$

	0.2 M	0	0
	0	0.2	0.2

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

$= -\log[0.2] = \boxed{0.69}$

EX: What is pH for 0.2 M H_2SO_4?

$$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$$

	0.2	0	0
	0	2*(0.2)	0.2

$pH = -\log 0.4 = 0.39$

YASSIN

* Strong Base 100% ionized :-

1) OH^- وجود

LiOH $Ca(OH)_2$
NaOH $Ba(OH)_2$
KOH $Sr(OH)_2$
RbOH
CsOH

Ex: What is pH of 0.011M solution of $Ca(OH)_2$

$$Ca(OH)_2 \longrightarrow Ca^{2+} + 2OH^-$$

0.01M 0 0
0 0.01M $2 * 0.01 = 0.02$

يوجد طريقتين :-

1) $[H^+][OH^-] = 1 * 10^{-14}$

$[H^+] = 4.6 * 10^{-13}$

$pH = -\log 4.6 * 10^{-13}$

$= 12.34$

2) $pOH = -\log 22 * 10^{-3}$

$= 1.66$

$pH + pOH = 14$

$pH = 12.34$

EX: what is pH for $1*10^{-14}$ M $Ca(OH)_2$?

pH = 7

وذلك لأن التركيز بسيط جداً وبالتالي لن يؤثر أي تأثير.

2) Na_2O / CaO $\xrightarrow{H_2O}$ $2OH^-$

EX: 0.01 mol Na_2O react with enough water to form 1L solution, calculate PH ?

$\frac{0.01}{1} = 0.01\ M$

$Na_2O \rightarrow 2OH^-$

0.01 0.02

$[OH^-] \cdot [H^+] = 1*10^{-14} \Rightarrow [H^+] = 5*10^{-13}$

PH = 12.3 PH = $-\log[H^+]$

3) *Ionic Hydride: H^{-1}

Na^+H^-, Li^+H^- $\rightarrow H^- \xrightarrow{H_2O} OH^-$

*Ionic Nitride

Na_3N $\rightarrow N^{-3} \xrightarrow{H_2O} 3OH^-$

YASSIN

3/27 # weak acid الحامض

$CH_3-\overset{O}{\overset{\|}{C}}-OH$

acetic acid ← . الخل

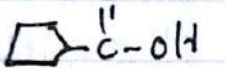
$CH_3\overset{O}{\overset{\|}{C}}-OH \rightleftharpoons H^+ + CH_3-\overset{O}{\overset{\|}{C}}-O^-$

كل حامض ضعيف له قاعدة مرافقة قوية .

$$K_a = \frac{[H^+]\cdot[CH_3-\overset{O}{\overset{\|}{C}}-O^-]}{[CH_3-\overset{O}{\overset{\|}{C}}-OH]}$$

The larger Ka the larger $[H^+]$ The strong acid.

EX: Which one of the following acid have highest acidity?

acid	Ka
a) HF	6.8×10^{-4}
b) 	6.3×10^{-5}
c) 	1.3×10^{-10}

EX: calculating Ka from pH & 0.1 M of Farmic acid ($H-\overset{O}{\overset{\|}{C}}-OH$) has pH = 2.38

1) Ka
2) Persent of ionization.

Sol:

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

0.1M	0	0
$-X$	$+X$	$+X$
$0.1-X$	X	X

نوجد $[H^+]$ من pH $\quad 4.2*10^{-3}M \quad 4.2*10^{-3}$

$$pH = 2.38$$
$$[H^+] = 10^{-2.38} = 4.2*10^{-3}M$$

$$ka = \frac{[4.2*10^{-3}]^2}{0.1-4.2*10^{-3}} = \boxed{1.8*10^{-4}}$$

b) Percent ionization $= \frac{[H^+]}{[H-\overset{O}{\overset{\|}{C}}-OH]}$

$$= \frac{4.2\times10^{-3}}{0.1} \times 100\%$$
$$= \boxed{4.2\%}$$

EX: Calculating pH From ka:

- Calculate pH of 0.3M solution of acetic acid $CH_3-\overset{O}{\overset{\|}{C}}-OH$ ($ka = 1.8*10^{-5}$)

Sol:

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

0.3	0	0
$-X$	$+X$	$+X$
$0.3-X$	X	X

$$ka = \frac{X^2}{0.3-X} \rightarrow X^2 = 5.4*10^{-6}$$
$$X = 2.3\times10^{-3}$$
$$[H^+] = 2.3*10^{-3}$$

نتجاهلها لانها صغيرة.

$$pH = -\log[H^+] = -\log[2.3*10^{-3}] = \boxed{2.64}$$

YASSIN

3/27 #Weak Base#

*NH_3 (قاعدة ضعيفة)

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

كل قاعدة ضعيفة لها حمض مرافق قوي

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

larger kb larger $[OH^-]$ lower $[H^+]$

EX: Which of the following substance have highes Basisity.

