اللجنة الأكاديمية لقسم الهندسة المدنية

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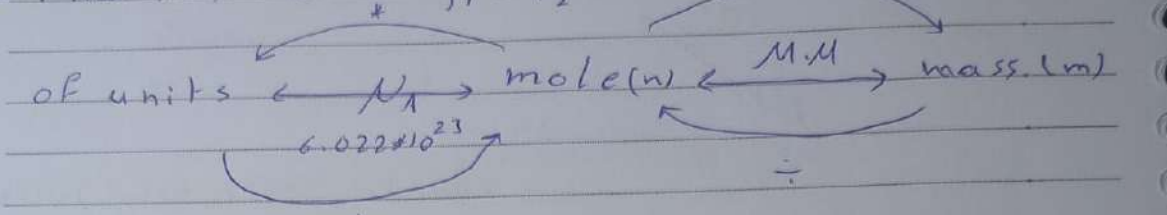
دفتر

أساسيات الكيمياء العامة

إعداد : دارين خالد

* Find M.M of $Ca_3(PO_4)_2$



$$moles = \frac{\#\ of\ units}{N_A} \qquad n = \frac{m}{M.M}$$

$3 * Ca + 2 * P + (4 * 2 * O) \Rightarrow$ الجواب النهائي 310.18 g/mol

M.M From periodic table الجدول الدوري

* Find M.M of $C_6H_5NH_2$

$6 * C = 6 * 12$ g/mol

$1 * N = 1 * 14$ g/mol

$5 * 2 * H = 7 * 1$ g/mol

$O = 13 * 2 = 6$ $\qquad O = 6 * 1 = 6$

* Find M.M of $Co(NO_3)_2 \cdot 6H_2O$

$1 * Co$

$2 * N$

$12 * O$

$12 * H$

كل رقم احمد ① الوحدة
② الكتلوب
③

القيمة
الوحدة
جبتهم منين الوحدة

* لما احل احاضر في الوحدة مع كل خطوة

* Find the mass of a carbon atom
* Find how many grams in amu

Mass to Mass Conversion

Mass A ⟶ Mass B

× Required / given (calculated) × mole B / mole A

Mole A ⟶ (mole ratio) ⟶ Mole B

mole A / mole B ·

E.X
- same molecular Formula نفس المركب
- same Balanced Equation نفس التفاعل الكيميائي

H_2O

1 mole H_2O ⟶ 2 mole H

1 mole H_2O ⟶ 1 mole O

1 mole O ⟶ 2 mol H

* How many atoms are in $1.00 * 10^{-9}$ g of U (1 ng)?

M.M → Molar mass U = 238.03 g/mole.

