اسألني عن الهندسة 2018

أهل الهمة

Chemistry II

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إعداد الطالبة: رشا القواسمة

22 / 1 / 2019

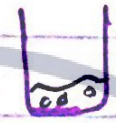
Ch. 11 :- Intermolecular forces and properties of liquids and solids:-

1) solids:-


→ متراصة
جزيئات ~~متقاربة~~

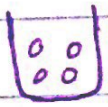
1) shap constant
2) volume constant
3) density$_S$ > d_L > dq
4) rigid

2) Liquids:-


جزيئات متقاربة

1) shape isn't constant
2) volume constant
3) $d_s > d_L >$
4) fluids

3) gases:


→ جزيئات متباعدة

1) shape and volume not constant

2) $d_g \underbrace{<<}_{\text{less.less}} d_L < dq$

3) fluids 4) compressable

$H^{+\delta} — Cl^{-\delta}$ .... $H^{+\delta} — Cl^{-\delta}$

Polar Intramulecular Intermolecular

P.S :- $+1$ 7 $+\delta$

$Na^{+}-Cl^{-}$ } $H^{+\delta}-Cl^{-\delta}$

* Types of Intermolecular forces :-

1) dipole - dipole (Both is Polar)

2) H - bonding

$A-H \ldots B-H$

↓ ↓

F F ~~Cl~~

~~Cl~~ O

O N

N

Why only - O, N, F - ?

Bc

3) london dispervsim forces (non Polar)

بنقل شحنة موجبة من الذرة بيصير عندها $\delta+$ و $\delta-$ ونفس الشيء مع . الذرة الثانية وبتجاذبو

كلما كانت المركب فيه جزيئات اكثر زادت قوة الرابطة

C_6H_{14} stronger than CH_4

How do transform from liquid to gas?

by breaking intermoleculare forces

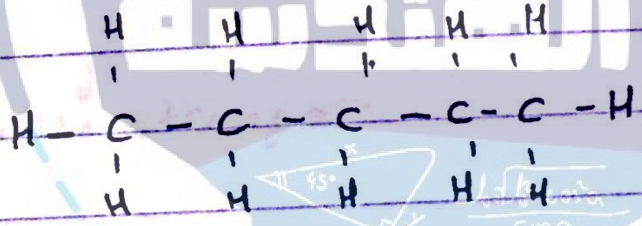
and when IMF increase the boiling increace boiling Points:-

C_2H_6	-88.6
C_4H_{10}	-0.5
C_6H_{14}	68.4
$C_{10}H_{22}$	174.1

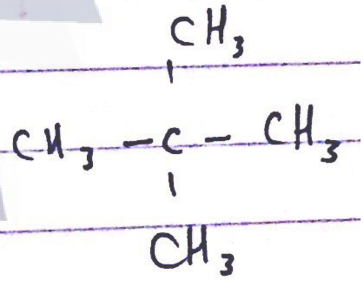
* Izomer:

C_5H_{12}

1)



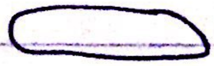
2)



What affekt on polaribisity?

1) molar mass ↑ → Polaribisity ↑

2) shape of malcular (chain) → Polaribisty ↑



chain

flower

london forces ~~in every m cp~~
in ~~an~~ every cpd

Ex: 1) H_2O → H-bonding + london forces

2) Cl-H , H-Br → Dipole-Dipole + london forces

one more type of IMF:-

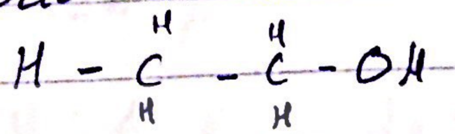
*Ion-Induced dipole

Ionic > Ion-Induced Dipole > H-bonding > Dipole-Dipole
> L.F
as the stronger

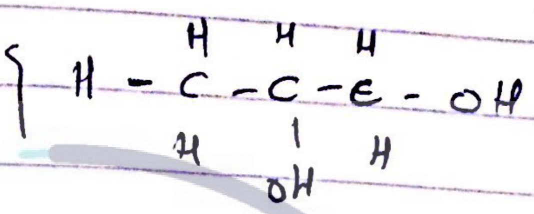
27-1 Sun

ex: 11.1

Below are ~~structers~~



$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-OH$



$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{OH}{C}}-\overset{H}{\underset{H}{C}}-OH$

~~stronger~~ higher boiling point

Bc → 2 H-Bonding

and the molar mass ~~is~~ more than the other one

ex: 11.2 a) ① KBr, ② $CH_3CH_2CH_2CH_2CH_3$, ③ CH_3CH_2OH

ionic — L.F — H-bond

2 $\overset{<}{\cancel{>}}$ 3 $\overset{<}{\cancel{>}}$ 1 lowist to highest

b) ① $CH_3CH_2NH_2$, ② $CH_3CH_2OCH_2CH_3$, ③ $HOCH_2CH_2CH_2OH$

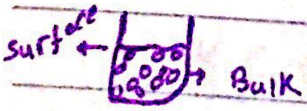
H-bond — L.F — 2.H-bond

2 < 1 < 3

oH more Polar than NH_2

* surface tension it's the energy ~~ner~~ needed to increase the ~~the~~ suface tension increase

intermolecular forces in the bulk more than is surface



energy is less in the bulk

IMF ↑ surface tension ↑

viscosity

IMF ↑ Viccosity ↑

$HOCH_3CH_2OH > CH_3-O-CH_3$

29-1-2019 tusday :-

vaporistian of IMF

liquid to gas

$KE \not\propto \overline{KE} \propto T$

جزيئات بتصطدم بالجدران وبتولد ضغط :

gas → Liquid (condensation)

Rate of vaporistion = Rate of condensation

Dynamic (equilibrium)

vapor presser constant

T↑ KE↑ and vapor pressure↑ (same liquid)

2 factors effect on vapor press. :-

1) Temp. ↑ vapor press. ↑

2) IMF ↑ " " ↓

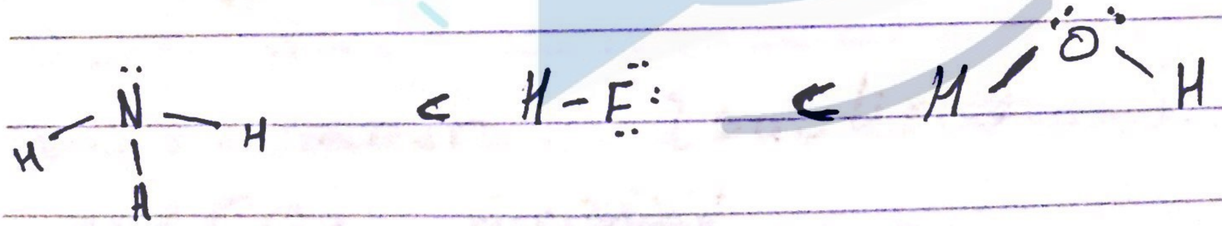
① $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ → Dipole-Dipole

2) H_2O H-bonding

عشان الغليان

~~الضغط~~ الجو الضغط الجوي ↑↓ الضغط البخاري ↓↑

عشان يصير غليان لازم ضغط جوي = ضغط بخاري



H-bonding in H_2O or OH is stronger ~~than~~ than NH_3

Bc: O has high electronigtive

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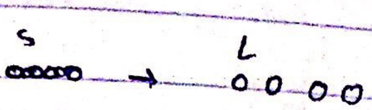
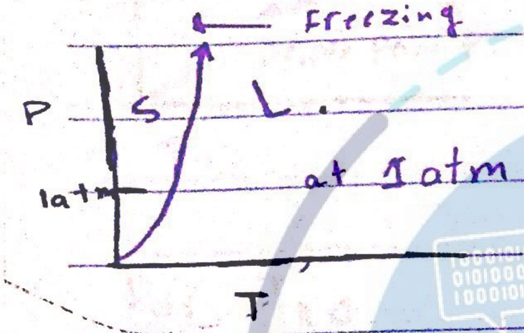
solid → liquid {melting or fusion}

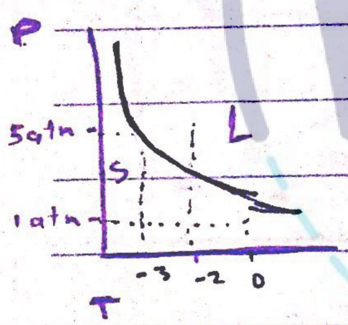
* $d_s > d_l$



for every thing expt ~~wt~~ H_2O:-



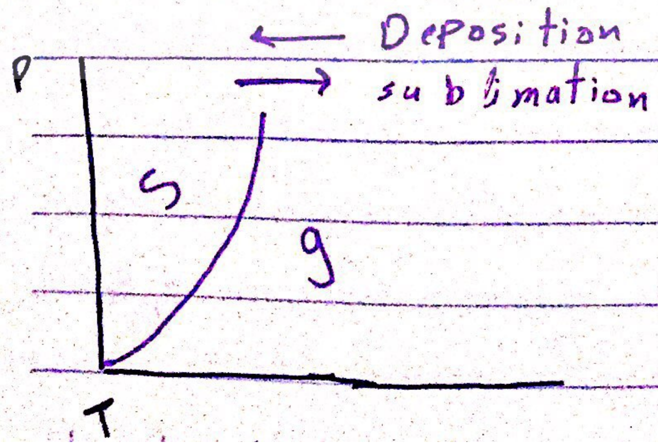
for H_2O * $d_{l(H_2O)} > d_{s(H_2O)}$



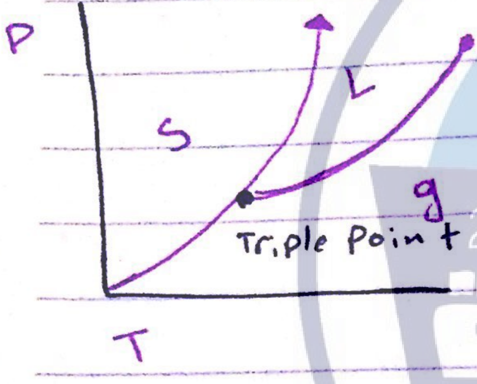
solid → vapor {sublimation}

ex: CO_2 طفاية حريق

gas → solid {Deposition}

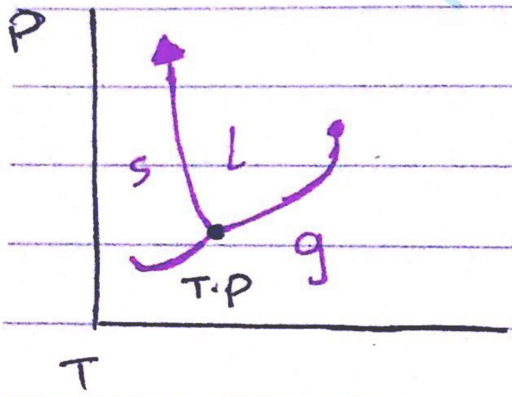


* phase Diagram



critical → ~~no~~ above or after this point we cannot have any Liquid !

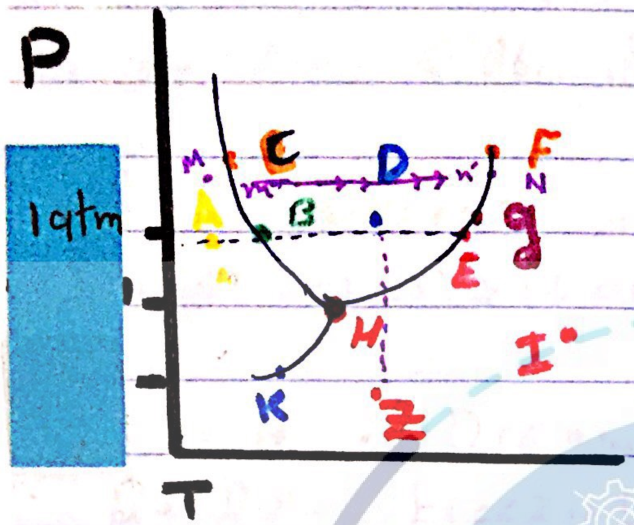
for H_2O



on lines there's 2 faces

3 / 2 / 2019

sunday



* notice that A, B, E has the same pressure which is 1 atm

* D and Z has the same Temp.

* M, m', N and n' has the same pressure

A → Solid

B → normal ~~boiling~~ melting point

C → melting Point

D → ~~gas (vapor)~~ liquid

E → normal B.P (Boiling Point)

F → Critical point

g → Boiling point

H → Triple point

I → gas (vapor)

K → sublimation Point

Q. What happens when we move from M to N?

Press. Constant, Temp. increase...

M is solid so it melt at m' ~~then~~ and when it Become Liquid n' is the Boiling point till we reach to N which's vapor

Q. to move from D to Z

(Press. decrease , Temp. constant)
and vaporization !

Z → A :- Deposition
D → A :- freezing
D → I :- vaporization
N → D :- condensation
A → Z :- sublimation

* as the IMF increase melting point and boiling point increase

solid + heat → liquid ΔH^{+}_{fus} Bc it's endo
↓
KJ/mol

ΔH الحرارة اللازمة لتكسير الروابط لمول واحد من المادة حتى الوصول للذوبان

liquid + heat → gas ΔH^{+}_{vap} endo

as IMF ↑ ∴ ΔH_{fus} and ΔH_{vap} ↑

$\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$

زيادة درجة حرارة لمادة صلبة بس لما بتكون اقل من درجة :- ° p.o.s

الانصهار ما رح تتكسر الروابط بس بتزيد الطاقة الحركية KE

* The Clausius - Clapeyron Equation :-

$$\left[\ln P = \frac{-\Delta H_{vap}}{RT} + C\right]$$

$$\ln P_1 - \ln P_2 = \frac{-\Delta H_{vap}}{RT_1} + \cancel{C} - \left(\frac{-\Delta H_{vap}}{RT_2} + \cancel{C}\right)$$

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

$$\boxed{R = 8.314\ J/mol\ K}$$

[For H_2O :- as the pressure ↑
Boiling point and melting point ↓

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$$\ln \frac{P_1}{P_2} = \frac{\Delta H_{vap}}{R} \left[\frac{T_1 - T_2}{T_2 \cdot T_1} \right]$$ وحدنا تغلطات !

Q. 11.39 $P_1 = 245$ torr , $T_1 = 290 K°$

$P_2 = 354$ torr $T_2 = 315$ K find ΔH_{vap}

$R = 8.314$ J/K mol

$$\ln \frac{245}{354} = \frac{\Delta H_{vap}}{8.314} \cdot \left[\cancel{240 - 1} \frac{1}{315} - \frac{1}{290} \right]$$

$$-0.36 = \frac{\Delta H_{vap}}{8.314} \cdot -2.7 \times 10^{-4}$$

$$\frac{-0.36}{-2.7 \times 10^{-4}} = \frac{\Delta H_{vap}}{8.314} \rightarrow 1363.1 \times 8.314 = \Delta H_{vap}$$

$\Delta H_{vap} = 11.3$ KJ /mol

Ex: 11,17 $T_1 = 0.0 C°$ $P_1 = 45.32$ mmHg

$\Delta H_{vap} = 30.1$ KJ /mol , $T_2 = 62.2 C°$, $P_2 = ?$

$$\ln \frac{45.32}{P_2} = \frac{3 \times 10^4}{8.314} \left[\frac{1}{335.2} - \frac{1}{273} \right]$$

$$\cancel{\ln} \frac{45.32}{P_2} = \overset{-2.46}{e}$$ بنا خذ e للطرفين

$$\frac{45.32}{P_2} = 0.8854 \rightsquigarrow P_2 = \frac{45.32}{0.8854} = 532 mmHg$$

/ /

Q. 11.13 $\Delta H = 40.5\ KJ$

$P_1 = 0.0992\ atm$ $T_1 = 27.3\ c^\circ$, $P_2 = 1atm$, $T_2 = ?$

$$\ln \frac{0.0992}{1} = \frac{40.5 \times 10^3}{8.314} \left[\frac{1}{T_2} - \frac{1}{300.3} \right]$$

$$-2.31 = 4871.3 \left[\frac{1}{T_2} - \frac{1}{300.3} \right]$$

$$-0.000474 = \frac{1}{T_2} - \frac{1}{300.3}$$

$$\frac{1}{T_2} = -0.000474 + \frac{1}{300.3}$$

$$\frac{1}{T_2} = 0.00286 \quad , \quad T_2 = 349.7$$

IMF ↑

surface ten. ↑ , vis. ↑ , B.p ↑ , m.p ↑

ΔH_{vap} ↑ , ΔH_{fus} ↑ , C.P ↑

only vapor press. ↓

Q. Which one of them has the higher vapor press ?

✓a) $CH_3CH_2CH_3$ L.F — molar mass = 44

b) CH_3OCH_3 L.F — molar mass = 46

c) CH_3CH_2OH H-bonding

d) $CH_3CH_2CH_2CH_3$ L.F — molar mass = 58

e) $CH_3CH_2CH_2Cl$ dipole-dipole

highest vapor Press. lowest IMF

the right anwser (a)

Q. Whichone of them has the highest B.p?

a) NH_3	B) BCl_3	C) Br_2	D) H_2O	E) CO_2
H-bonding	L.F	L.F	H-bond	L.F

D is the right anwser !