1

Base	kb
a) $H-\underset{H}{N}-H$	1.8×10^{-5}
b) NH_2OH	1.1×10^{-10}
c) NH_2CH_3	4.4×10^{-4}

2

Base	kb
a)  N (Pridine)	1.7×10^{-9}
b) ClO^-	3.3×10^{-7}
c) CO_3^{-2}	1.8×10^{-4}
d) HS^-	1.8×10^{-7}

YASSIN

Ex: calculate The conc of $[OH^-]$ in 0.15 M solution of NH_3 ($K_{b_{NH_3}} = 1.8 \times 10^{-5}$).

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

	0.15	0	0
	$-x$	$+x$	$+x$
	$0.15-x$	x	x

$$K_b = \frac{x^2}{0.15 - (x)}$$

جاهز

$$1.8 \times 10^{-5} = \frac{x^2}{0.15}$$

$$x^2 = 2.7 \times 10^{-6} \rightarrow x = 1.6 \times 10^{-3} M$$

$$[OH^-] = 1.6 \times 10^{-3} M$$

Ex: Solution is made by adding solid sodium hypo chlorite NaClO ($K_b = 3.3 \times 10^{-7}$) to enough water to make 2L of solution if the solution has pH = 10.50 How many mole of NaClO were added to the water?

$$ClO^- + H_2O \rightleftharpoons HClO + OH$$

y	0	0
$-x$	$+x$	$+x$
$y-x$	x	x

الخميس 3/29 ✱Relation ship between ka, kb

$$ka * kb = \overset{kw}{1 * 10^{-14}}$$

Acid	ka	(kb) base
HF	$6.8 * 10^{-4}$	$(F^-) = 6.8 * 10^{-4} * kb = 1 * 10^{-14}$ $kb = 1.5 * 10^{-11}$

✱ ① calculate ka OR calculate kb السؤال يأتي

② calculate Acid dissociation constant FOR HF الحمض المقابل القاعدة المرافقة

③ // Base // // // // F^-

✱ Acid-Base properities of salt solution :-

Salt ← pH = 7 natural
pH < 7 acid
pH > 7 Base

I Salt from strong acid & strong base

حمض قوي قاعدة قوية

$NaCl_{(Salt)} \xrightarrow{H_2O} NaOH + HCl \Longrightarrow pH = 7$

Ex: calculate pH for 0.3M NaCl :-

1) 7.8
2) 7
3) 9.7
4) 4.9

Ex: // // // // // $CaNO_3$?

pH = (7)

YASSIN

الخميس 3/29 *بسم الله*

2 Salt from strong Acid and weak base :- (pH<7)

Eg:

NH_4cL → OH^- / H^+ → NH_4OH , HcL

$AL(NO_3)_3$ → OH^- / H^+ → $AL(OH)_3$, HNO_3

Ex: calculate pH for 0.3 M solution of NH_4cL (k_b of $NH_3 = 1.8 * 10^{-5}$).

a) 13.33 **b) 4.89** c) 7 d) 11.67

Sol:

$[H^+]$ لأنه

$NH_4cL \xrightarrow{H_2O} NH_4OH + HcL$

ابتدائي	0.3	0	0
k_a يتأين	$-X$	$+X$	$+X$
	$0.3-X$	X	X

$k_a * k_b = 1 * 10^{-14}$

$1.8 * 10^{-5} * k_a = 1 * 10^{-14}$

$k_a = 5.6 * 10^{-10}$

$k_a = \frac{X^2}{0.3-X}$ (X مهمل)

$X^2 = 1.68 * 10^{-10}$

$X = 1.3 * 10^{-5} = [H^+]$

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

$= \boxed{4.89}$

[3] Salt from weak acid and strong base : pH > 7

NaClO

OH^- / H^+

NaOH (قوي) / H_2O (ضعيف)

قاعدي

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

OH^- / H^+

$Ba(OH)_2$ (قوي) / $CH_3-\overset{O}{\overset{\|}{C}}-OH$ (ضعيف)

قاعدي

[4] Salt from weak acid and Weak base :