Ch. 12 Mixtures of propties of slutions:-

Mixtures

Homogeneous
has on phase

Hetrogeneous
has 2 Phases
or more

solutions:-

solute

solvent

7 / 2 / 2019

Louis

liquid solution

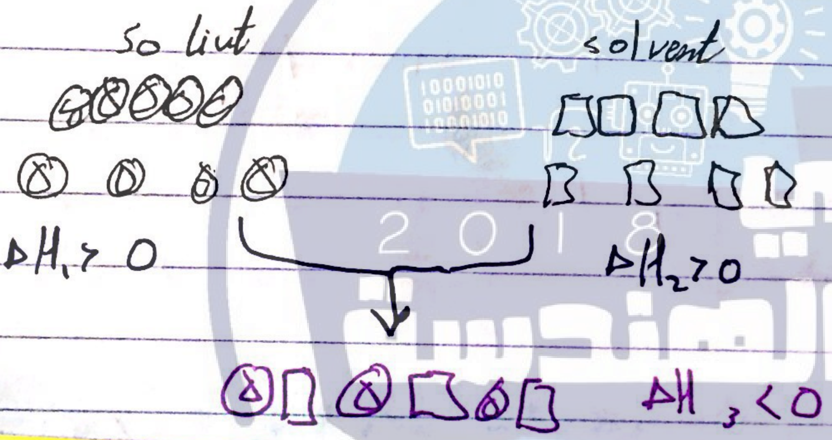
solut — solvent

solud
liquid
gas

liquid

* صلب مذاب في سائل لحد الاشباع
وقتها الصلب ما بذوب

* في السائل مذاب في سائل
ماله حالة اشباع وممكن
يتحول المذاب الى مذيب



$\overset{+}{\Delta H_1} + \overset{+}{\Delta H_2} + \overset{-}{\Delta H_3}$

$= \Delta H$ sol

If $\Delta H_3 > [\Delta H_1 + \Delta H_2]$

$\Delta H_{sol} < 0$ so the solution formed

If $\Delta H_3 < [\Delta H_1 + \Delta H_2]$

$\Delta H_{sol} > 0$ so the solution will not formed

ΔH_{sol} for NaCl = +4 kJ/mol

How?! ~~2~~ disorder!

2 factors make the solution formed?

1) energy 2) disorder

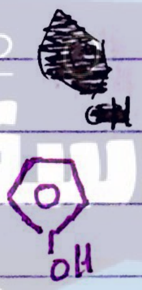
the enthalpy change

When the particles from one mole of solute are dissolved in the solvent is called the solvation energy

If the solvent is water the solvation energy can be called the hydration energy

ΔH_{sol} For NaCl positive and small
so the solution formed

suger in water
↓H-bonding



$\Delta H_3 = \Delta H_1 + \Delta H_2$
$\rightarrow \Delta H_{sol} = 0$
Ideal solution

Effect of temp. on solubility :-

solubility: the maximum amount of solute dissolved in a solvent at equilibrium
We can also say that solubility is:

the mass of solute that forms a saturated solution with a given mass of solvent at a specified temp.

For gases as the temp. increase, the solubility decrease

$CO_2 + H_2O \rightarrow H_2CO_3$

pressure; ↑ the solubility ↑

Henry's law :-

الذائبية ← $C \propto P$

$C = K_H P$ $K = \frac{\underline{mol}}{L.atm}$ or $\frac{g}{L.atm}$

Henry's constant

$$\boxed{P = K'_H C \quad \frac{atm}{mol / L}}$$

Ex: 12.7) at 0.11 $\frac{\underline{mol}}{L}$, P = 1, what is K ?

~~or~~

$K_H = \frac{C}{P} = \frac{0.11}{1} = 0.11\ mol / L.atm$

Ex: 12.1) محلول بالكتاب مثال على الاسئلة بتيجي بالامتحان

$C_1 \leftarrow C_{N_2} = 0.0152\ g/L$, $P = 585\ torr \rightarrow P_1$

$C_2 \leftarrow C_{N_2} = ?$ when $P = 823\ torr \rightarrow P_2$

$$\frac{C_1 = \cancel{K_H} P_1}{C_2 = \cancel{K_H} P_2} \rightarrow \frac{C_1}{C_2} = \frac{P_1}{P_2}$$

← الحل

$$\frac{0.0152}{C_2} = \frac{585}{823}$$

$$C_2 = \frac{0.0152 \times 823}{585} = 0.0214 \text{ g/L}$$

قانونه هينري لايطبق على الغازات التي تتفاعل مع الماء
مثل : CO_2 ، NH_3 ، SO_2 ، SO_3

*concentations units :-

1) Molarity = $\frac{\text{mole of solute}}{\text{(L) of soln}}$ = $\boxed{M}$
مولارية

soln = solute + solvent
A + B

2) Mass % (A) = $\frac{\text{mass A}}{\text{mass A + mass B}}$ x 100%

3) molality = $\frac{\text{mole of solute}}{\text{mass of solvent (Kg)}}$ = $\boxed{m}$
مولالية

Ex: 12.11) If you prepared 44.00g of Na_2SO_4 in 250g in H_2O, what's the m = ?

$m = \frac{\text{moles of } Na_2SO_4}{\text{mass of } H_2O \text{(kg)}}$

molar mass Na_2SO_4 = 142.04 g/mol → moles of Na_2SO_4 = $\frac{44 g}{142.04}$ = , $m = \frac{\text{mol } Na_2SO_4}{0.25 \text{Kg } H_2O}$ = 1.236 m

$\frac{250 g}{1000}$ = 0.25 Kg

concentation units ---

4) mole fraction $\boxed{X}$

A , B , C

$$X_A = \frac{mol\ A}{mol\ A + mol\ B + mol\ C}$$

$$X_{solute} = \frac{mol\ solute}{mol\ solute + mol_{solvent}}$$

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

mole % = $X_A \times 100\%$

5) percentage by mass - volume

$10\% \frac{m}{V} \rightarrow \frac{mass\ solute}{volume\ slon} \times 100\%$

$$\frac{10\ g\ solute}{100\ mL\ soln} \times 100\%$$

Ex: finding m from mass %.

10% NaCl , m = ?

$\frac{10\ g\ NaCl}{100\ g\ NaCl + H_2O} \times 100$ ➡ $\frac{mol\ NaCl}{kg\ H_2O}$

21/2/2019

Ex. 12.14:- 37% HCl $m = ?$

mass ~~W~~% $= \frac{37}{100} \times 100\%$ $m = \frac{\text{mol of solute}}{\text{Kg solvent}}$

mol HCl $= \frac{37}{36.46} = 1.01$

mass of solvent $= 100 - 37 = 63\,g$

$m = \frac{1.01\ mol}{63 \times 10^{-3}\ Kg}$

Ex: 12.15   HBr 40%

$\frac{40\ \text{solute}}{100\ \text{sln}}$ $d = 1.38\,g/mL$

$M = ?$

$\frac{\text{mol solute}}{\text{L soln}}$

mass % $= \frac{M \times \text{molar mass}}{1000 \times d} \times 100\%$

$40 = \frac{M \times 80.91}{1000 \times 1.38} \times 100\%$

$M = 6.82\,M$

Q. 12.75 $m = ?$ NaCl soln. 1.50 M NaCl
$d = 1.036\,g/ml$

M = $\frac{\text{mol of solute}}{\text{L of soln}}$ m = $\frac{\text{mole of solute}}{\text{mass of solvent (kg)}}$

mass = $\cancel{\frac{d}{V}}$ = 1 L × 1.036 g/mL

→ 1 L × 1.036×10^{-3} g/L = 1036 g (Solution)

~~mole~~ mass NaCl = 1.5 × 58.45 = 87.66 g NaCl

mass of solvent = 1036 − 87.66 = 948 g

$m = \frac{1.5\,mol}{448 \times 10^{-3}} = 1.58\,m$

mass % = $\frac{87.66}{1036} \times 100$

$X_{nacl} = \frac{\text{mol NaCl}}{\text{mol NaCl} + \text{mol } H_2O} = \frac{1.5}{1.5 + \frac{948}{18}}$

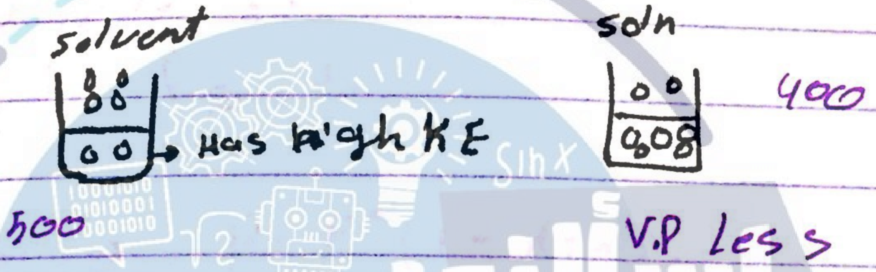
$X_{NaCl}\,\% = \frac{1.5}{1.5 + 948/18} \times 100$

53 → 67 ختام

Colligative properties

خواص تعتمد على الكمية وليس على النوعية

vapor Press.



why the vapor press ↓ in the soln ?

1) لانو جزيئات ال solute بتحجب هروب الجزيئات

2) لانو الفوضوية زادت وبقل الدافع لمغادرة السطح وتحوله للحالة الغازية

Raul's low

P^{o} → vapor press for pure solvent

$$\underset{\text{soln}}{P} = X_{\text{solvent}} P^{o} \rightarrow \text{solvent}$$

$X \rightarrow 0 - 1$

$X = 1$, $P = P^{o}$, $x = 0$ no P

$P = P^\circ X_{solvent}$

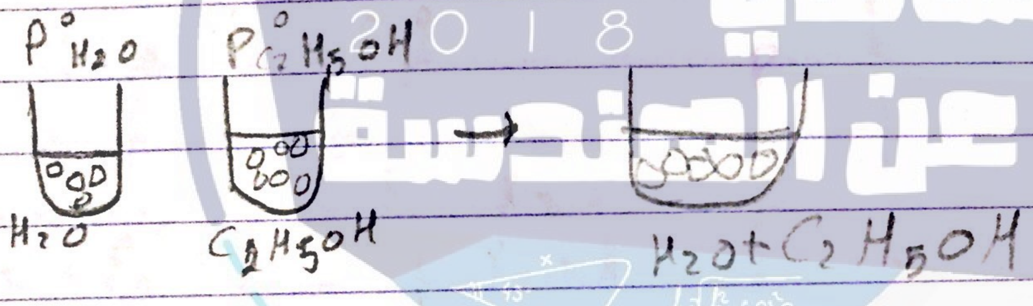
$X_{solvent} + X_{solute} = 1$

$X_{solvent} = 1 - X_{solute}$

$P = P^\circ X_{solvent} \rightarrow P = P^\circ (1 - X_{solute})$

$\rightarrow P = P^\circ - P^\circ X_{solute} \rightarrow P^\circ X_{solute} = P^\circ - P$

$\boxed{P^\circ X_{solute} = \Delta P}$



$P_{total} = P_{H_2O} + P_{C_2H_5OH}$

$= (P^\circ X)_{H_2O} + (P^\circ X)_{C_2H_5OH}$

Ex: 12.17) $C_{16}H_{22}O_4$ Mm = 278 g/mol

$P^\circ = 0$ zero + 20 g in 50 g C_5H_{12}

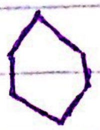
mm = 72.7 g/mol

$P^\circ = 541$ torr

$P = (P^\circ X_{solvent}) = 541 \times 0.906 = 490$ torr

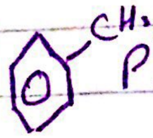
$$\boxed{X_{C_5H_{12}} = \frac{50/72.7}{(50/72.2)+(20/278)} = 0.906}$$

Ex: 12.19) ①



$P^\circ = 66.9$ torr

②



$P^\circ = 21.1$ torr

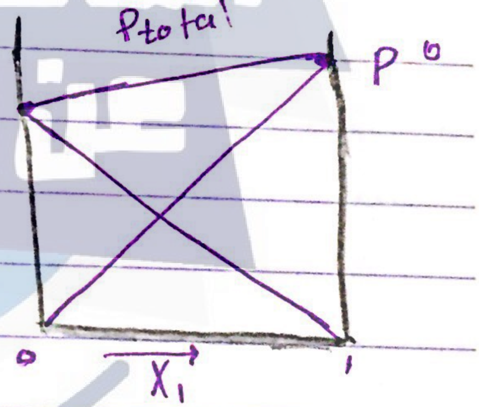
$X_2 = 0.25$

1) $X_1 = 1 - 0.25 = 0.75$

$P_{total} = (66.9 \times 0.75) + (21.1 \times 0.25) = 55.4$ torr

$P_1 = P_1^\circ X_1 \rightarrow X_1 = 0 \rightarrow P_1 = 0$

$X_1 = 1 \rightarrow P_1 = P_1^\circ$



$P_2 = P_2^\circ X_2$

$X_2 = 1 - X_1$

$X_2 = 0$
$X_1 = 1$
$P_2 = 0$
$P_1 = P^\circ$

vapor press. Lowering

1) Elevation of boiling Point ارتفاع درجة الغليان

2) Depression of freezing point انخفاض درجة التجمد

$\underset{\text{so pure}}{T_b^\circ} < \underset{\text{solution}}{T_b} \rightarrow \Delta T_b = T_b - T_b^\circ$

$T_F^\circ > T_F \rightarrow \Delta T_f = T_f^\circ - T_f$

$\Delta T_b = T_b - T_b^\circ$ Elevation bp

$\Delta T_f = T_f^\circ - T_f$ Depression fp

$\Delta T_b = K_B\, m$ $\quad K_{b\,H_2O} = 0.51$

مولاليتي

$\Delta T_f = K_f\, m$ $\quad K_{f\,H_2O} = 1.86$

K_b ، K_f خاصية المادة المذيبة

Ex: 12.8) (محلول) astmate the fp for soln made from 10g $(NH_2)_2CO$ Mw = 60.06 g/mol what's the freezing point in 125 g of H_2O?

K_f for $H_2O = 1.86$ $\quad K_f$ for $(NH_2)_2CO = ?$

$$m = \frac{(10\,g / 60.06\,g/mol)}{125 \times 10^{-3}\,kg} = 1.33\ m$$

$\Delta T_f = 1.86 \times 1.33 = 2.47$

$\underset{\text{fp } H_2O}{T_f = 0} - 2.47 = -2.47 \rightarrow$ for $(NH_2)_2CO$

Ex: 12.22) How many grams of $C_6H_{12}O_6$ ($M_w = 180.9$ g/mol) in 255 g H_2O, to rasie the b.p to 102.36°

1) $\Delta T_b = K_b\, m$ $\qquad\qquad \Delta T_b = T_b - T_b^{\circ}$

$2.36 = \overset{0.51}{\cancel{1.86}} * m$ $\qquad\qquad = 102.36 - 100$

$\qquad\qquad = 2.36$

2) $m = \dfrac{2.36}{0.51} = 4.61\, m$

$4.61\, m = \dfrac{n_{C_6H_{12}O_6}}{255 \times 10^{-3}} \longrightarrow n = 1.04$ mol

3) grams $= 1.04 * 180.9 = 188$ g

Ex: 12.23) soln made by 3.46 g of unknown cpd in 85 g C_6H_6 → بنزين → ($T_f = 4.13$) → for soln what's the molar mass for this cpd?

$K_{f\,C_6H_6} = 5.07$, $T_f^{\circ} = 5.45$

1) $\Delta T_f = \overset{5.45 - 4.13}{\cancel{4.13 - 5.45}} = \cancel{-}\,1.32$

$1.32 = 5.07 * m$

2) $m = \dfrac{1.32}{507} = 0.260\, m$

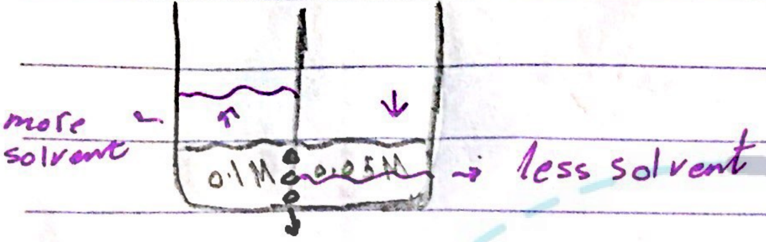
$0.260 = \dfrac{n}{85 \times 10^{-3}} = n = \overset{0.022\text{ mol}}{\cancel{0.260 \times}}$

3) Molar mass $= 3.46 \div 0.022$

$\boxed{= 156\ g/mol}$

Osmosis:

الخاصية الاسموزية:
انتقال الماء من تركيز عالي الى تركيز منخفض



التقوب بالنافذة تنقل
المذيب من تركيز اقل
الى تركيز اعلى

Osmatic Pressure:- after the solvent increased in the soln.

law for osmatic press. :-

$PV = nRT \rightarrow P = \frac{n}{V} RT \rightarrow P = MRT$

$\rightarrow \left[\pi = MRT \right]$

mol/$\cancel{L}$ · $\cancel{L}$·atm/$\cancel{mol}$·$\cancel{K}$ · $\cancel{K}$ = atm

Ex: 12.25) what's the osmatic press. in mmHg when mass = 5g, and molar mass = 235000 g/mol in 100 mL equas soln at 4C°?

1) $n = 5 / 235000 = 2 \times 10^{-5}$ | 2) $M = \frac{2 \times 10^{-5}}{100 \times 10^{-3}} = 2.12 \times 10^{-4}$

3) $\pi = 2.12 \times 10^{-4} * 0.0821 * 277 = 4.84 \times 10^{-3}$ atm

4) press. in mmHg: $4.84 \times 10^{-3} \times 760 = 3.6784$

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Ex:27) mass = 137.2 mg , V = 100 mL at 4C°
π = 6.45 cm H_2O , what's the molar mass?

$\pi = MRT = \pi = \frac{n}{V} RT$

$6.24 \times 10^{-3} = \frac{n}{100 \times 10^{-3}} * 0.0821 * 277$

$n = \frac{(6.24 \times 10^{-3})(100 \times 10^{-3})}{0.0821 * 277} = 2.75 \times 10^{-3}$

cmHg $= \frac{6.45}{13.6}$
$= \frac{0.476 \text{ cmHg}}{76 \text{ cmHg}}$
$= 6.24 \times 10^{-3}$ atm

$n = \frac{\text{mass}}{\text{molar mass}} \rightarrow \text{molar mass} = \frac{\text{mass}}{n}$

$\text{MoW} = \frac{137.2}{2.75 \times 10^{-3}} = 4.998 \times 10^{3}$ g/mol

density

H_2O	Hg
1g/cm³	13.6 g/cm³

osmatic Press. :-
we use it when we have very high molar mass bc the change of temp. will be too low !

Colligative Properties for electrolytic

$C_6H_{12}O_{6(s)} \rightarrow C_6H_{12}O_{6(aq)} \longrightarrow \Delta T_f = 1.86(1)(1M) = 1.86$

$NaCl_{(s)} \rightarrow Na^+ + Cl^- \longrightarrow \Delta T_f = 1.86(2)(1M) = 3.72$

$CaCl_2 \rightarrow Ca^{2+} + 2Cl^- \rightsquigarrow 3$
$KCl \rightsquigarrow 2$
$K_2SO_4 \rightsquigarrow 3$
$MgSO_4 \rightsquigarrow 2$
$C_{12}H_{22}O_{11} \rightsquigarrow 1$

why we put salt on the ice?
Bc ionic give more depressure

dissociation → salt $i > 1$

Association → organic cpd ex P. 613

2 mol → 1 mol → $i = 1/2$

$i < 1$

	i at 0.1M	
NaCl	2	1.87
K_2SO_4	3	2.84
$MgSO_4$	2	1.21
	من المعادلة	من التجربة

ليش العدد اللي من التجربة اقل؟

لانو بعض الايونات بترجع بترتبط بعد التفكك (ion paring)

$$\boxed{\Delta T_f = i K_f m} \qquad \boxed{\Delta T_b = i K_b m}$$

cpd	i	ΔT_b
$CaCl_2$	~~4~~ 3	$3 K_b$
$AlCl_3$	4	$4 K_b$
KCl	2	$2 K_b$
$C_6H_{12}O_6$	1	$1 K_b$

Q. What's the higher B.p ? $AlCl_3$

Q. what's the higher B.p elvetion? $AlCl_3$

Q. " " " osmatic press ? $AlCl_3$

Ch.13 Chemical Kinetics

1) Rate → the speed of rxn → we study it to control the speed

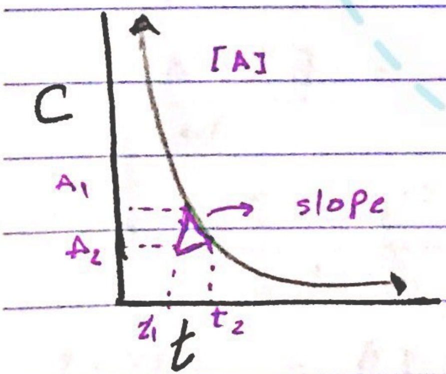
factors effect on Rate?

1) temp.
2) catalysis (الانزيمات)
3) Molarity التركيز
4) السطح المعرض للتفاعل

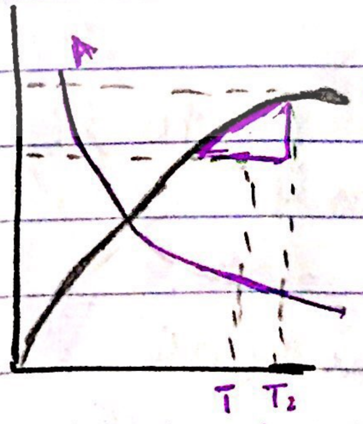
كل ما نزيد عدد الجزيئات بتزيد عدد الاصطدامات (collison)

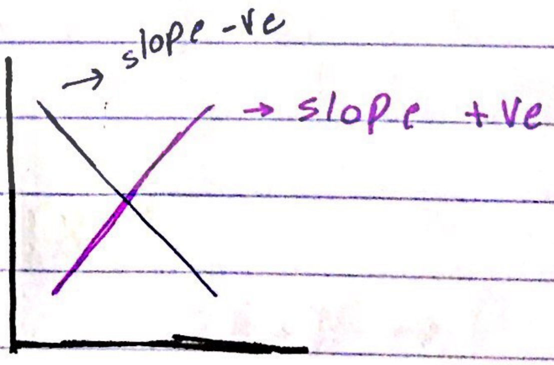
(M ↑ , n ↑ , Collison ↑)

$$\text{Rate} \propto \frac{1}{t} \rightarrow \text{Rate} = \frac{-\Delta[\ \ ]}{\Delta t} = M/S$$



$$\frac{-\Delta[A]}{\Delta t} = \frac{-(A_2 - A_1)}{t_2 - t_1}$$





A → P

$$\frac{-\Delta[A]}{\Delta t} = \frac{\Delta[P]}{\Delta t}$$

2A → P

$$\frac{\Delta[P]}{\Delta t} = -\frac{1}{2}\frac{\Delta[A]}{\Delta t}$$

$aA + bB \rightarrow cC + dD$

$$-\frac{1}{a}\frac{\Delta[A]}{\Delta t} = \frac{-1}{b}\frac{\Delta[B]}{\Delta t} = \frac{1}{c}\frac{\Delta[C]}{\Delta t} = \frac{1}{d}\frac{\Delta[D]}{\Delta t}$$

Ex. 13.1) $IO_3^- + 3SO_3^{-2} \rightarrow I^- + 3SO_4^{-2}$

(نتأكد انو المعادلة موزونة قبل الحل)

$$\frac{\Delta[SO_3^{2-}]}{\Delta t} = 2.4\times10^{-4}$$

1) find $\frac{\Delta[I^-]}{\Delta t}$

$$\frac{-\Delta[IO_3^-]}{\Delta t} = -\frac{1}{3}\frac{\Delta[SO_3^{-2}]}{\Delta t}$$

$$= \frac{\Delta[I^-]}{\Delta t} = \frac{1}{3}\frac{\Delta[SO_4^{-2}]}{\Delta t}$$

$$-\frac{1}{3}\frac{\Delta[SO_3^{-2}]}{\Delta t} = \frac{\Delta[I^-]}{\Delta t}$$

$$\frac{2.4\times10^{-4}}{3} = 8\times10^{-5}\ M/S$$

2) find $\Delta[SO_4^{-2}]$

$$-\cancel{\frac{1}{3}}\frac{\Delta[SO_3^{-2}]}{\Delta t} = \cancel{\frac{1}{3}}\frac{\Delta[SO_4^{-2}]}{\Delta t}$$

$$2.4\times10^{-4} = 2.4\times10^{-4}$$

Rate Laws

$$Rate = K\,[A]^x[B]^y$$

$Rate = K\,[A]^2\,[B]^3$ $2A + 3B \rightarrow P$

X غلط لانو ما بنقدر نحدد الارقام الا بالتجربة

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sun day

$$\text{Rate} = \underset{\sim}{K} [A]^x [B]^y$$

Rate constant

and it's constant at constant Temp.

Rate Method

	[A]	[B]	Rate
1	0.1	0.2	0.4
2	0.2	0.2	0.8
3	0.1	0.4	1.6

x

$$\text{Rate}_1 = K_1 [A]^x [B]^y$$

$$\text{Rate}_2 \; K_2 \; [A]^x [B]^y$$

$$\boxed{K_1 = K_2}$$

~~Rate~~ $$\frac{0.4}{0.8} = \frac{[0.1]^x \cancel{[0.2]^y}}{[0.2]^x \cancel{[0.2]^y}}$$

$$\frac{0.4}{0.8} = \left[\frac{0.1}{0.2}\right]^x \rightarrow \frac{1}{2} = \left[\frac{1}{2}\right]^x \rightarrow x = 1$$

y

$$\frac{\text{Rate}_1}{\text{Rate}_3} = \left[\frac{B_1}{B_2}\right]^y$$

$$\frac{0.4}{1.6} = \left[\frac{0.2}{0.4}\right]^y \rightarrow \frac{1}{4} = \left[\frac{1}{2}\right]^y \rightarrow y = 2$$

$$\boxed{\log \tfrac{1}{4} = y \log \tfrac{1}{2}}$$

y طريقة لحساب ←

If [A]*2 and Rate *2 → $x = 1$

$$K = \frac{Rate}{[A]^x [B]^y} \rightarrow \frac{0.4}{[0.1]^1 [0.2]^2} = 100\ M^{-2} S^{-1}$$

order ↔ الرتبة

p. 640 the taple checkit

$x = 1$ → 1st order for [A]

$y = 2$ → 2nd " " [B]

3rd order for all

Q. 13.57 A + B + C → P

	[A]	[B	[C]	Rate
1	0.01	0.01	0.01	2.35×10^{-3}
2	0.02	0.01	0.01	4.70×10^{-3}
3	0.02	0.03	0.02	4.23×10^{-2}
4	0.02	0.03	0.03	4.23×10^{-2}

find x, y, z

$[A]^x, [B]^y, [C]^z$

1) $x = \frac{4.70 \times 10^{-3}}{2.35 \times 10^{-3}} = \frac{0.02}{0.01} = 2$

$\rightarrow [A]^1 \rightarrow x = 1$

2) $y = \frac{4.70 \times 10^{-3}}{4.23 \times 10^{-2}} = 1/9 = \left(\frac{1}{3}\right)^2$

$\left[\frac{0.01}{0.03}\right]^y = \left(\frac{1}{3}\right)^y \rightarrow y = 2 \rightarrow [B]^2$

3] $Z = 0$ لانو الـ [C] تغير والـ Rate

ما تغير ← order=0

$K = \frac{2.35\times10^{-2}}{(0.01)(0.01)^2} = 23500\ M^{-2}s^{-1}$

1st order	s^{-1}
2nd "	$M^{-1}s^{-1}$
3rd "	$M^{-2}s^{-1}$
4th "	$M^{-3}s^{-1}$
Zero "	$M s^{-1}$

Integrated Rate low:-

$$nA \longrightarrow P$$

$Rate = K[A]$

$= \frac{-\Delta[A]}{\Delta t} = K[A]$

$= \frac{-dA}{dt} = K[A]$

$\int_{A_0}^{A} \frac{-dA}{A} = \int_{t=0}^{t} K\,dt$ $t = 0$ $K = t$ $[A] = [A_0]$

$\ln A \Big]_{A_0}^{A} = -Kt \Big]_{t=0}^{t}$

$\boxed{\int \frac{dx}{x} = \ln x}$ $\ln A - \ln[A_0] = Kt - K[0] =$

1st order rxn

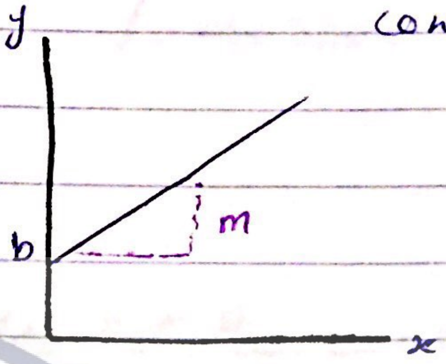
$$y = mx + b$$

where: $y = \ln[A]$

$m = -K$

$\ln[A_0] = b$

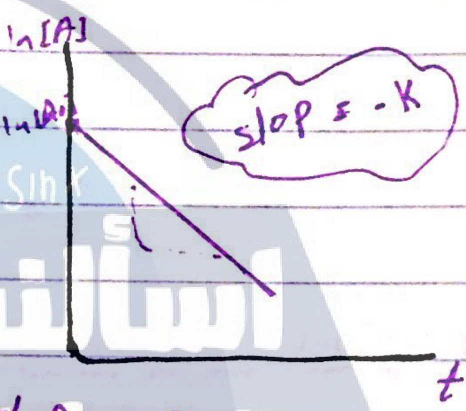
$$\ln[A] = -Kt + \underbrace{\ln[A_0]}_{\text{constant}}$$



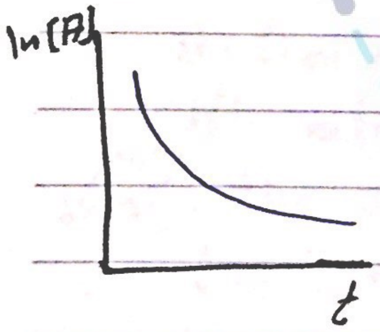
* as the time goes on the conc. of A ↓ (مواد متفاعلة)

v.i slope = - K

↳ slope has to be nigative



* A plot of ln[A] vs t a straight line is obtained with slope = -3 what is K? $\boxed{K = 3}$



لما تكون الرسمة منحنى بنعرف انها 1st order

لوما زبط بنعرف 2nd order

وممكن يجي بالسؤال soppose that is 1st order

Ex 13.16) $C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$
glucose fructose

the rxn is 1st order with a pate constant K equal to $6.17 \times 10^{-4}\ s^{-1}$ at 35 C°, suppose the intial sucrox conc. was = 0.40 M [A_0]

←

(a) What will the conc. be after 2 hours? [A]!

$\ln[A] - \ln 0.40 = -6.17\times10^{-4}\,s^{-1}$ / 2 hrs * 3600 s/hrs

$\ln[A] = -5.36$

$[A] = 4.7\times10^{-3}\,M$

(b) How many minutes will it takes for the conc. of sucose to drop to 0.30 M?

[A]

$\ln 0.30 - \ln 0.40 = -6.17\times10^{-4} * t$

$t = 466\,s \rightarrow t = 7.8\ min$

(→ غلط! الحل على النسبة والتناسب !)