$NH_4C_2H_3O_2$

NH_4OH / $CH_3-\overset{O}{\overset{\|}{C}}-OH$

NH_3 ضعيف — $CH_3-\overset{O}{\overset{\|}{C}}-OH$ ضعيف

Kb — Ka

$Ka > Kb$

pH > 7

pH < 7

NH_4Cl

NH_3 / HCN

$Ka < Kb$

pH > 7

$FeCO_3$

$Fe(OH)_2$ / H_2CO_3

$Ka = Kb$

pH = 7

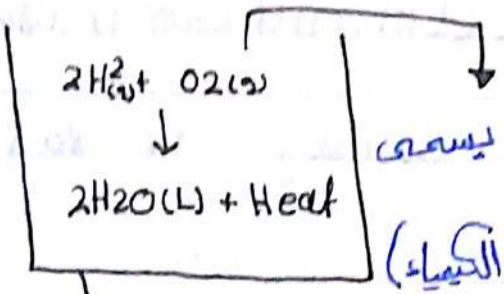
4/1 # Thermochemistry (ch6)

The Relationship between chemical Rxn and energy.

Unit = Joule (J)

1 cal = 4.184 (J)

system and surrounding :-



ماداخل الوعاء يسمى system (الذي يركز عليه الكيمياء)

الوعاء وماحوله surrounding التفاعل يسمى

* Internal energy :- (ΔE) change.

$\Delta E = E_f - E_i$ ← قانون.

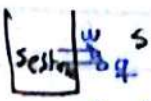
$\Delta E = W + q$ (work) (heat) ← (كيو)

$\Delta E = Work + heat$ ← قانون

$\Delta E = (-)$ → exothermic طارد للطاقة

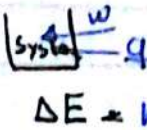
$\Delta E = (+)$ → endothermic ماص للطاقة

*



$\therefore \Delta E = -w + -q$

$\Delta E = (-)$ → exothermic



$\Delta E = w + q$

$\Delta E = (+)$ → endothermic.

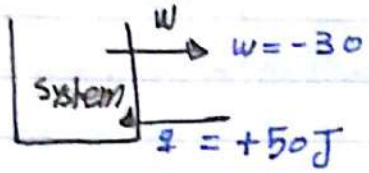
مصطلحات تأتي في الأسئلة :-

Perform: أنجز
done: أنجز

absorb: امتص
Released: تطلق / أطلق
evolve: يطلق

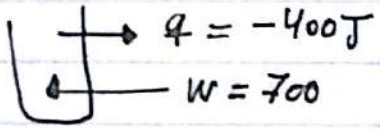
Ex: system absorb 50J as heat and does 30J as Work. calculate ΔE (Internal energy change)

a) -20. b) +20J c) +80J d) -80 J



Ex: In particulat processe. The surrounding perform 700J of work upon the system while the system evolves 400J of heat to the surrounding ΔE = ?!

a) +300 J b) -300 J c) -1100 J d) +1100 J



ΔE = 700 - 400 = +300

الأحد 4/1

※ Entholpy ΔH(وذلك لأنه لا يوجد Work)

$\Delta E = q_{p} \equiv \Delta H \, (J)$

1 atm

$\boxed{\Delta H = q_p}$

Heat Released or absorb from Chemical Reaction at 1 atm.

※ proparities of ΔH:

[1] inthalpy is extensive proparities: تزداد الـΔH مع ازدياد كمية المادة.

Ex: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \rightarrow \Delta H = -802 \, kJ$

$2CH_{4(g)} + 4O_2 \rightarrow 2CO_2 + 4H_2O \rightarrow \Delta H = -1604 \, kJ$

Ex: How much heat is realeased when 4.5g of CH_4 is burned in constant pressure system?

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \rightarrow \Delta H = -802 \, kJ$

$\Delta H = 4.5g \times \frac{1}{16} \times \frac{-802 \, kJ}{1 mole}$

$= \boxed{-226 \, kJ}$

ΔH

تفاعل طارد ← (-)

تفاعل ماص ← (+)

2 اذا عكسنا التفاعل لا تنسو تعكسو اشارة ΔH

3 اذا جمعنا معادلات نجمع ΔH لهما.