* Half life of a rxn : $t_{1/2}$ (فترة نصف العمر)

the time needed for the conc. to be half it's initial value $[A] = 1/2\,[A_0]$

(or) the amount of time required for Half of the reactant to disopear

* the equations of half life depend on the order o the rxn

$\ln\dfrac{[A_0]}{[A]} = Kt$ at $t = t_{1/2}$

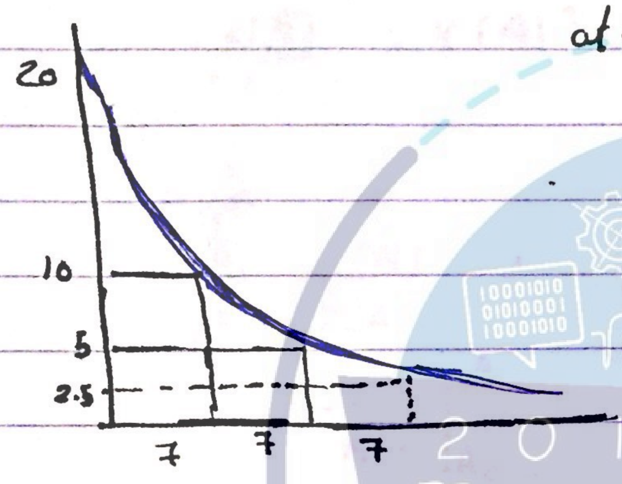
$[A] = 1/2\,[A_0]$

$$\ln\frac{[\cancel{A_0}]}{1/2\,[\cancel{A_0}]} = Kt_{1/2} \rightarrow \ln 2 = \underset{\text{constant}}{\underline{K}}\,t_{1/2}$$

$t_{1/2}$ بتعتمد على K فقط ما بتعتمد على $[A_0]$

لانو K بتختلف من مادة لمادة

at same Temp. → K constant



20 → 10 7 min
10 → 5 7 min
5 → 2.5 7 min

[1st order only]

* How to calculate $t_{1/2}$ (previous Ex):

$t_{1/2} = \frac{\ln 2}{K} \rightarrow t_{1/2} = \frac{\ln 2}{6.17 \times 10^{-4}\ s^{-1}} = 1123\ s$

if $A_0 = 0.3 \rightarrow 0.15 = 18.7$ $= 18.7\ min$

not affected by [A]

* t = ? for 75% completed of 1st order
$K = 0.1\ min^{-1}$

$[A] = 25 \rightarrow$ 75 لانو راح

$100 \xrightarrow{t_{1/2}} 50$

$50 \xrightarrow{t_{1/2}} 25$ $t_{1/2} = \frac{\ln 2}{0.1} = \frac{0.693}{0.1} = 6.9$

time (total) $= 2 \cdot 6.9 = 13.8$

* 2nd order rxn:-

$$nA \to P$$

$$Rate = K[A]^2$$

$$\frac{-\Delta[A]}{\Delta t} = K[A]^2$$

$$\frac{-\Delta[A]}{[A]^2} = K\Delta t$$

$$\int_{A_0}^{A} \frac{-d[A]}{[A]^2} = \int_{t=0}^{t=t} K\,dt$$

$$-\left(\frac{-1}{A}\right)\Big]_{A_0}^{A} = Kt\Big]_{0}^{t}$$

$$\boxed{\frac{1}{(A)} - \frac{1}{(A_0)} = Kt}$$

or $\dfrac{1}{[A]} = Kt + \dfrac{1}{[A_0]}$

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Q. 13.21) $2D \rightarrow P$ $K = 6.3 \times 10^{-3}\ M^{-1}s^{-1}$

Rate = $K[D]^2$ $0.864M \downarrow \rightarrow D_0$

to $0.0768 \rightarrow D$

A] t = ?

$$\frac{1}{0.0768} - \frac{1}{0.864} = 6.3 \times 10^{-3}(t)$$

t = 1883 s

B] if $D_0 = 0.255$ M , D = ? after 2.54 min

$$\frac{1}{D} - \frac{1}{0.255} = (6.3 \times 10^{-3})(2.54 \times \cancel{10}\,60)$$

$$\frac{1}{D} = 4.88 \rightarrow D = 0.205M$$

C] $t_{1/2}$ = ?

$$\frac{1}{(6.3 \times 10^{-3})(0.255)} = 623\ s = 10.4\ min$$

Ex 13.24)

$$2NO_2 \rightarrow 2NO + O_2$$

$[NO_2]_0 = 6.54 \times 10^{-4}$ M initial Rate = $4.42 \times 10^{-7}\ M^{-1}s^{-1}$

K = ?

Rate = $K[NO_2]^2$

$$K = \frac{4.42 \times 10^{-7}}{[6.54 \times 10^{-4}]^2} = \boxed{1.03\ M^{-1}s^{-1}}$$

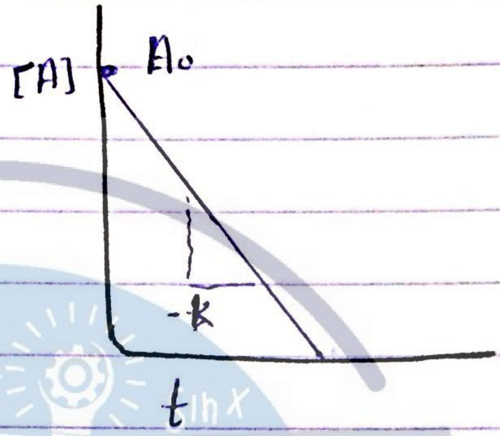
$t_{1/2}$ for zero order rxn :-

$$Rate = K = \frac{-\Delta[A]}{\Delta t}$$

$$\int_{A_0}^{A} \frac{-d[A]}{dt} = \int_{t=0}^{t} K\,dt$$

$$A\Big]_{A_0}^{A} = -Kt\Big]_{t=0}^{t}$$

$$[A] - [A_0] = Kt$$



متناقص

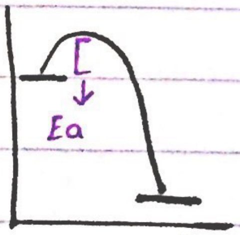
$$[A] = -Kt + [A_0]$$

$$\frac{1}{2}A_0 - A_0 = -Kt_{1/2}$$

$$\frac{1}{2}A_0 = Kt_{1/2}$$

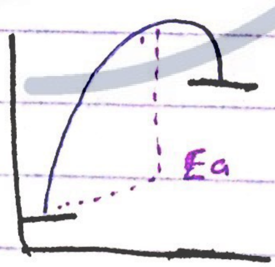
* Collisions :-

①



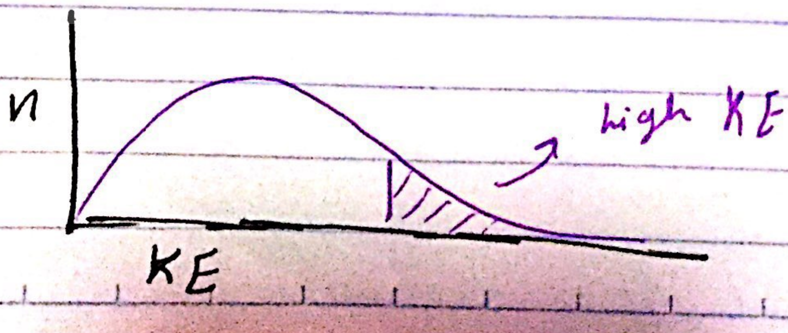
$\Delta H < 0$

②



$\Delta H > 0$

* activation energy * جزيئات عندهم القدرة عشان تروح عالتفاعلات



$k = Ae^{-E_a/RT}$

Rate $\propto$ K   T↑, Rate↑, K↑

E_a↓ Rate↑

Arhenous constant

$\overset{\text{constant}}{K} = \overset{\uparrow}{A}\, e^{-E_a/RT}$ $R = 8.314\ J/K.mol$

ev'

$\ln K = \ln A - \frac{E_a}{RT}$

$\ln K_1 = \ln A - \frac{E_a}{RT_1}$

$\ln K_2 = \ln A - E_a/RT_2$

$\ln K_1 - \ln K_2 = \cancel{\ln A} - \frac{E_a}{RT_1} - \cancel{\ln A} + \frac{E_a}{RT_2}$

$\ln \frac{K_1}{K_2} = \frac{E_a}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$

Ex 13.26] the Rate constan $\overset{K_1}{=} 3.2\ M^{-1}S^{-1}$ at $T_1 = 355\ C°$ and $K_2 = 23\ M^{-1}S^{-1}$, $T_2 = 405\ C°$
What's the value of Ea in KJ/mol

$T_1 = 628$, $T_2 = 678$

$\ln \frac{3.2}{23} = \frac{E_a}{8.314} \left(\frac{1}{678} - \frac{1}{628}\right)$

$E_a = 139 \times 10^3\ J/mol \rightarrow 139\ KJ/mol$

Ⓑ what would be the Rate constant at 310 c°

$K_1 = 3.2$ $T_1 = 628$

$K_2 = x?$ $T_2 = 583$

$$\ln \frac{3.2}{K_2} = \frac{139 \times 10^3}{8.314}\left(\frac{1}{583} - \frac{1}{628}\right)$$

$$\ln K_2 = -0.907$$

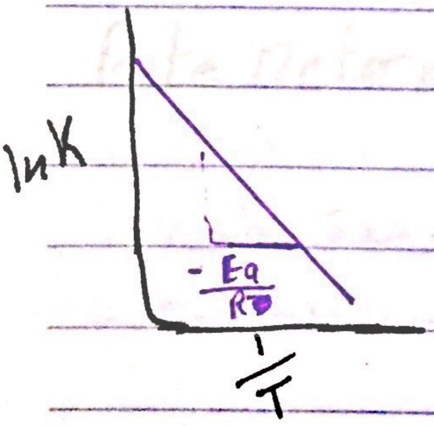
$$K_2 = 0.40 M^{-1} S^{-1}$$

$$\ln K = \ln A - \frac{Ea}{RT}$$

K	T
x	y
z	d
A	B

$$y = mx + B$$

$$\ln K = -\frac{Ea}{RT} + \ln A$$



$$-\text{slope} = -\frac{Ea}{R}$$

$\rightarrow Ea = \text{slope} * R$

* Mechanism of rxn

① $2NO_2Cl \rightarrow 2NO_2 + Cl_2$

② $NO_2Cl \rightarrow NO_2 + Cl$

③ $Cl + NO_2Cl \rightarrow NO_2 + Cl_2$

$2 + 3 = 1$ ✓

Elemantry steps

$Rate_2 = K_2[NO_2Cl]$ slow

$Rate_3 = K_3[NO_2Cl][Cl]$ fast

$Rate = K[NO_2Cl]$

exp.

Rate Determiny step (RDS)

slowest step

اذا كان التفاعل فيه خطوة بتلنن بتفاعل بسرعة ووحدة ببطء

بكون سرعة التفاعل نفس الخطوة اللي بتتفاعل ببطء

ال Rate law الصحيح يكتب من الخطوة البطيئة

$2NO + 2H_2 \rightarrow N_2 + 2H_2O$ $Rat = K[NO]^x[H_2]^y$

(1) $2NO + H_2 \rightarrow \cancel{N_2O} + H_2O$ slow exp:

(2) $\cancel{N_2O} + H_2 \rightarrow N_2 + H_2O$ fast $Rate = K[NO]^2[H_2]$

N_2O produced then consumed

Intermediate

Elementary steps

bi molecular	مكون من مركبين	2nd order
unimolecular	،، ،، مركب واحد	1st order
termolecular	،، ،، مركبات	* 3rd order

R فيه اتزان

$2NO \rightleftharpoons N_2O_2$ fast

$\cancel{N_2O_2} + H_2 \rightarrow \cancel{N_2O} + H_2O$ slow

$\cancel{N_2O} + H_2 \rightarrow N_2 + H_2O$ fast

Rate law : $k[N_2O_2][H_2]$

$Rate_{forward} = k_f[NO]^2$

$Rate_{reverse} = k_v[N_2O_2]$

$\rightarrow k_f[NO]^2 = k_v[N_2O_2]$

$\rightarrow [N_2O_2]^* = \frac{k_f[NO]^2}{k_v}$

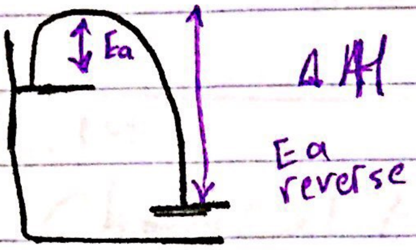
$\rightarrow Rate = k\frac{k_f[NO]^2}{k_v}[H_2]$

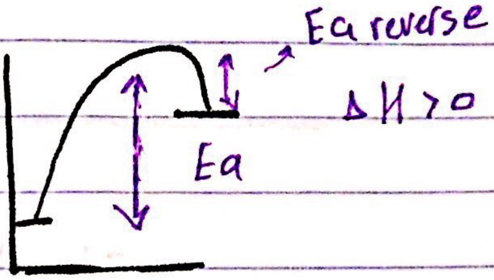
$k = \frac{kk_f}{k_v} \rightarrow Rate = k[NO]^2[H_2]$

ممنوع يطلع بال Ratelaw

Intermediate

~~Catalysts~~: (catalysis)





ال catalysis بتقلل الـ Ea فبزيد الجزيئات اللي الها طاقة كافية

7-3-2019 :-

catalysis:

Homogenous	Hetrogenous	Enzym
the Phase of the catalysis has the same Phase of the rxn	the phase doesn't seems like the rxn's Phase	

$CH_3COOCH_3 + H^+_{(aq)} \rightarrow CH_3COOH +$ ~~CH_3~~ CH_3COH

Pt

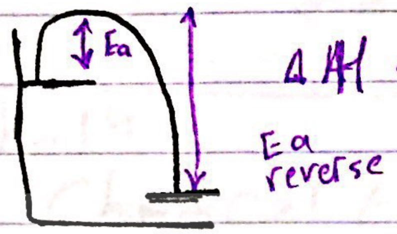
ex of catalysis

ال catalysis مابتستهلك بالتفاعل !

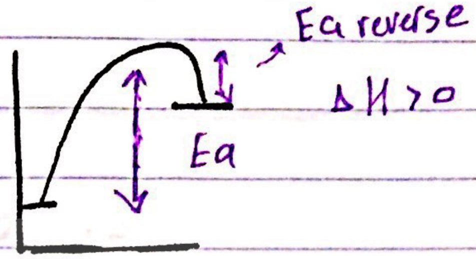
Hetrogenous catalysis better then Homogenous

DE it's easy to useit again

~~Catalysis~~: (catalysis)



$\Delta H < 0$



$\Delta H > 0$

ال catalysis بتقلل ال Ea فبتزيد الجزيئات الي الها طاقة كافية

7-3-2019 :-

catalysis:

Homogenous	Hetrogenous	Enzym
the Phase of the catalysis has the same Phase of the rxn	the Phase doesn't seems like the rxn's Phase	

$CH_3COOCH_3 + H^+_{(aq)} \rightarrow CH_3COOH + \cancel{CH_3}$
CH_3COH

Pt

ال catalysis مابستهلك بالتفاعل !

ex of catalysis

Hetrogenous catalysis better then Homogenous

Be it's easy to useit again

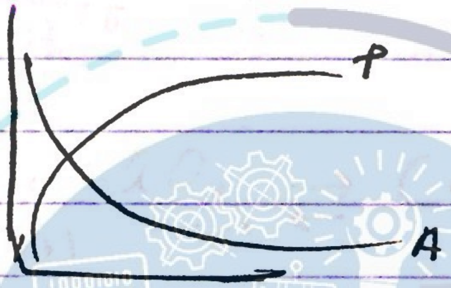
Enzyms → موجودة في جسم الانسان بتسرع عملية الهضم

Ch. 14

Chemical Equilib. :-

Dynamic

$A \rightleftarrows P$



$2NO_{2(g)} \rightleftarrows N_2O_4(g)$ الاتزان ~~يعني تحول~~ عكسي تام
التراكيز تضلها ثابتة

$N_2O_4 \rightleftarrows 2NO_2$

بالاتزان عادي لو صار المتفاعل هو الناتج والعكس !

	[NO]	$[N_2O_4]$	$[NO_2]$	$[N_2O_4]$	$\frac{[NO_2]}{[N_2O_4]}$	$\frac{[NO_2]^2}{[N_2O_4]}$
(1)	0.00	0.67	0.0547	0.643	0.685,	~~1.6×10^{-3}~~ 4.6×10^{-3}
(2)	0.030	0.50	0.0475	0.491	0.0967	4.6×10^{-3}
(3)	0.20	0.00	0.0204	0.0848	0.227	4.6×10^{-3}

$$so \rightarrow \frac{[NO_2]^2}{[N_2O_4]} = \text{constant at constant Temp} = K_c$$

Equiqlib. const

K_c → Equilib const

K → Rate constant

$$aA + bB \rightleftharpoons cC + dD$$

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

[Ex. 14.2] $CH_{4(g)} + 2O_{2(g)} \rightleftharpoons CO_{2(g)} + 2H_2O$

Write the equilib. law ..

$$K_c = \frac{[CO_2][H_2O]^2}{[CH_4][O_2]^2}$$

$$K_c = \frac{[CO][H_2]^3}{[CH_4][H_2O]}$$

Write the ~~rxn equation~~ chemical equ.?