Ex:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O_{(g)} \quad \Delta H = -802$$

$$2H_2O_{(g)} \rightarrow 2H_2O_{(L)} \quad \Delta H = -88$$

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O_{(L)}$$

$$\Delta H = -890$$

*Specific heat

specific heat: the amount of heat required to 1g of object to raise 1 c° / 1 k.

$$S.heat = \frac{q}{wt \times \Delta T} = \frac{J}{g \cdot k^{\circ}_{c}}$$

$\Delta T = T_2 - T_1$

heat capacity: the amount of heat required to an object to raise its temperature of 1c°, 1k.

$$C = S.m$$

Moles heat capacity: " " " " " " " 1mole " " " " .

$$C = S.M.M$$

Ex:- calculate The specific heat of water if 209J is ~~released~~ required to increase The Temprature of 50g of Water by 1 k.

$$S.heat = \frac{209}{50 * 1} = 4.18 \ \frac{J}{g.k}$$

M.heat احسب لنفس السؤال.

75.2

Ex: The specific heat of iron is 0.432 $\frac{J}{g.k}$ If 240J of heat is added to 75g of iron at 25c° what would be the final temp.

a) 75 C° b) -100 c° . c) 100c° d) -75c°

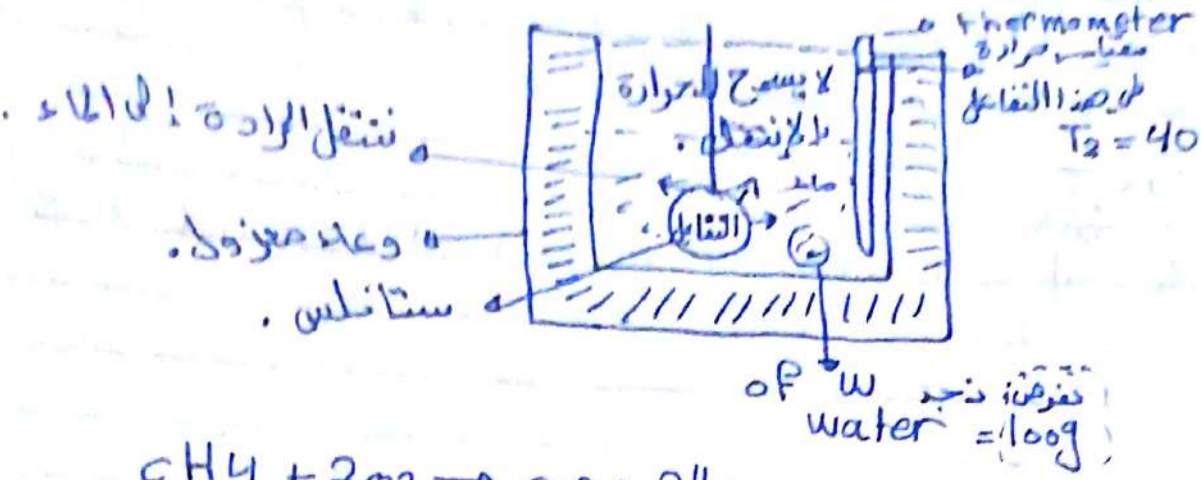
$$S.heat = \frac{q}{wt \cdot \Delta T} \Rightarrow 0.452 = \frac{240}{7.05k \ \Delta T}$$

$\Delta T = 75$

$T_2 - T_1 = 75$

$T_2 = 100c^{\circ}$

* اسم الجهاز .
* Instrument : calorimeter اسم الطريقة .
* calorymitry
  ↳ method measure ΔH



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

ΔH : ΔH للتفاعل . المنزاحة من قبل الماء

∴ ΔH ⇒

$$\text{specific heat}_{H_2O} = \frac{\Delta H}{Wt \times \Delta t}$$

$$\Delta H = Wt \times \Delta T \times \text{specific heat}$$

لهذا التفاعل $\Delta H = \underset{\text{s.heat}}{4.18} \times 100 \times (40-25)$

← اشارة ΔH تتحدد بارتفاع درجة حرارة الماء أو انخفاضها .
(+) (-)

الخميس 4/5 Hess's law *24*

* Using the information below:- Ex1:

① $MnO_{2(s)} \rightarrow MnO(s) + \frac{1}{2}O_2(g)$ $\Delta H_1 = 136$ kJ

تتغير

② $MnO_2(s) + Mn(s) \rightarrow 2MnO(s)$ $\Delta H2 = -249$ kJ

تبقى كما هي

Calculate ΔH_3 for the Reaction.