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

$$K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]} \qquad 3H_2 + N_2 \rightleftharpoons 2NH_3$$

$$K_c' = \frac{[N_2]^3[N_2]}{[NH_3]^2} \qquad 2NH_3 \rightleftharpoons 3H_2 + N_2$$

$$\boxed{K_c = \frac{1}{K_c'}}$$

يعني ممكن يعطينا قيمة K_c ويطلب قيمة K_c' ←

$$4NH_3 \rightleftharpoons 2N_2 + 6H_2$$

$$K_c'' = \frac{[N_2]^2[H_2]^6}{[NH_3]^4} = \left[\frac{[N_2]\,[H_2]^3}{[NH_3]^2}\right]^2$$

$K_c'' = [K_c]^n$ ← لو رفعنا المعادلة لأس معناته بنقدر نقول

$n \rightarrow$ الأس اللي رفعناه

(10-3-2019)

$2N_2 + O_2 \rightleftharpoons 2N_2O$ $\quad K_{c_1} = \frac{[N_2O]^2}{[N_2]^2[O_2]}$

$2N_2O + 3O_2 \rightleftharpoons 4NO_2$ $\quad K_{c_2} = \frac{[NO_2]^4}{[N_2O]^2[O_2]^3}$

$2N_2 + 4O_2 \rightleftharpoons 4NO_2$

$K_{c_1} * K_{c_2} = K_{c_3} = \frac{[NO_2]^4}{[N_2]^2[O_2]^4}$

Ex 14.5) $2CO + O_2 \rightleftharpoons 2CO_2$

$K_{c_1} = 3.3 \times 10^{91}$

$2H_2 + O_2 \rightleftharpoons 2H_2O_{(g)}$ $\quad K_{c_2} = 9.1 \times 10^{86}$

What's the value of K_{c_3} for this equ. $H_2O_{(g)} + CO \rightleftharpoons H_2g + CO_2$

عشان اطلع Kc المعادلة
النهائية عند جمع معادلتين
بضرب Kc للمعادلتين

* سؤال ممكن يجي يعطي
Kc1 و Kc2 ويطالب Kc3

soln:- $2CO + \cancel{O_2} \rightleftharpoons 2CO_2$

$2H_2O \rightleftharpoons \cancel{O_2} + 2H_2$

$(2CO + 2H_2O \rightleftharpoons 2CO_2 + 2H_2) * \frac{1}{2} \rightarrow CO + H_2O \rightleftharpoons CO_2 + H_2$

$\sqrt{3.3 \times 10^{91}} * \frac{1}{\sqrt{9.1 \times 10^{86}}}$ بناخذ جذر ونضرب Kc1 في Kc2

$K_{c_3} = 1.9 \times 10^{2}$

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

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ $\quad KP = \frac{P(NH_3)^2}{PN_2(PH_2)^3}$ (gases)

$PV = nRT \rightarrow P = \frac{n}{v}RT \rightarrow P = MRT$

$Kp = \frac{(RT)^2[NH_3]^2}{(RT)[N_2][H_2](RT)^3} \rightarrow \frac{[NH_3]^2(RT)^2}{[N_2][H_2]^3(RT)^4} = K_c(RT)^{-2}$

$-2 = \Delta n$

$Kp = K_c \Delta n \rightarrow \Delta n = \Sigma n_{(g)}(P) - \Sigma n_{(g)}(R)$

total # of moles of Prodect of gases

total # of moles of reatcnt of gases

Kc & Kp const. at const. Temp

Ex: 14.8) $2N_2O_{(g)} \rightleftharpoons 2N_{2(g)} + O_{2(g)}$

$Kc = 7.3 \times 10^{34}$ (at const. Temp) , $Kp = ?$

certian

at room temp → 1atm → 25C°

Temp at K = 298

$\Delta n = 3 - 2 = 1$

$Kp = Kc(RT)^{\Delta n}$

$Kp = (7.3 \times 10^{34}) * (0.0821) * (298)$

$Kp = 1.8 \times 10^{36}$

2phases hetrogenous equilibrum

solid doesn't effect on the eqa or conc of soln

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

$Kc' = \frac{[Na_2CO_3][H_2O][CO_2]}{[NaHCO_3]^2}$

$Kc = [H_2O][CO_2]$

$K_p = P(H_2O) \ast P(CO_2) \rightarrow K_p = K_c (RT)^{\Delta n}$

Δn = moles of Product − moles of Reactant (in gases)

solid → costant

بس بندخل

& gases و aqueos

اذا ما عطاني تركيز H_2O

او كانت liquid ما بندخلها

Ex: 14,11) $CaCO_{3(s)} + H_2O_{(l)} + CO_{2(aq)} \rightleftharpoons Ca^{+2}_{(aq)} + 2HCO^-_{3(aq)}$

$$K_c = \frac{[Ca^{+2}][HCO_3^-]^2}{[H_2O]\,[CO_2]}$$

density = 1 $\quad \overset{\downarrow}{M} = 1$

volume = 1 يعني لو ما حطيناها

عادي ما بتفرق

14 / 3 / 2019

(14.7)

$A \rightleftharpoons B$ $K_c = 10$ 0.1 M A

	A	B
ini	0.1 M	0
change	$-x$	$+x$
eq.	$0.1-x$	x

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

$10 = \frac{x}{0.1-x}$

Ex: 14.16) $2CO_{(g)} + O_{2(g)} \rightleftharpoons 2CO_{2(g)}$

the $[O_2]$ decrease by 0.030 M

change of [CO] and $[CO_2]$

~~change~~	2CO	O_2	$2CO_2$
Change	$-2x$	$-x$	$+2x$

$x = 0.030 \rightarrow [CO]$ and $[CO_2] = 2 * 0.030$

Ex: 14.17) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

at eq. the following was given ~~constraion~~, find K_c

$CO \rightarrow 0.180$ M , $H_2O \rightarrow 0.0411$ M

$CO_2 \rightarrow 0.150$ M , $H_2 \rightarrow 0.20$ M

$K_2 = ?$ $K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} = \frac{[0.150][0.20]}{[0.180][0.0411]}$

$= \boxed{4.06}$

Ex: 14.18) $PCl_{3(g)} + Cl_{2(g)} \rightleftharpoons PCl_{5(g)}$

0.2 mol 0.1 mol 0

put them in 1 L , so

$\boxed{M = \frac{n}{V}} \rightarrow M_{PCl_3} = 0.2\,M$, $M_{Cl_2} = 0.1$

eq. $\frac{0.12 \text{ mol}}{1\ L}$

Q: How much the change if $PCl_3 = 0.12\,M$

	PCl_3	Cl_2	PCl_5
ini	0.200	0.100	0
Change	$-x$	$-X$	$+x$
	$0.200-X$ $=0.12$	$0.100-X$	X

$0.200 - x = 0.12 \rightarrow 0.200 - 0.12 = \boxed{0.08}$

value of X

Q. what's the value of Kc?

$[PCl_3] = 0.12$

$[Cl_2] = 0.02$

$[PCl_5] = 0.08$

$K_c = \frac{[0.08]}{[0.12][0.02]} =$

Ex:14.19) $N_2O_4 \rightleftharpoons 2NO_{2(g)}$

$K_c = 4.61 \times 10^{-3}$ ↓ ↓ ● 2L

0.0466 mol

$M = \frac{0.0466\ mol}{2\ L}$ → at eq.

N_2O_4 $2NO_2$

ini

change

eq. $\frac{0.0466\ mol}{2\ L}$ $\boxed{??NO_2}$ → المطلوب

$K_c = \frac{[NO_2]^2}{[N_2O_4]} \rightarrow [NO_2]^2 = K_c\,[N_2O_4]$

$\rightarrow [NO_2] = \sqrt{(4.61 \times 10^{-3}) \times (0.0466/(2)}$

Ex:14.20) at eq. $K_c = 4.10$

$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$

0.210 M ?? 0.910 0.885

$$K_c = \frac{[CH_3COOC_2H_5]\,[H_2O]}{[CH_3COOH]\,[C_2H_5OH]}$$

$$4.1 = \frac{[0.91]\,[0.085]}{[0.21]\,[C_2H_5OH]} \rightarrow$$

$[C_2H_5OH] = 8.48 \times 10^{-3}$

$K_c = 4.$

Ex:14.~~2~~21) $H_2 + I_2 = 2HI$ $\boxed{K_c = 49.5}$

~~ini~~ → $\frac{0.2\,mol}{1L}$ $\frac{0.2\,mol}{1L}$

	H_2	I_2	$2HI$
ini →	0.2 M	0.2 M	0
change	−x	−x	+2x
eq.	0.2 − x	0.2 − x	2x

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \rightarrow \cancel{K_c} \sqrt{49.5 = \frac{[2x]^2}{[0.2-x]^2}}$$

$$\rightarrow \frac{2x}{0.2-x} = 7.04 \rightarrow 2x = 7.04(0.2-x)$$

$2x =$

$x = \boxed{0.156}$

$0.200 - 0.156 = 0.044$

eq.	$[H_2]$	$[I_2]$	$[HI]$
	0.044	0.044	0.312

Ex:14.22) $H_2 + I_2 \rightarrow 2HI$ $K_c = 49.5$

	H_2	I_2	$2HI$
ini	0.200	0.100	0
change	−x	−x	+2x
eq.	0.2 − x	0.1 − x	2x

$\boxed{ax^2 + bx + c}$

$$49.5 = \frac{(2x)^2}{(0.2-x)(0.1-x)} \rightarrow 45x^2 - 14.85x + 0.99 = 0$$

$$x = \frac{-b \sqrt{b^2 - 4ac}}{2a}$$

Ex : 14.23) $2NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_{2(g)}$

$K_c = 2.3 \times 10^{-9}$ $2NH_3 \rightarrow 0.0431 mol$ in 1L

	$2NH_3$	N_2	$3H_2$
ini	0.0431	0	0
change	$-2x$	$+x$	$+3x$
equ.	$0.0431-2x$	x	$3x$

$$K_c = \frac{[N_2][H_2]^3}{[NH_3]^2} \rightarrow 2.3 \times 10^{-9} = \frac{(x)(3x)^3}{(0.0431-2x)^2}$$

اذا كانت قيمة K_c قليلة كتير معنا تو تركيز النواتج قليل كتير وهون لانو

K_c قيمتها كتير قليلة بنحسب $x = 0$ بالمتفاعلات

$$2.3 \times 10^{-9} = \frac{27x^4}{(0.0431)^2} \rightarrow x^4 = \frac{2.3 \times 10^{-9} \times (0.0431)^2}{27}$$

$$x^4 = 1.6 \times 10^{-13} \rightarrow x = 6.3 \times 10^{-4}$$

لو تشاتيليه : بحكي انو كل تفاعل كيميائي لازم يوصل للاتزان

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \quad K_c' = 4.3 \times 10^8$$

هون اذا غيرنا تركيز المتفاعلات المفروض يتغير ~~تركيز~~ قيمة K_c بس
هون المشكلة انو K_c ثابت عند درجة حرارة ثابتة فاللي بصير هـ
هو انو بختل الاتزان والسهم رح يروح ناحية النواتج
ونفس الشي اذا زدنا تركيز النواتج السهم حيروح للمتفاعلات
ولو مثلنا تركيز مادة كاللة كمان رح يتغير اتجاه السهم
بس الـ K_c رح يضل ثابت

Change Press. by :-

1) change volume اذا زاد الحجم بقل الضغط بروح السهم
لجهة المولات الاكثر سواء كانت نواتج او
متفاعلات اما اذا كان عدد المولات للنواتج والمتفاعلات متساوي
وتغير الضغط ← no effect

2) Change con. of react. or Prod.

3) adding inert gas زي اضافة He مثلاً وما رح
يتفاعل مع ولا اشي و المعادلة الكيميائية ما رح تتغير

K_c is constant at constant Temp

4) Change of Temp.

* في تفاعل exo لو زدنا درجة الحرارة حيميل السهم للمتفاعلات
وتقل K_c ← $T\uparrow K_c\downarrow$ علاقة عكسية

* في تفاعل endo وزدنا درجة الحرارة السهم بروح للنواتج
ورح تزيد K_c ← هون علاقة طردية بين $T\uparrow K_c\uparrow$

4) addition of catalys → no effect on K_c

لانو هو بس ~~بسو~~ بسرع التفاعل ، ولانه التفاعل متزن رح تحس عنه
التفاعل الامامي ماهي يتساوي سرعة التفاعل العكسي

(سؤال بالكتاب فيه غلط)

ex: 14.48) $C_2H_{4(g)} + H_2O_{(g)} \rightleftharpoons C_2H_5OH_{(g)}$

$\Delta H = -44.6\ KJ$, adding H_2O ?

السهم بيروح لليمين والـ K_c مابتأثر

$V\downarrow$ → الضغط بيزيد ورح يروح السهم للجهة اللي بكون فيها عدد المولات اقل

$T\uparrow$ → K_c رح يقل لانو exo ورح يروح السهم للمتفاعلات

$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ $K_c = 49.5$

ini $0.1M$ $0.1M$ $0.1M$ $Q_c = \frac{(0.1)^2}{(0.1)(0.1)} = 1$

$Q_c < K_c$ يقل الخام ويزيد النـ

equilibrium shift to Products

التفاعل بضل يتحرك لحتى يوصل للاتزان

reaction Quotien in any time not in equilibrium.

$Q_c > K_c$ يزيد الخام ويقل النـ

equilibrium shift to reactants

$Q_c = K_c$ → K_c stays constant, Q_c change

at equilibrium

$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ $K_c = 0.05$ partial press

0.1 atm 0.6 atm 0.2 atm

which of the following is correct?

a) this eq will shift to the products

b) we will have differnt K_c

c) we are at eq

d) this rxn will shift to reactants

e) we dont have enough information

/ /

Ch 15

Acid and Bases

Bronested - lory
- acid → proton donor
- Base → proton acceptor

$HCl_{(aq)} + H_2O \rightleftharpoons H_3O^+ + Cl^-$

acid (strong) — base — conjugate acid — conjugate Base (weaky)

* Always conjugate in Products

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

base — acid — conjugate acid — conjugate base

H_2O → am fatory
- acid
- base

اذا كانت بتفاعل مع قاعدة قويه بتاخذ سلوك الحمض

،، ،، ،، حمض قوي ،، ،، القاعدة

Ex: 15.1]

a) HI / H^+ x not conjugate Pair

b) NH_2^- / NH_3 ✓

c) HPO_4^{-2} / H_3PO_4 x

d) H_2CO_3 / HCO_3^- ✓

$H_2CO_3 \rightleftharpoons HCO_3^- + H^+$

$HCO_3^- \rightleftharpoons CO_3^{-2} + H^+$

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + \underset{H^+}{H_3O^+}$ حامض ضعيف بعطيني

weak acid — conjucate base (strong)

يعني قاعدة ~~بحل~~ بتكون قوية

HCl

Binary acid $\quad$ $H_2SO_4 \rightarrow$ exoacid

$H-x \rightarrow H^+ + x^-$ كل ما كان كسر الرابطة

أسهل كل ما كان الحمض قوي

* بتكون الرابطة القطبية لما يكون في فرق بال ~~electron~~ electronigativty

HF $\quad$ GO $\quad$ *كل ما زاد الفرق يكون more polar

HI $\quad$ OO $\quad$ سهل كسرها

* القطبية حالة بين convelant and Ionic

factors effecton strong acid ? $\quad$ E.N ↑ → acid stronger*

1) size ↑ → acidty ↑

2) electronigativity ↑ acid stronger

* اذا مشينا على ↑ الجدول الدوري عمودي الـ size الي بيقل

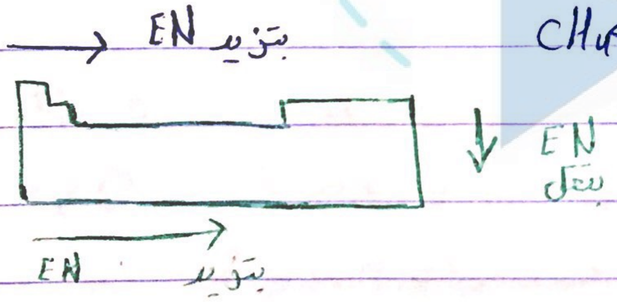
↓ بتزيد الحجم

HI > HBr > HCl > HF

more strong ←

* اذا كنا بنمشي على صف بالجدول الدوري الـ EN بتقل

CH$_4$ < NH$_3$ < H$_2$O < HF



OXO acids:-

HNO_3 $\quad$ $-\overset{|}{x}-O-H$

H_2SO_4 $\quad$ centeratom $\quad$ O دائماً

$HClO_4$

↓ center atom $\quad$ بتغير القطبية حسب ~~[illegible]~~ الـ atoms وعددها

factors effect on oxo acids:

1) number of O atoms → اذا بزيد العدد بتجهد C.a اكثر

2) electo nigativity — EN more Polar بصير

$H_2SO_4 > H_2SO_3$ → stronge

$HNO_3 > HNO_2$

$HClO_4 > HBrO_4 > HIO_4$

CH_3NH_2 → Base

NH_4^+ → not base

ليش ما في FHO_3 ؟

F → n = 2 s, p

ما في افلاك توسع ē و

small size

Lewis:
- → e^- donor → Base
- → e^- acceptor → acid

coardination bond

MgO — $MgO + H_2O \rightarrow Mg(OH)_2$

insoluble (Precipate)

Na_2O — $Na_2O + H_2O \rightarrow 2NaOH$

CaO — $CO_2 + H_2O \rightarrow H_2CO_3$ في اكاسيد بنذوبها وبنعطيها

acid or Base بنحدد شو هو حسب موقعو بالجدول الدوري

FeO — فلزات + H_2O → Basic soln

CO_2 — لافلزات + H_2O → acidic soln

NO_2

$SO_2 + H_2O \rightarrow H_2SO_3$, $SO_3 + H_2O \rightarrow H_2SO_4$

$AlCl_3 \xrightarrow{H_2O} Al^{+3} + 3Cl^-$

$Al^{+3} + 6H_2O \rightarrow Al(H_2O)_6^{+3}$

$Al(H_2O)_6^{+3} + H_2O \rightleftharpoons [Al(H_2O)_5OH]^{+2} + H_3O$

acidic soln

Ch.16:- Acid - Base equilib.

acid → $Ph < 7$

Base → $Ph > 7$

~~Poh~~ →

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

$Ph = -\log 1 \times 10^{-6}$

$Ph =$ ~~-log~~ 6

$Poh = -\log [OH^-]$

$PK = -\log K$

$2H_2O \rightleftharpoons H_3O^+ + OH^-$

$K_c = [H_3O^+][OH^-]$ مانختصر فيه

$Ph + Poh = 14$

$Kw = [H^+][OH^-] \rightarrow Kw = 1 \times 10^{-14}$

in ~~H_2~~ H_2O

$[H^+] = 1 \times 10^{-7}$, $[OH^-] = 1 \times 10^{-7}$

$Poh < 7$ → Base , $Poh > 7$ → acid

/ /

24/3 sun

$HCl \rightarrow H^+ + Cl^-$ * الحمض القوي بتفكك تفكك كامل بالماء

0.1M 0.1M 0.1M

strong acids :- H_2SO_4 , HBr , HNO_3 , HI , $HClO_4$

Ex: 16.6) What's the pH of 0.0050M HNO_3 ?