$Mn(s) + O_2(g) \rightarrow MnO_2(s)$

نعكس ونضرب ×2 ؛ $\Delta H_1 = -272$

كما هي $\Delta H_2 = -249$

الآن ① $2MnO(s) + O_2(g) \rightarrow 2MnO_2(s)$ $\Delta H_1 = -272$

نجمع ② $MnO_2(s) + Mn(s) \rightarrow 2MnO$ $\Delta H_2 = -249$

$Mn(s) + O_2(g) \rightarrow MnO(s)$ ← المعادلة المطلوبة

$\Delta H_3 = \Delta H_1 + \Delta H_2$

$= -521$

Ex2: Using the information below:

3x① $Fe_2O_3(s) + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_2(g)$ $\Delta H_1 = -26$ kJ

ونعكسها

② $3Fe_2O_3(s) + CO \rightarrow 2Fe_3O_4(s) + CO_2(g)$ $\Delta H_2 = 59$ kJ

2x③ $Fe_3O_4(s) + CO(g) \rightarrow 3FeO + CO_2(g)$ $\Delta H_3 = 38$ kJ

Calculat ΔH for

$FeO + CO \rightarrow Fe + CO_2$

* في أشياء موجودة في الأعلى وليست موجودة في المعادلة

~~① 3CO(g) →~~ ،

4/8 * standerd enthalpy of reaction.

$\Delta H^\circ_{rxn} = \Delta H^\circ_{product} - \Delta H^\circ_{Reactants}$

* $\Delta H^\circ_{Formation}$ for element = zero

T = 25
P = 1atm Na, Li, AL, H2, O2, N2, AU .....
con = 1M

Ex: ΔH° for combustion of $C_6H_{12}O_6$ (glucose) is -2816 kJ what is ΔH_f for glucose.

$$C_6H_{12}O_{6(s)} + 6O_2 \longrightarrow 6CO_{2(g)} + 6H_2O$$

$\Delta H^\circ = 0$ ∴ عنصر

-285.8	ΔH H2O
-393.5 kJ/mole	ΔH CO2 kJ/mole

للتفاعل $\Delta H^\circ = -2816$ kJ

$$\Delta H^\circ_{Rxn} = \Delta H \text{ product} - \Delta H \text{ reactant}$$

$$-2816 = (-285.8 * 6 - 393.5 * 6) - \Delta H^\circ_{reactant}$$

$$\Delta H^\circ_{glucose} = -1259.8 \text{ kJ}$$

* ch: W: Entropy, free energy and equilibrium.

الاحد 4/8 # Thermodynamics:

Def: *study of energy and its tranformation.
* spontaeous processes

Spontaneous change: change takes place without outside assistance.
التغير التلقائي. التغير الذي يحدث دون مساعدة خارجية.

$Mg_{(s)} + HCl_{(aq)} \longrightarrow MgCl_2 + H_2\uparrow$. $\Delta H(-)$

∴ all exothermic Rxn are spontaeous Rxn.

Enthalpy : ΔH

→ Entropy : ΔS (مقياس الفوضى)
↳ measure of randomness

$H_2O_{(s)} \xrightarrow{heat} H_2O_{(g)}$
ice gas

ΔS positive موجب

$\Delta S = S_{product} - S_{reactant}$
كبير (صغير)

∴ ΔS ← موجبة

⊗ predect whether ΔS is +ve of -ve

1) $Ag^+_{(aq)} + \bar{C}L_{(aq)} \longrightarrow AgCL_{(s)}$
ΔS = كبير - قليل
ΔS = (-ve)

* تعتمد على عدد الحالات

2) $N_{2(g)} + 3H_{2(g)} \longleftarrow 2NH_3$
ΔS = كبير - قليل
= (-ve)

③ $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$

$\Delta S > 0$

*Calculation of entropy change ΔS°.

$$\Delta S^\circ = \Sigma n\, S^\circ_{(product)} - \Sigma m\, S^\circ_{(Reactant)}$$

Ex: calculate ΔS° for the synthesis of ammonia from $N_{2(g)}$ and H_2O

$$N_{2(g)} + 3H_2 \longrightarrow 2NH_3$$

ΔS = -ve

Reactant is less than product so it is +ve

S° :- * 191.5 $\frac{J}{mole.k}$ (N_2) , 130.6 $\frac{J}{mole.k}$ (H_2) , 192.5 $\frac{J}{mole.k}$ (NH_3)

$$\Delta S = (2 * 192.5) - (3 * 130.6 + 1 * 191.5)$$

$$= \boxed{-198.3 \frac{J}{mol.k}}$$

* enthalpy → ΔH

entropy → ΔS

Free energy → ΔG

الجديد 4/12

ΔH°	ΔS°	ΔG
−	+	Spont (−) at all T
+	−	Nonspont (+) at all T
+	+	(−) Spont at high T
−	−	(−) Spont at low T

ΔG : Free energy
- Useful Work.
- combination between enthalpy ΔH and entropy ΔS

$$\Delta G = \Delta H - T\Delta S.$$

ΔH°, ΔG° → element form = zero

ΔS° → element form ≠ zero.

EX: Calculating standard free energy change ΔG°

$$\Delta G^\circ = \Sigma n G^\circ_{product} - \Sigma m G^\circ_{Reactant}.$$

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

ΔG_f°: zero, zero, $-16.66 \frac{kJ}{mol}$

$$\Delta G_{Rx} = [2 \times -16.66] - [zero + zero]$$

$$\Delta G = -33.32\ kJ$$

spont

الخميس 4/12 تابع

2) calculate ΔG For

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

$\Delta G = \boxed{+ 33.32\ kJ}$

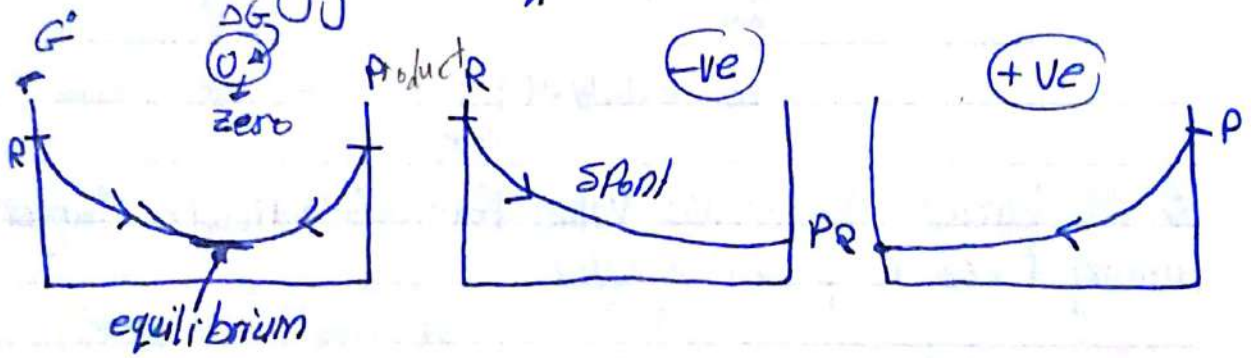
لا يحدث .

* ينطبق على ΔG كل ما ينطبق على ΔH عند تغير المعادلات .

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

$K = \frac{[C].[D]}{[A].[B]}$

* Free energy and equilibrium :-

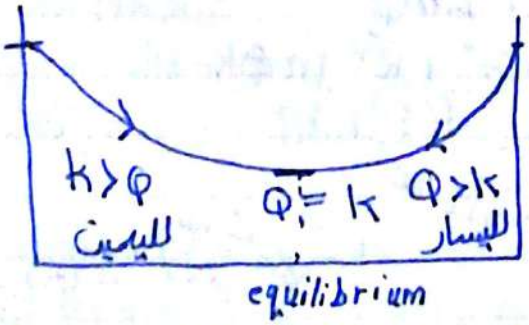


عند الإتزان ΔG = zero

$\Delta G = G_P - G_R$

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

$Q = \frac{[P]}{[R]}$ → نواتج / متفاعلات



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

R → 8.314 J/mol.K

T = 25c°

P = 1 atm

$\Delta G = \Delta G^\circ$

عندما النسبة بين التراكيز = 1

$\frac{[P]}{[R]} = 1$

$\ln Q = \ln 1$

= zero

YASSIN

4/12

Ex: Calculate ΔG at 298 k for Rxn that consist of 1atm N_2, 3atm H_2, 0.5 atm NH_3

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

$\Delta G^\circ = -33.32 \frac{kJ}{mole}$.

~~$\Delta G = -33.32 * 10^3$~~

sol:

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

1 atm 3 atm 0.5 atm

$Q = \frac{(0.5)^2}{(3)^3 \cdot (1)} = 9.3 \times 10^{-3}$

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

R: $\frac{J}{mole}$ الثابت

$= -44.9 \frac{kJ}{mole}$

* the larger negative value for ΔG indicate larger driving force to produce NH_3.

* at equilibrium $\Delta G = 0$

$Q = K$

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

At equilibrium $\Rightarrow$ $0 = \Delta G^\circ + RT \ln K$

$\Delta G^\circ = -RT \ln K$

متأكد العلاقة بين الثوابت و ΔG

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

* $\Delta G = (-) \rightarrow K$ كبيرة — تفاعل تلقائي

$\Delta G^\circ = (+) \rightarrow K$ صغيرة — تفاعل غير تلقائي

EX:- Use standard free energy of formation ($\Delta G^\circ = -33.33\ kJ$) to calculate the equilibrium constant [kp] at 25C° for the Rxn....