$[H^+] = [HNO_3] \rightarrow pH = -\log 5\times10^{-3} = 2.30$

$pOH = 11.70$

strog bases: عناصر المجموعة الاولى اللي بذوبو بالمي

weak bases: NH_3

Ex: 16.7) calculate POH and PH of 1.20g KOH in 250ml of water (Mw = 56.10g/mol)

$M = \frac{(1.20)/56.10}{250\times10^{-3}} = 0.0856M$

$pOH = -\log 0.085 = 1.07$, $pH = 14 - 1.07 = 12.93$

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

weak acid

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

$$\underbrace{K_c[H_2O]}_{K_a} = \frac{[CH_3COO^-][H_3O]}{[CH_3COOH]}$$

→ a = acid

Ex 16.16] $pH = 1.83$, $K_a = ?$, $pK_a = ?$

$HA \rightarrow 0.20M$

$$HA \rightleftharpoons H^+ + A^-$$

ini	0.20	0	0
Change	$-x$	$+x$	$+x$
equ.	$0.20-x$	x	x

$K_a = \frac{(x)^2}{(0.20-x)}$

$x = [H^+] \rightarrow$ ~~$10^{-1.83}$~~ arc $-\log 1.83 = 0.0148 = x$

$K_a = \frac{(0.0148)^2}{(0.20-0.0148)} = 1.18\times10^{-3}$

$pK_a = -\log 1.18\times10^{-3}$
$= 2.93$

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

ini	0.100	x	x
change	$-x$	$+x$	$+x$
eq.	$.100-x$	x	x

$K_a = 1.8\times10^{-5}$

$K_a = \frac{(x)^2}{0.100-\underset{zero}{x}} \longrightarrow x^2 = 1.8\times10^{-5} \times 0.100 = 1.8\times10^{-6}$

$x = 1.34\times10^{-3}$

$pH = -\log 1.34\times10^{-3} = 2.87$

$\boxed{pK_a = -\log K_a}$

$$HA \rightleftharpoons H^+ + A^-$$

3.8 % ionized
$K_a = ?$
$pK_a = ?$

ini	0.0100M	0	0
change	$-x$	$+x$	$+x$
eq	$0.01-x$	x	x

$x = \frac{3.8}{100} * 0.01M$
$= 3.8\times10^{-4}$

$K_a = \frac{(3.8\times10^{-4})^2}{(0.01-3.8\times10^{-4})} = 1.5\times10^{-5}$

$pK_a = 4.8$

$* K_{\underline{b}} = K_c * [H_2O] \rightarrow$ for bases

base

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

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

$$CH_3CO\cancel{O}H + H_2O \rightleftharpoons CH_3\cancel{C}OO^- + H_3O^+$$

$$CH_3COO^-\cancel{H} + H_2O \rightleftharpoons CH_3CO\cancel{O}H + OH^-$$

$$2H_2O \rightleftharpoons H_3O^+ + OH^-$$

$K_w = 10^{-14}$ $[K_w = K_a * K_b]$

حمض مرافق ↳ قاعدة مرافقة

[Ex: 16.18) $B + H_2O \rightleftharpoons BH^+ + OH^-$

	B		BH^+	OH^-
ini	0.01M		0	0
change	$-x$		$+x$	$+x$
eq.	$0.01-x$		x	x

$pOH = 3.90$
$K_b = ?$
$pK_b = ?$

$pOH = 3.90$

$[OH^-] = \text{arc-log } 3.90 = 1.3 \times 10^{-4}$

$$K_b = \frac{(1.3\times10^{-4})^2}{(0.01 - 1.3\times10^{-4})} = 1.6\times10^{-6}$$

$pK_a = 5.79$

/ /   26 - 3

PH of salt soln.

$CH_3COONa \longrightarrow CH_3COO^- + Na^+$

0.1M   0.1M   0.1M

$CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$ تميه

hydrate

$K_a = 1.8 \times 10^{-5}$ 0.1M

$K_b = \frac{10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$

$CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$

	CH_3COO^-	CH_3COOH	OH^-
ini	0.1M	0	0
change	$-x$	$+x$	$+x$
eq	$0.1-x$	x	x

$5.6 \times 10^{-10} = \frac{(x^2)}{(0.1-x)}$

↳ $x = 0$, K_b too small

$x = \sqrt{5.6 \times 10^{-10} \times 0.1} = 7.5 \times 10^{-6}$

pOH = 5.12   PH = 8.87

Ex: 16.27) $CH_3NH_3Cl \longrightarrow CH_3NH_3^+ + Cl^-$

500 ml , 25g   0.74   (salt)   0.74   0.74

M = 0.74

$CH_3NH_3^+ + H_2O \rightarrow CH_3NH_2 + H_3O^+$

	$CH_3NH_3^+$	CH_3NH_2	H_3O^+
ini	0.74	0	0
change	$-x$	$+x$	$+x$
eq.	$0.74-x$	x	x

$K_b = 4.5 \times 10^{-4}$

←

$$K_a = \frac{10^{-14}}{4.5\times10^{-4}} = 2.2*10^{-11}$$

$$K_a = \frac{[CH_3NH_2][H_3O^+]}{[CH_3NH_3^+]}$$

$$2.2*10^{-11} = \frac{x^2}{\underset{\rightarrow 0}{0.74 - x}} \rightarrow x^2 = 2.2*10^{-11} \times 0.74$$

$$x = 4.0\times10^{-6}$$

$$pH = 5.39$$

CH_3COONa basic salt $PH>7$

CH_3COOH weak acid — $NaOH$ strong base

NH_4Cl acidic salt $PH<7$

NH_3 weak base — HCl strong acid

$NaCl$ neutral $pH = 7$

$NaOH$ strong base — HCl strong acid

بالامتحان لازم نعرف اذا الملح حمضي ولا قاعدي عشان نعرف نستعمل Ka ولا Kb ومش شرط يعطينا اللي لازم استعملها ممكن يعطيني الثاني وانا احسب من Kw .

$CH_3COONH_4 \rightarrow K_b = K_a$

هو مش معادلتين عشان لانو weak acid و weak base

واذا ما عطاني Ka و Kb بنحكي not enogh information

* PH of Diprotic (H_2A)

ex:

① $H_2CO_3 \rightleftharpoons HCO_3^- + H^+ \quad Ka_1 = 4.3 \times 10^{-7}$

② $HCO_3^- \rightleftharpoons CO_3^{2-} + H^+ \quad Ka_2 = 5.6 \times 10^{-11}$

صعب ناخذ شحنة موجبة من مركب ~~متعادل~~ سالب اكتر من انو ناخذها من مركب متعادل

$Ka_2 < Ka_1$

① $H_2CO_3 \rightleftharpoons HCO_3^- + H^+ \quad Ka = 4.3 \times 10^{-7}$

H_2CO_3	HCO_3^-	H^+
$0.1M$	0	0
$-x$	$+x$	$+x$
$0.1-x$	x	x

$[H^+] = \sqrt{4.3 \times 10^{-7} \times 0.1}$

$= \boxed{2.07 \times 10^{-4}}$

② $HCO_3^- \rightleftharpoons CO_3^{2-} + H^+ \quad Ka = 5.6 \times 10^{-11}$

طلعناها من موجة تصير تركيز $[H^+]$ ←

HCO_3^-	CO_3^{2-}	H^+
2.07×10^{-4}	0	2.07×10^{-4}
$-x$	$+x$	$+x$
$2.07 \times 10^{-4} - x$	x	$2.07 \times 10^{-4} + x$

$$5.6 \times 10^{-11} = \frac{(x)(\cancel{2.07 \times 10^{-4} + x})}{(\cancel{2.07 \times 10^{-4} - x})} \rightarrow x = 5.6 \times 10^{-11}$$

PH ← رح نشتغل بالمعادلة الاولى لانو بالثانية ال x صغيرة كتير

$PH = -\log 2.07 * 10^{-4} = 3.68$

/ /   28-3

section 16.7

Weak acid and it's salt:

CH_3COOH / CH_3COONa

Weak base and it's salt:

NH_3 & NH_4Cl

Buffer solution

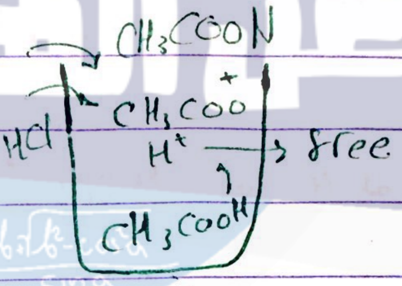
يقاوم التغير في PH عند اضافة
حمض او قاعدة قوية ولان
ذكو بد كمية الحمض و
القاعدة قليل !

$$CH_3COONa \rightarrow CH_3COO^- + Na^+$$

0.1   0.1   0.1

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

$0.1 \mp x$ $0.1 + x$ x



$K_a = 1.8 \times 10^{-5}$

$$1.8 \times 10^{-5} = \frac{[\cancel{x}][0.\cancel{1}+x]}{[0.\cancel{1}-x]} \rightarrow [H^+] = 1.8 \times 10^{-5}$$

$pH_1 = 4.74$

$$HCl \rightarrow H^+ + Cl^-$$ → اول ما نحطوا بتفكك

0.01   0.01   0.01

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

$[CH_3COO^-] = 0.1 - 0.01 = 0.099$ → ينقص بمقدار HCl المضاف

$[CH_3COOH] = 0.1 + 0.01 = 0.11$ → يزيد بمقدار HCl المضاف

$$1.8 \times 10^{-5} = \frac{\cancel{[0.11]}[H^+][0.099]}{[0.11]}$$

$[H^+] = 2 \times 10^{-5}$, $pH_2 = 4.70$

$\Delta pH = pH_2 - pH_1$

$= -0.04$

* الماء مش محلول منظم لانو اذا زدنا عليه قاعدة او حمض رح يتغير ال PH كتير

$$\begin{tikzcd} & PH_{H_2O} = 7 \arrow[dl] \arrow[dr] & \\ acid \arrow[d] & & base \arrow[d] \\ 2 & & 12 \end{tikzcd}$$

$$\overset{0.1}{CH_3COONa} \rightarrow \overset{0.1}{CH_3COO^-} + \overset{0.1}{Na^+}$$

$$\underset{0.1}{CH_3COOH} \rightarrow \underset{0.1}{CH_3COO^-} + \underset{x}{H^+}$$

رح يتجه اليمين عشان يعوض نقصان التركيز

$$\underset{0.01}{NaOH} \rightarrow \underset{0.01}{Na^+} + \underset{0.01}{OH^-} \rightarrow$$ رح تتفاعل مع H^+

$$[CH_3COOH] = 0.1 - 0.01 = 0.099$$

$$[CH_3COO^-] = 0.1 + 0.01 = 0.11$$

$$[H^+] = 1.8 \times 10^{-5} = K_a \rightarrow PH = 4.79$$

$$\Delta PH = 4.79 - 4.74 = 0.05$$

* Always:
PH_1 → before the addition any acidor base or any solution

$$NaA \rightarrow A^- + Na^+$$

$$HA \rightleftharpoons H^+ + A^-$$

لما يكون acid لحاله
بكون $[A^-] = [H^+]$

ولما يكون Paffar بكون
$[A^-]$ من معادلة NaA

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$\log K_a = \log[H^+] + \log\frac{[A^-]}{[HA]}$$

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

$$\boxed{PH = PK_a + \log\frac{[A^-]}{[HA]}}$$

experimentally $PH = 5$

PKa for acid nearly of PH for Puffor.

$PKa = 4.74$

4.62

4.82 CH_3CH_2COOH

4.89 → the best CH_3CH_2COONa

4.59

$$PH = PKa + \log \frac{[CH_3CH_2COONa]}{[CH_3CH_2COOH]}$$

$$5.0 = 4.89 + \log \frac{[A^-]}{[HA]}$$

$$0.11 = \log \frac{[A^-]}{[HA]} = \frac{1.3 \text{ from salt}}{1 \text{ from acid}}$$

* هل هذا محلول منظّم؟

1) $H_3PO_4 / NaHCO_3$ no

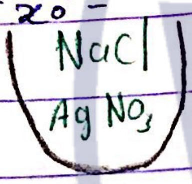
2) H_2CO_3 / Na_2CO_3 no

3) HI / NaI no (should be weak acid)

Ch. 17 solubility and equilibrium

What's solubility? هي اكثر كمية من المذاب يمكن اذابتها بالمذيب

Ex:-



$NaCl \longrightarrow Na^+ + Cl^-$

$AgNO_3 \longrightarrow Ag^+ + NO_3^-$

Na^+ and NO_3^- → spectators ions

$$AgCl \rightleftharpoons Ag^+ + Cl^-$$

$$K_c = \frac{[Ag^+][Cl^-]}{\underbrace{[AgCl]}_{const.}}$$

$K_c * [AgCl] = K_{sp}$ → sp means حاصل ضرب الذائبية على الاتزان

$$K_{sp} = [Ag^+][Cl^-]$$

Ex: $PbI_2 \rightleftharpoons Pb^{2+} + 2I^-$

$$K_{sp} = [Pb^{2+}][I^-]^2$$

/ /

31-3-2019
sunday

$Al(OH)_{3(s)} \rightleftharpoons Al^{3+} + 3OH^-$

$K_{sp} = [Al^{3+}][OH^-]^3$

Ex: 17.3) the solubility of TlI $\rightleftharpoons Tl^+ + I^-$

$K_{sp} = [Tl^+][I^-]$, solubility $= 5.9 \times 10^{-3}$ g/L

calculate Ksp? (Mw = 331.29 g/mol)

Anwser: $\left[\begin{array}{l} S = 5.9 \times 10^{-3} / 331.2 = 1.8 \times 10^{-5} \\ K_{sp} = (1.8 \times 10^{-5})^2 = 3.2 \times 10^{-10} \end{array} \right]$

Ex: 17.4) solubility $= 4.3 \times 10^{-5}$ M of Ag_3PO_4

Ksp = ?

$Ag_3PO_4 \rightleftharpoons 3Ag^+ + PO_4^{3-}$ $K_{sp} = [4.3 \times 10^{-5}] * [3 * 4.3 \times 10^{-5}]^3$

$1 \rightleftharpoons 3 + 1$ $(Ag^+)^3$ للتركيز 3 مضروب ب 3 ومرفوع للاس

$K_{sp} = [Ag^+]^3 * [PO_4^{3-}]$ $K_{sp} = 9.4 * 10^{-17}$

Ex: 17.5)

ⓐ what's solubility of AgBr when $K_{sp} = 5.4 \times 10^{-3}$

$AgBr \rightleftharpoons Ag^+ + Br^-$

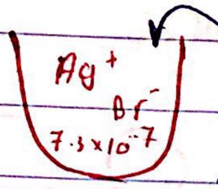
$K_{sp} = [Ag^+][Br^-]$, $s = \sqrt{K_{sp}} = 7.3 * 10^{-7}$

ⓑ solubility of $PbBr_2$, $K_{sp} = 6.6 \times 10^{-6}$, s = ?

$PbBr_2 = \overset{s}{Pb^{2+}} + \overset{2s}{2Br^-}$ $K_{sp} = (s) * (2s)^2$

$s = \sqrt[3]{\frac{6.6 \times 10^{-6}}{4}} = 0.024M$ $K_{sp} = 4s^3$

$K_{sp} = 5.4 \times 10^{-13}$ of AgBr



$$NaBr \rightarrow Na^+ + Br^-$$

0.1M 0.1 0.1

$$AgBr \rightarrow Ag^+ + Br^-$$

s s + 0.1

$K_{sp} = [Ag^+][Br^-] \rightarrow K_{sp} = (s)(s+0.1) = 5.4 * 10^{-13}$

نشيل s ونحطها zero لانو Ksp صغير كتير!!!