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

$K = e^{-\left(\frac{-33.33 \times 10^3}{8.314 \times 298}\right)} = \boxed{692.9}$

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

EX:- For the Rxn to:-

$\Delta H^\circ = -56.9\ kJ \quad 2NO_2(g) \rightleftharpoons N_2O_4(g)$

$\Delta S^\circ = -175\ \frac{J}{K}$

Calculate kp at 100C

$K = e^{-\frac{\Delta G}{RT}}$

$\Delta G = -56.9 * 10^3 + 373 * -175 =$

$\Delta G^\circ = 122.175\ kJ$

$= 122.2 \times 10^3\ J$

$K = e^{-\frac{122.2 \times 10^3}{8.314 \times 373}} = 7.7 \times 10^{-8}$

EX: In the following Rxn at 298k and 1 atm.

$2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

$\Delta H^\circ = -198\ kJ$

$\Delta G^\circ = -140\ kJ$

$\Delta S^\circ = ?1$

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

$-140\ kJ = -198\ kJ - 298\ \Delta S\left(\frac{kJ}{K}\right)$

$\Delta S = -0.195\ \frac{kJ}{K} \longrightarrow \Delta S = -0.195 \times 10^3 = 0 - 195\ \frac{J}{K}$

a) $-195\ \frac{J}{K}$ c) $+0.195\ \frac{J}{K}$

b) -0.195 d) $58\ kJ$

Apr 21 4/15 *21*

Ex: one mole of (A)g and one mole of (B)g placed in 1L flask and heat to 400k The Rxn

$A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)}$

is founded to occure At equilibrium 0.78 mole of C(g) are present. what is standard free energy change for this Rxn.

Sol: $-9.2 \frac{kJ}{mole}$

	A(g) +	B(g) ⇌	C(g)
I	1M	1M	0
C	-x	-x	+x
E	1-x	1-x	x
	1-0.78	1-0.78	↳ 0.78
	0.22	0.22	0.78

$\Delta G^\circ = -RT \ln K_c$

$= -8.314 \times 400 \times \ln 16.11$

$= 9.2 \frac{kJ}{mole}$

$K = \frac{[C]}{[A][B]} = 16.11$

ch12: electrochemistry

↳ study of the interchange of chemical and electrical energy.

* and concerned with two process that involve oxidation – reduction. (Redox)

* Gelvanic cells:-
Generation of electric current (تيار) from spontaneous or chemical Rxn.

* Oxidation-reduction

* Involve transfer of ē from reducing agent to the oxidizing agent

$Zn(s) \longrightarrow Zn^{+2} + 2\bar{e}$ (نصف تفاعل التأكسد)

زيادة في الشحنة

(LEO)
lose ē oxidation.

← يعني لما يفقد الكترونات (تكون الإلكترونات في النواتج) يكون تفاعل تأكسد

نقصان في الشحنة

$Cu^{+2} + 2\bar{e} \longrightarrow Cu$ (نصف تفاعل اختزال)

GER
Gain ē Reduction

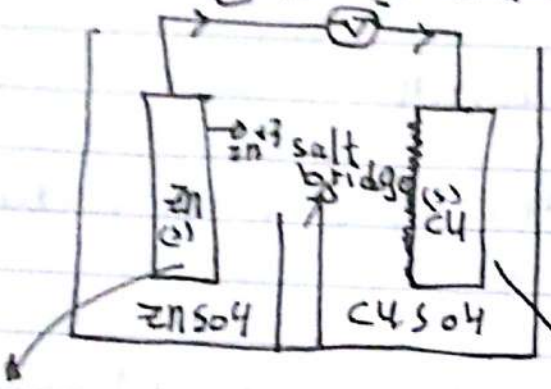
* يعني لما يكسب ē (تكون الإلكترونات مع المتفاعلات) نقول بأن هذا العنصر حدث له اختزال.

Ex: $Zn + Cu^{+2} \longrightarrow Zn^{+2} + Cu$

Which one is oxidizing agent and which one is Reducing agent.

→ Zn ⟵ Reducing agent
Cu^{+2} ⟵ oxidizing agent.

انتبه ⟵ العامل المؤكسد والعامل المختزل يكون في المتفاعلات وليس في النواتج.



مهبط
Reduction (cathode)

مصعد
oxidation (anode)

* اللي بحدث له تأكسد يكون مصعد واللي بحدث له اختزال هو المهبط

Cell potential : (E_{cell})

⇒ the pull of electron (ϵ) by oxidizing agent through wire from Reducing agent.

* ($\frac{J}{coulomb}$) volt وحدة قياس جهد الخلية هي

* Standard Reduction potential :-

anode $Zn \longrightarrow Zn^{+2} + 2\epsilon$ $\quad \varepsilon^\circ = +0.76$ (volt)

cathode $2H^+ + 2\epsilon \longrightarrow H_{2(g)}$ $\quad \varepsilon^\circ = 0$

$Zn + 2H^+ \longrightarrow Zn^{+2} + H_{2(g)}$ $\quad \varepsilon^\circ = +0.76$ volt

Ex: $Zn^{+2} + 2\epsilon \longrightarrow Zn$ $\quad \varepsilon^\circ = -0.76$

$Cu^{+2} + 2\epsilon \longrightarrow Cu$ $\quad \varepsilon^\circ = 0.34$

Find E_{cell} :

E_{cell} = ε° الاختيرة - ε° البكرة

المعادلة يلي الها oxidizing agent على أعلى ε° تبقى كما هي وتعكس المعادلة الأخرى.

Sol:

$Zn^{+2} + 2\epsilon \longrightarrow Zn$ $\quad \varepsilon^\circ = -0.76$

$Zn \longrightarrow Zn^{+2} + 2\epsilon$ $\quad \varepsilon^\circ = 0.76$

$Cu^{+2} + 2\epsilon \longrightarrow Cu$ $\quad \varepsilon^\circ = 0.34$

$\varepsilon^\circ_{cell} = 0.76 - 0.34 = 0.42$ volt

$Zn + Cu^{+2} \longrightarrow Zn^{+2} + Cu$

قيمة ε° لا تتغير الا اذا قلبت المعادلة (تعكس اشارتها) ولكن في حال ضرب المعادلة لا تضرب E_{cell}

* consider a galvanic cell on Redox Rxn:

$Fe^{+3} + Cu \rightarrow Cu^{+2} + Fe^{+3}$ $E^\circ = ??$

$2 \times Fe^{+3} + e \rightarrow Fe^{+2}$ $E^\circ = 0.77V$

$2 \times Cu^{+2} + 2e \rightarrow Cu$ $E^\circ = 0.34$

$2Fe^{+3} + 2e \rightarrow 2Fe^{+2}$ $E^\circ = 0.77V$

$Cu^{+2} + 2e \rightarrow Cu$ ($E^\circ = 0.34$)

نعكسه

$Cu \rightarrow Cu^{+2} + 2e$ $E^\circ = 0.34$

$2Fe^{+3} + 2e \rightarrow 2Fe^{+2}$

$2Fe^{+3} + Cu \rightarrow Cu^{+2} + 2Fe^{+2}$

$E^\circ = 0.43$

$\Delta G^\circ = -nFE^\circ$ ($F \rightarrow 96.485 \frac{C}{mole \cdot e}$)

n: عدد الإلكترونات; E°: J/C (V)

calculate ΔG°??

$\Delta G^\circ = -2(96.485) * 0.43$

$= -82.9$ J (spont)

H.W: consider a galvanic cell based on the Rxn:

$Al^{+3} + Mg_{(s)} \rightarrow Al + Mg^{+2}$ 0.71(V) 0.617

Give the balanced cell Rxn and calculate E°, ΔG° for the cell

$Al^{+3} + 3e \rightarrow Al_{(s)}$ $E^\circ = 1.66$ (V)

$Mg^{+2} + 2e \rightarrow Mg_{(s)}$ $E^\circ = -2.37$ (V)

line notation:-

$Zn / Zn^{+2} // Cu^{+2} / Cu$

↓ Reduction agent (Anod oxidation)
↓ salt bridge
↓ oxidation agent (cathod Reduction)

دائما هيك شكلها.

*Nearnest equation:

$$E = E^{\circ} - \frac{0.0592}{n} \log Q$$

$E = E^{\circ} \xrightarrow{\text{عندما}} Q = 1$ أي (1) التراكيز تساوي

أنبه الوصلب ما الودقل .

EX: $Zn(s) / Zn^{+2}(2M) // Cu^{+2}(3M) / Cu(s)$

calculate E if you know that $E^{\circ} = 1.10$ V

$$E = E^{\circ} - \frac{0.592}{n} \log Q$$

$$= 1.10 - \frac{0.592}{2} * \log\left(\frac{2}{3}\right) \Rightarrow E = 1.105 \text{ V}$$