$K_{sp} = 5.4 \times 10^{-13} = (s) * (0.1) \rightarrow s = \frac{5.4 \times 10^{-13}}{0.1}$ ~~×0.1~~

$s \boxed{= 5.4 \times 10^{-12}}$

اذا راح سهم ~~المعكا~~ المعادلة لليمين بجف الصلب وبتزيد الذائبة واذا راح لليسار بخف بتزيد المادة الصلبة الراسبة

~~Exercise~~

~~Ex~~:17.8) calculate solubility of Ni_3PO_4 if we added $[PO_4^{3-}] = 2.0 \times 10^{-6}$ and $K_{sp} = 4.7 \times 10^{-32}$

Ni^+

$$Ni_3PO_4 \rightleftharpoons 3Ni^+ + PO_4^{3-}$$

3s ~~2~~s + 2.0×10^{-6}

$K_{sp} = (3s)^3(\cancel{s} + 2 \times 10^{-6})$

zero Bc Ksp too small

$\frac{4.7 \times 10^{-32}}{2 \times 10^{-6}} = 27s^3 \rightarrow s = \sqrt[3]{\frac{4.7 \times 10^{-32}}{(2 \times 10^{-6})(27)}} = 7.6 \times 10^{-8}$

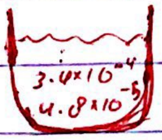
$[Ni^+] = 3 * 7.6 \times 10^{-8} = 2.3 \times 10^{-7}$

/ /

$[Br^-] = 3.4\times10^{-4}$] already in the soln.

$[Ag^+] = 4.8\times10^{-5}$] $K_{sp} = 5.4\times10^{-13}$

do think there will be solid?



$Q_c = [Ag^+][Br^-]$

$4.8\times10^{-5} * 3.4\times10^{-4} = \underline{1.6\times10^{-8}}$

$K_{sp} < Q_c$

$5.4\times10^{-13} < 1.6\times10^{-8}$ ppt will be formed

$$\boxed{\begin{array}{l} \left.\begin{array}{l} Q_c < K_{sp} \\ Q_c = K_{sp} \end{array}\right\} \rightarrow \text{no ppt} \quad \text{بدون راسب} \\ \\ Q_c > K_{sp} \rightarrow \text{ppt} \quad \text{في راسب} \end{array}}$$

ممكن ما يعطيني التركيز مباشرة !

Ex: 50 mL of 0.05 M Br^-
with 60 mL of 0.005 M Ag^+

$$\underset{0.05 * 50}{M_1 V_1} = \underset{x}{M_2}\ \underset{\underset{(60+50)}{110}}{V_2}$$

$M_2 = 0.0227$

end of Ch.17

2 / 4 / 2019

is this night
isn't forever
at least we're
together

Chapter 18

Thermodynamix :-

universe = system + surr.

$\Delta E = q + w$

Spontaneus ⇆ تلقائي

ليش كل هاي الأشياء بتصير تلقائياً؟ (احتراق البنزين ، سقوط عمارة .. الخ)

factors effect on spon. rxn:

① energy (minimum)

② disorder (maxmum)

$C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$ + heat

disorder عشوائية

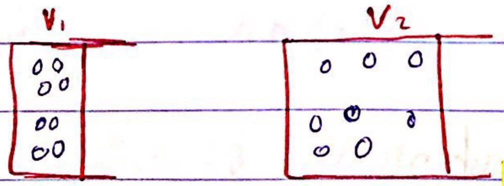
← عامل مهم لحصول الأمور تلقائياً"

$\Delta H = H_f - H_i$ → state function

ΔH also → excustive propertis BC it's dep. at # of moles

Entropy

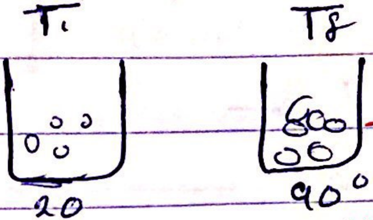
S → state → $\Delta S = S_f - S_i$



it does effect ! ← ① volume

V ↑
enthropy ↑

2) Temp.



→ تزداد التصادمات

if the Temp ↑ the KE will ↑ so entropy ↑ too

Entropy → العشوائية → S رمزها

3) Physical state الحالة الفيزيائية :

$S_{solid} < S_{liquid} <<< S_{gas}$

---

if the rxn spontaneus, two factors effect on it:

1) heat 2) entropy

ΔS of universe > 0 → it's spontaneus

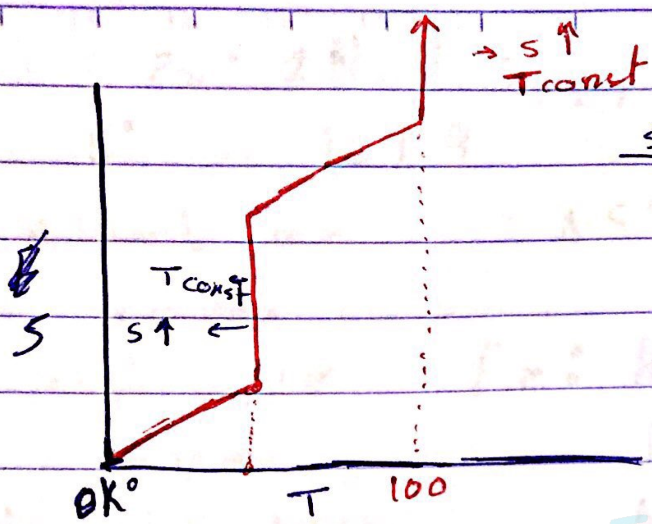
$\Delta S_{universe} = \Delta S_{system} + \Delta S_{sour.}$

$aA + bB \rightarrow cC + dD$

$\Delta H_{rxn} = \sum n \Delta H_{f}(P) - \sum n \Delta H_{f}(R)$

2nd law of thermodynamics:

if the entropy(s) for the universe is increase than the Process is spontaneos



$aA + bB \rightarrow cC + dD$

$\Delta H_{rxn} = \sum n \Delta H_f^\circ (P) - \sum n \Delta H_f^\circ (R)$

ex $\Delta S = S_{23C^\circ} - T_{273C^\circ}$

$\Delta S = T_{23C^\circ} \leftarrow$ zero

$$\Delta S = \sum n S^\circ_{(P)} - \sum n S^\circ_{(R)}$$

$\Delta H^\circ \rightarrow 0 \rightarrow$ standar ~~const~~

* 1atm / 25C° / 1M

$\Delta S_{uni} = \Delta S_{sys} + \Delta S_{surr} > 0$ for spon. process

Ex: $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$ ΔH = KJ/mol

S° 197.9 205 213.6 ΔS = J/K·mol

$\Delta S^\circ = [2 \times 213.6] - [2 \times 197.9 + 205] = -173.63$ J/K·mol

كبيرة وسالبة لانو عنا غازات * في الغازات اذا كان عدد المولات بالمتفاعلات

اكبر من عدد المولات بالنواتج ← بتقل عدد المولات ← بقل S ← ΔS° (-)

/ /

Ex: $2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + H_2O_{(l)} + CO_{2(g)}$

$S°$ 109.9 135.98 69.9 213.6

$\Delta S° = 213.6\ J/Kmol$

* متى ما شفنا الغاز بنوقف عنده

* اول شي بنشوف الغازات.

* اذا ماني غازات بنطلع وين في عدد مولات اكثر

Ex: $H_{2(g)} + CuO_{(s)} \rightarrow Cu_{(s)} + H_2O_{(l)}$

131 43.5 33.3 188.7

$\Delta S° = 47.5\ J/Kmol$ (صغيرة)

* سؤال توقع اشارة ΔS ← بنتطلع على الغاز ← اذا: $\#n_{(P)} = \#n_{(R)}$

ΔS ← صفر او عدد صغير جداً وممكن تكون $\oplus$ او $\ominus$

* $\Delta S°$ for pure elemnts $\rightarrow \neq 0$

① $I_{2(g)} \rightarrow 2I_{(g)}$ $\Delta S > 0$

② $2Zn_{(s)} + O_{2(g)} \rightarrow 2ZnO_{(s)}$ $\Delta S < 0$

③ $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$ $\Delta S \approx 0$

* if water condensation $\rightarrow \Delta S < 0$

* heating H_2 $\left(\underset{60°C}{H_{2(g)}} \rightarrow \underset{80°C}{H_{2(g)}}\right)$ $\Delta S > 0$

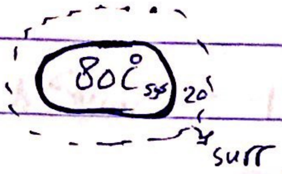
* sugar crystallization $(aq \rightarrow s)$ $\Delta S < 0$

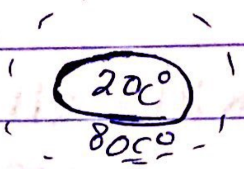
* sublimation of I_2 $(s \rightarrow g)$ $\Delta S > 0$

ΔS for system = $\oplus$ → we dont know if it spon.

ΔS_{system} → isn't enough, we should calculate ΔS_{surr}

ΔS_{uni} → بتحدد اذا spon اولا





* heat transfer from system to surr.

* this rxn is exo thermic

نفس القيمة بختلفو بالاشارة
$\Delta H(sys) = \ominus$
$\Delta H_{surr} = \oplus$

* Heat transfer from surr. to ~~*~~ system

* this rxn is endthermic

* entropy Change of surrounding depend on Temp

$\Delta S(surr) \propto -\Delta H(sys)$ $\left\{ -\ominus^{+} \quad -\oplus^{-} \right.$

$\Delta S(surr) = \frac{-\Delta H(sys)}{T(sys)}$

كل ما كانت درجة حرارة ال surr اقل الحرارة الي بتجيه بتزيد و رح تأثر فيه اكثر!

* لما يصير Thermal equili. بصير:

$T_{for(sys)} = T_{for(surr)}$

Ex: $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$ $\Delta H^\circ = -92.6$

$\Delta S_{surr} = \frac{-92.6\times10^{3}}{298\ K}$ J / ~~KJ~~ mol $= 311$ J/K.mol

متوقع تكون $\ominus$ لانه $R<P$ مولات | $\Delta S_{sys} = -199$ J/K.mol → معطى

/ /

تكملة →

$\Delta S_{(uni)} = -199 + 311 = +112\ J/K.mol$

the rxn is spon.

$\Delta S_{(uni)} = \left[\Delta S_{sys} - \frac{\Delta H_{sys}}{T}\right] > 0$ spon.

$\hookrightarrow * T$

$T\Delta S_{(uni)} = [T\Delta S_{sys} - \Delta H_{sys}] > 0$

$\hookrightarrow * \ominus$

$-T\Delta S_{uni} = [-T\Delta S_{sys} + \Delta H_{sys}] < 0$

$\hookrightarrow$

$\Delta G = [\Delta H_{sys} - T\Delta S_{sys}] < 0$

new thermodynamic property

ΔG و ~~الي~~ بتحدد اذا spon or nonspon

$\Delta G < 0 \rightarrow$ spon.

$\Delta G > 0 \rightarrow$ nonspon.

$\Delta G = 0 \rightarrow$ equilibrium

* لو عرفنا اشارة ΔH وكانت exo ـــ لازم احسب عشان اعرف اذا spon

* important:

* criterion → the sign of ΔH isn't criterion for the spon. of a chemical rxn

المعيار

* the sign of ΔS isn't criterion for the spon. of chemical rxn.

* the sign of ΔG is the criterion for the spon. of chemical rxn

$$heat + H_2O_{(s)} \rightarrow H_2O_{(l)}$$

endo , $\Delta H > 0$

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

* اذا اعطيتها عند درجة حرارة $T = 15c°$ بتذوب واذا $T = -15$ ما بتذوب

* الحراره عامل بحدد اذا spon اولا

ΔH	ΔS	
−	+	spon
+	−	non spon
−	−	depents on T (spon at low Temp
+	+	depents on T (spon at high Temp)

$T\uparrow \quad T\Delta S\uparrow$

$-T\Delta S > \Delta H$

$\Delta G > 0$ (non spon)

* factors effect on ΔG :

1) T

2) ΔS_{sys}

3) ΔH_{sys}

7/4/2019 sunday

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

stander $\Delta G^\circ rxn = \sum n\Delta G^\circ_{f(P)} - \sum n\Delta G^\circ_{f(R)}$ $\Delta G > 0$ spont.

$\Delta G < 0$ nonspont.

$\Delta H^\circ_{rxn} = \sum n\Delta H^\circ_{f(P)} - \sum n\Delta H^\circ_{f(R)}$ $\Delta G = 0$ at eq.

ΔH°_f for pure element $= 0$

$NaOH + HCl \rightarrow H_2O + NaCl$ $\Delta H^\circ rxn$

$H_2 + 1/2\, O_2 \rightarrow H_2O$ ΔH°_f

~~the heat change of 1mol of cpd~~

ΔG°_f → it's free energy change when 1mol of cpd informed from it's pure elements of their stander state.

Q. is the following spont. or nonspont.?

$CaCO_3 \rightarrow CaO + CO_2$

$\Delta H^\circ rxn = 177.8\ kj/\cancel{mol}$

$\Delta S^\circ rxn = 160.5\ J/K\ mol$ at 25C°

$\Delta G = 177.8 - 298 * 160.5 \times 10^{-3} = 130\ kj/mol$

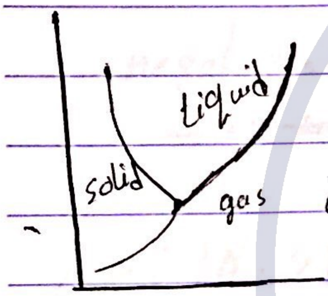
/ /

the last Q. it's spont. at high temp.

$0 = 177.8 - T(160.5\times10^{-3})$

$T = \frac{177.8}{160.5\times10^{-3}} = 1108\,K = 835\,C^\circ$

لو كانت درجة الحرارة عالية هالقد ممكن يأثر على الكالسيوم كاربونيت
والمادة unsolible



at eq.

$H_2O_{(s)} \rightarrow H_2O_{(l)}$ melting

ΔH_{fus}

$\Delta S_{melting}$ $G = 0$

$\Delta S_{melt.} \rightarrow T$

Heat + ~~ΔH~~ $H_2O_{(l)} \rightarrow H_2O_{(g)}$ ∴ $\Delta H_{vap} > 0$

$\Delta S_{vap} > 0$

$$\boxed{S_{(s)} < S_{(l)} <<< S_{(g)}}$$

$\Delta H_{vap} = 4\,KJ$, $T_b = 100\,C^\circ$, $\Delta S_{vap} = ?$

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

$0 = 40 - 373\Delta S \rightarrow \Delta S = \frac{\Delta H}{T} \rightarrow \frac{40}{373} * 10^3 =$

$$\boxed{107\ J/K.mol}$$

/ /

Ex: 18.20) the heat of vap. for NH_3 = 21.7 KJ/mol
and T_b = -33.3 C°, what's ~~ΔH~~ΔS vap?

T = 239.7

$\Delta S_{vap} = \frac{21.7\times10^3}{\cancel{(-33.3+273)}} / 239.7 = \Delta S = 90.5$ J/K.mol

لو ما حولنا الحرارة لـ K رح تطلع ΔS ← negative
وهاد مش منطقي !!! ~~[illegible]~~

Ex: 18.21) ΔH vap for Hg = 60.7 KJ/mol
S of Hg (l) = 76 J/K.mol
S of Hg (s) = 175 J/K.mol
What's T_b?

ΔS = 175 - 76 = 99

$T_b = \frac{60.7\times10^3}{99} = 613$ K

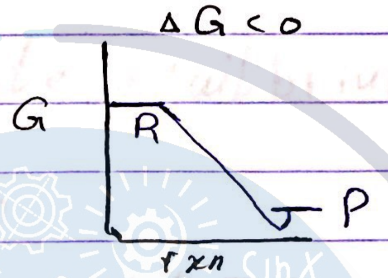
9 / 4 / 2019

محذوف 15.6
محذوف 16.9

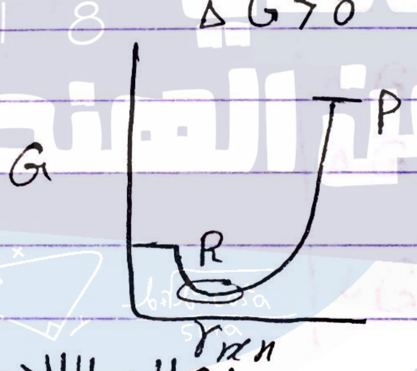
Chemical equilibrium :-

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

$Q = \frac{[\ \ ]_P}{[\ \ ]_R}$ (at any time)


$\Delta G < 0$

اذا $\Delta G < 0$ ← spont.
يعني بجب يروح للProducts ، وموقع
الاتزان بكون لعند الـ products


$\Delta G > 0$

$\Delta G > 0$ ← non spont.
بكون الاتزان عند المتفاعلات
اكثر

محلول بالكتاب

Ex: 18.8) $NH_4Cl_{(s)} \rightarrow NH_{3(g)} + HCl_{(g)}$

is this rxn spont.?

if we have p = 1 atm (for the gases), given that ΔG°_f = − 95.27 for NH_4Cl, for NH_3 = − 16.7, and for HCl = − 203.9

$Q_P = 1 \times 1 = 1$

$\Delta G^\circ_{rxn} = 91.9$ KJ

$\Delta G = 91.9 + (8.314 \times 10^{-3}) \times 293, \ln 1$

$\Delta G > 0$, non spont.

[redacted]

Ex:18.26) $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$ $\Delta G^\circ = -5.40$ KJ/mol

P 0.26 atm 0.598 atm

$Q = 8.85$

$\Delta G = -5.40 + (8.314\times10^{-3})\times298 * \ln 8.85$

$\Delta G = 0$

we're ate equilibrium

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

$Q = K$ at equilibrium , $\Delta G = 0$

$0 = \Delta G^\circ + RT \ln k$

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

ΔG°

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

$\Delta G^\circ = \sum n\Delta G_{f(P)} - \sum n\Delta G_{f(R)}$

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

Ex:18.48)

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

at equilibrium $\Delta G^\circ = ?$

$Kp = 6.9\times10^5$

at 25C°

$\Delta G^\circ = -(8.314 * 10^{-3})(298)(\ln 6.9\times10^5)$

$\Delta G^\circ = -33.3$ Kj/mol

/ /

$$\begin{bmatrix} 18.1 \\ 18.7 \\ 18.10 \end{bmatrix}$$

Exc: 18.29) $\Delta G^\circ = 3.3\ kJ/mol$ at 25°C

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

$$3.3\ kJ = -8.314 \times 10^{-3} \times 298 \times \ln K$$

$$\ln K = -1.33$$

$$K_p = 0.26$$

2nd law : $\Delta S_{universe} > 0$ for spon

$$\Delta S_{uni} = 0 \text{ at eq.}$$

$$\Delta S_{uni} = \Delta S_{system} + \Delta S_{sur.}$$

$$\Delta S_{sys} = \sum n S^\circ_p - \sum n S^\circ_R$$

21/4/2019 Ch. 19

Electro Chemistry

التيار الكهربائي بصير من طريق انتقال الالكترونات (تأكسد واختزال)

$NaOH + HCl \rightarrow NaCl + H_2O$ ← مافي انتقال الكترونات
بس فيه انتقال البروتونات
acid-base rxn

$Na^+ + Cl^- \rightarrow NaCl$

↓ انتقال الكترونات تأكسد ~~oxide~~
اختزال !

$2\overset{0}{Mg} + \overset{0}{O_2} \rightarrow 2\overset{+2}{Mg}\overset{-2}{O}$

$2Mg \rightarrow 2Mg^{+2} + 4e^-$ oxidation

$O_2 + 4e^- \rightarrow 2O^{-2}$ reduction

→ each one is half rxn

$2Mg + O_2 \rightarrow 2Mg^{+2} + 2O^{-2}$
2MgO

Mg reducing agent
O_2 oxidizing agent

عملية التأكسد والاختزال
بتصير تلقائياً" او غير تلقائياً
↓
بمساعدة زي
اضافة كهربا

الخلية الجلفانية : بتحول الطاقة الكيميائية لكهربائية

الخلية الالكترونية : بتحول الطاقة الكهربائية للكيميائية

الخليه الجلفانيه / تلقائيه sponto

x، الكهربائيه / غير تلقائيه nonsponto

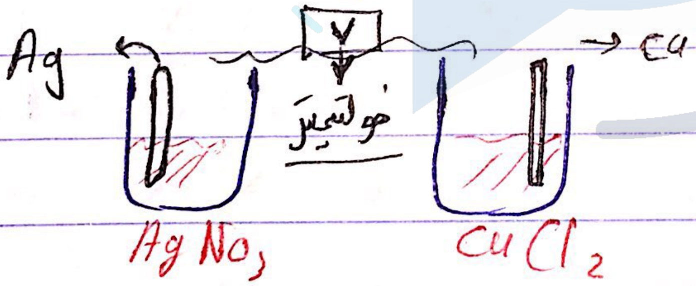
$Fe \rightarrow Fe_2^{3+}O_3$ ~~جسر~~

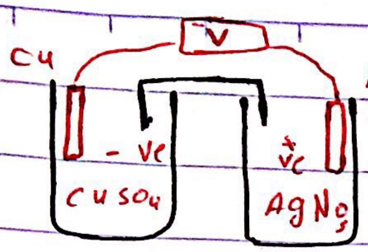
رطوبة

Voltic الخليه الجلفانيه

$AgNO_3$

$Ag + Cu^{2+} \rightarrow Ag^{+} + Cu_{(s)}$





سبب وجود القنطرة الملحية بتولد فرق
جهد وما بصير في تيار يقرأه الفولتميتر وبدونها
بكون الفولتميتر مابعد فيه تيار لانه بتكون الخلية
* لازم يكون المحلول ايوني بوصل تيار كهربائي (مفتوحة)

$Cu + Ag^+ \rightarrow Cu^{2+} + Ag$

* $Cu \rightarrow Cu^{2+} + 2e^-$ → oxidation half rxn (anode) -ve
* $2(Ag^+ + e^- \rightarrow Ag)$ → reduction half rxn (cathode) +ve

Ag^+ oxidizing agent / Cu reducing agent

oxi-red-agent → always in reactants

* pure water $[H] = [OH]$
* saytorated solution
* Matter in tube salt
  ↳ KCl , KNO_3

شروط القنطرة الملحية :

1) strong electrolyte

2) inert مادة خاملة ما بتفاعل مع الايونات

3) neutral [7 = PH الـ]

في القنطرة

+ion → Anode

-ion → cathode

* Anode (-ve) → oxid~~izing~~ation
* cathode (+ve) → reduction

Ex 19.1) $Mg_{(s)} + Fe^{+2}_{(aq)} \rightarrow Mg^{+2} + Fe$

1) write the half rxn

$Fe^{2+} + 2e \rightarrow Fe$, $Mg \rightarrow Mg^{+2} + 2e^-$

oxidizing agent — reducing agent

② write the cell notation :

$Mg | Mg^{2+} || Fe^{2+} | Fe$

Ex 19.2) $Al | Al^{3+} || Ni^{2+} | Ni$

$(Al \rightarrow Al^{3+} + 3e^-) * 2$

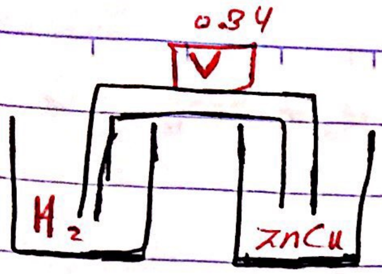
$(Ni^{+2} + 2e^- \rightarrow Ni) * 3$

$2Al + 3Ni^{+2} \rightarrow 2Al^{3+} + 3Ni$

$6\bar{e}$ = عدد الالكترونات

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

/ /



Pt | $H_{2(g)}$ 1atm | H^+ 1.0M || Cu^{2+} 1.0M | $Cu_{(s)}$

$H_{2(g)} + Cu^{2+} \longrightarrow Cu + 2H^+$

$E^\circ_{cell} = E^\circ_{cathod} - E^\circ_{anode}$

$0.34 = E^\circ_{cathod} - 0$

$E_{cathod} = 0.34\,V$

$\overbrace{Zn + Cu^{2+}}^{anode} \longrightarrow \underbrace{Cu^{2+}}_{}$ ...

$\overbrace{Zn + \underbrace{Cu^{2+} \longrightarrow Cu}_{cathod} + Zn^{+2}}^{anode}$

$E^\circ_{cell} = E^\circ_{cathod} - E^\circ_{anode}$

$= 0.34 - (-0.76)$

$= 1.107$

↓ as we go down the strength of oxidizing agent become weaker and strength of reducing agent become stronger

oxidizing agent → reducing agent	E°
$Fe + 2e^- \longrightarrow 2F^-$	2.87
$Cl_2 + 2e^- \rightarrow 2Cl^-$	1.36
$Ag^+ + \bar{e} \rightarrow Ag$	0.80
$Cu^{2+} + 2\bar{e} \rightarrow Cu$	0.34
$2H^+ + 2\bar{e} \rightarrow H_2$	0.00
$Zn^{2+} + 2e \rightarrow Zn$	-0.76
$Li^+ + e \rightarrow Li$	-3.05

[$E^\circ_{cell} > 0$ the rxn is spon]

$\underline{Cu} + Zn^{2+} \rightarrow Cu^{2+} + Zn$

فلى ال Cu يتأكسد

يعني هو الاقوى

* من الجدول اذا كان في عنصر شمال السهم تفاعل مع عنصر تحتو يمين السهم معناتو التفاعل spon.

*if Zn^{2+} reacted with Li is the rxn spon.?
not spon !

* العنصر الي ترتيبو فوق هو cathod والي تحت هو anode

$Ag^{+} + Cu \rightarrow Cu^{2+} + Ag$ → spon.

Half rxn = $2(Ag^{+} + e \rightarrow Ag)$ $E^\circ = 0.8$ (ما بضربها بـ 2)
$Cu \rightarrow Cu^{2+} + 2e$ $E^\circ = -0.34$ تقلبها !
لانه عكسناها

ليش ما ضربناها؟ لانو E° intesive property و ما بتأثر بالكمية وعدد المولات

* for spon. rxn : ① $E^\circ > 0$
② $\Delta G^\circ < 0$

وحدة E° ب $V = J/C$

$\Delta G^\circ = -n F E^\circ$
n- عدد الالكترونات

$mol \cdot \frac{C}{mol} \cdot \frac{J}{C} = J$ $96500 \; C/mol = F$ ثابت فرادي
E°_{cell}

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

$E^\circ_{cell} = 0.80 - 0.34$

$= 0.46\ V$

* بنحط الجهد الاختزالي زي ما هو بالجدول

$\Delta G^\circ = -2 \times 96500 \times 0.46 \times \underline{10^{-3}}$

$= -88.78\ KJ$

عشان نطلعها KJ

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

$E^\circ_{cell} = 0.34 - (-0.76) = 1.1$

$\Delta G^\circ = -2 \times 96500 \times 1.1 \times 10^{-3}$

$= -212.3\ KJ$

18/4/2019

Ch.19 , 19.6
19.9
مش معنا

Ex: 19.14 if $E^\circ = 0.53$, what's ΔG°?

$F = 96500\ C$

$n = 2$

$\Delta G^\circ = -2 \times 96500 \times 0.53 \times 10^{-3} = -102\ KJ$

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

$\Delta G^\circ = -nFE^\circ$

$R = 8.314\ J/K\,mol \leftarrow$ at 25°C $\leftarrow$ $E^\circ = \frac{RT\ln K}{nF}$

$T = 298K$

$F = 96500$

$$\Big\Downarrow$$

$$\boxed{\frac{RT}{F} = 0.0257}$$

$\ln K = \frac{nFE^\circ}{RT}$

$$\Big\Downarrow$$

$E^\circ = \frac{0.0257\ln K}{n}$

$\ln K = \frac{nE^\circ}{0.0257}$

Ex: 19.15)

$Cu^{2+} + 2Ag \rightarrow 2Ag^{+} + Cu_{(s)}$

$E^\circ = -0.46\ V$

$K_c = ?$

$\ln K = \frac{2 \times (-0.46)}{0.0257} = -35.8$

$K_c = 2.8 \times 10^{-16} < 1$ يعني البط أقل من المقام بكثير K_c قليلة كثير

the rxn isn't spon. ← معناتو نتائج هاد التفاعل قليلة جداً يعني

عشان يصير التفاعل .span نعكس التفاعل

$E^\circ = +0.46 \rightarrow \ln K = \frac{2 \times 0.46}{0.0257} \Rightarrow K_c = 3.5 \times 10^{15} > 1$

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

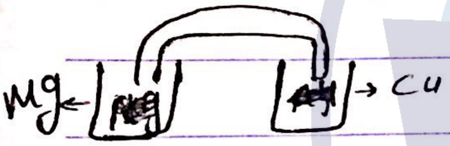
$$\frac{-nFE = -nFE^\circ + RT\ln Q}{-nF}$$

$$\boxed{E = E^\circ + \frac{RT\ln Q}{-nF}} \rightarrow \text{neunerst eq.}$$

$\rightarrow E = E^\circ - \frac{0.0257}{n}\ln Q$

Ex: 19.17) $0.015\,M = [Cu^{2+}]$ dipping , immersed

$2.2 \times 10^{-6}\,M = [Mg^{2+}]$



$Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$

$Cu^{2+} + 2e^- \rightarrow Cu$ 0.34

$Mg^{2+} + 2e \rightarrow Mg$ −2.37

$E^\circ_{cell} = 2.71$

$E_{cell} = ?$ $\rightarrow Q = \frac{[Mg^{2+}]\,\cancel{[Cu]}}{[Cu^{2+}]}$

الصلب ما بنحطو

$E = 2.71 - \frac{0.0257}{2}\ln\frac{2.2\times10^{-6}}{0.015}$

$= 2.82$

بقدر اتحكم بالتركيز عشان احصل على E اكبر
عشان اتحكم بكمية الكهرباء الناتجة

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Ex: 19.18) $Sn_{(g)} + 2H^{+}_{(aq)} \longrightarrow Sn^{2+}_{(aq)} + H_{2(g)}$

$E^{\circ} = 0.14$, $[Sn^{2+}] = 0.01M$, Press for $H_2 = 0.965$ atm

$E = ?$

pH = 2

$$E = E^{\circ} - \frac{RT}{nF} \ln Q$$

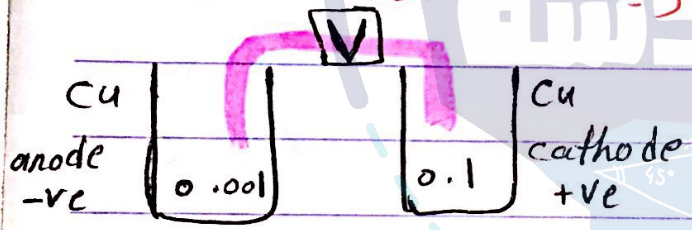
$$Q = \frac{[0.01][0.965]}{[10^{-2}]^2}$$

$$[H^{+}] = \text{arclog } 2 = 10^{-2}$$

$$E = 0.14 \times \frac{0.0257}{2} \ln \frac{[0.01][0.965]}{[10^{-2}]^{2}} = \boxed{0.08}$$

لو نشتغل على E° احسن من E عشان تنتج كهرباء اكثر

وممكن اغير بالتراكيز عشان ازيد قيمة E



$Cu \rightarrow Cu^{2+} + 2e^{-}$ (0.001)

$Cu^{2+} + 2e^{-} \rightarrow Cu$ (0.1)

* التركيز المنخفض هو الانود

* بصير oxidition عشان يزيد التركيز و reduction عشان يقل التركيز وتصير التراكيز متساوية .

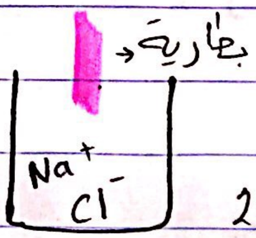
* $\bar{e}$ moves from anode to cathode

$Cu | Cu^{2+} (0.001) \| Cu^{2+} (0.1) | Cu$

$Cu^{2+} (0.1) \rightarrow Cu^{2+} (0.001)$

$E^{\circ} = 0.34 - 0.34 = \underline{0}$

$E = 0 - \frac{0.257}{2} \ln \frac{0.001}{0.1} = \boxed{0.059}$



$Na^+ + e^- \rightarrow Na$

$2Cl^- \rightarrow Cl_2 + 2e^-$

Na^+Cl^- (molten)

* بتختلف الخلية الكهربائية (الالكترونية) عن الجلفانية ب:

1. بتصير ب Beaker واحد
2. الكاثود بكون سالب والانود موجب

Ex: 19.12 محلول بالكتاب

How many grams of Cu will be deposited (ترسب) at 2.00 A, for 19.0 min

$(A \times t_{(s)} = C)$

$1 mol\ e^- \rightarrow 96500\ C$

$1 mol\ Cu \rightarrow 2 mol\ e^-$

$1 mol\ Cu \rightarrow 63.5 g$

$2 \times (19 \times 60) = 2.28 \times 10^3\ C$

$1 mol\ e^- \rightarrow 96500\ C$

$x mol\ e^- \rightarrow 2.28 \times 10^3$

$x = 0.02363$

$1 mol\ Cu \rightarrow 2 mol\ e^-$

$y\ mol \rightarrow 0.02363$

$y = 0.0118$

$[0.0118 \times 63.5 = 0.750 g]$

or

$$2A \times (14 \times 60)s \times \frac{1 mol\ e^-}{96500C} \times \frac{1 mol\ Cu}{2 mol\ e^-} \times \frac{63.5 g}{1 mol\ Cu}$$

(حل مختصر)

Ex: $2e + H_2O \rightarrow 2OH^- + H_2\ (g)$

4 A for 13 min ?

$$4 \times (13 \times 60) \times \frac{1 mol\ e^-}{96500} \times \frac{2 mol\ OH^-}{2 mol\ e^-} = 0.0323$$

Electrolys of aqueous K_2SO_4

cathode

- $e^- + K^+ \rightarrow K$ $-2.92\ V$
- $2H_2O + 2e^- \rightarrow 2OH^- + H_2$ $-0.83V$

anode

- $SO_4^{2-} \rightarrow S_2O_8^{2-} + 2e^-$ $-2.01\ V$
- $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ $-1.23V$

* less negative will formed

so:

$2H_2O + 2e^- \rightarrow 2OH^- + H_2$

nd $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$