A. $6.02 * 10^{14}$ atoms

B. $4.20 * 10^{11}$ atoms

C. $2.53 * 10^{12}$ atoms

D. $3.95 * 10^{-31}$ atoms

E. $2.54 * 10^{21}$ atoms

mass (m) ⟵ ÷ M.M ⟶ moles (n) ⟵ × N_A ⟶ number of units

+ ÷

$$\frac{m = 1 * 10^{-9}}{M.M \quad 238.03} = 4.201 * 10^{-12} \text{ n}$$

number of units = $n * N_A = 4.201 * 10^{-12} * 6.022 * 10^{23}$

$= 2.529 * 10^{12} \approx 2.53 * 10^{12}$ atoms

group A
4 persons

group B
6 persons

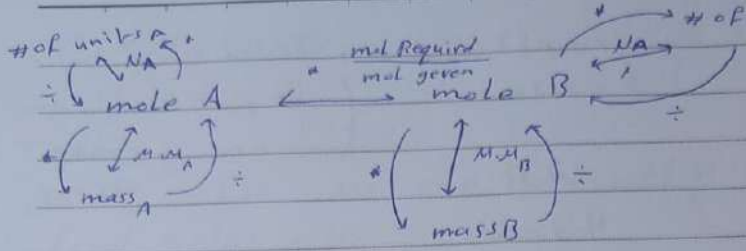
→ Team of 2.
one person from each group

1A + 1B → AB
4 teams
Max

L.R

① اقل كمية
② يستهلك بالكامل
③ هو الوعيد الذي يستخدم لتحديد كمية المواد الباقية

Excess Reagent
زيادة / فائض



For N_2O_5

* a sample of N_2O_5 has $3*10^{21}$ atom of N

2- Find O mass in the Sample

1- Find the sample mass = 1.62g

3- Find total number of atoms

4- Find mass of O atoms

$16\ g/mol$

* نسبة الذرات تعني نسبة المولات
* نسبة المولات تعني نسبة الجزيئات

1) $\frac{3*10^{21}\ atoms\ N}{6.022*10^{23}\ atoms\ N/mole} * \frac{1\ mol\ N_2O_5}{2\ mol\ N} * 108\ \frac{g\ N_2O_5}{mol\ N_2O_5}$

$= 1.62\ g$

2) $\frac{N}{2} : \frac{O}{5}$

$3*10^{21}\ atoms\ N * \frac{5\ atom\ O}{2\ atom\ N}$

$= 7.5*10^{21}\ atoms\ O$

3) # of atom N + # of atom O

$3*10^{21}\ atom + 75*10^{21}\ atom$

$= 1.05*10^{22}\ atom$

PRENKO

$3H_2 + 1N_2 \longrightarrow 2NH_3$

Reaction Coefficients

3 : 1 : 2

stoichrometrac equivalent (mole Ratio)

$3\,mol\ H_2 \longleftrightarrow 2\,mol\ NH_3$

$1\,mol\ N_2 \longleftrightarrow 2\,mol\ NH_3$

$3\,mol\ H_2 \longleftrightarrow 1\,mol\ N_2$

* If 1.5 mol H_2 Reacted

- how many NH_3 moles produced
- how many N_2 will react
- find NH_3 molecules produced

given = 1.5 mol H_2

$* \frac{2}{3}$ ↓

Required = ? mol NH_3

different substances ↓ use mole Ratio

$1.5\ mol\ H_2 * \frac{2\ mol\ NH_3}{3\ mol\ H_2}$

$= 1\ mol\ NH_3$

$1.5\ mol\ H_2 * \frac{1\ mol\ N_2}{3\ mol\ H_2} = \frac{1.5}{3}\ mol\ N_2$

$2A + 3B + C \longrightarrow 2D + 3F$

PRENKO

Boyle's Law

$P \propto \frac{1}{V}$ بثبات n, T

$K_1 = P_1 V_1 = P_2 V_2$

Charles's Law

$T \propto V$ بثبات n, P

$K_2 = \frac{T_1}{V_1} = \frac{T_2}{V_2}$

Gay-Lussac's Law

$T \propto P$ بثبات n, V

$K_3 = \frac{T_1}{P_1} = \frac{T_2}{P_2}$

Avogadro's Principle

$n \propto V$ بثبات P, T

$K_4 = \frac{n_1}{V_1} = \frac{n_2}{V_2}$

Dalton's Law

$n \propto P$

$K_5 = \frac{n_1}{P_1} = \frac{n_2}{P_2}$

Mixed Gas Law $\Rightarrow \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

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

MF	EF	N
$C_6H_{12}O_6$	CH_2O	6
C_4H_8	CH_2	4
$C_{11}H_{22}$	CH_2	11
C_3H_6	CH_2	3
$C_{20}H_{40}$	CH_2	20
H_2O	H_2O	
N_2O_5	N_2O_5	

1- find moles of each atom

2- find simplest ratio between atoms moles (ratio, etc)

3- Convert to a whole number if necesary

* Salt of Ba & Cl was reacted and converted to 2.34g $BaSO_4$ and 2.86g AgCl

M.M = 233 g/mol M.M = 143 g/mol

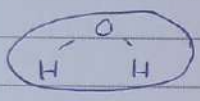
Find E.F of the salt $BaCl_2$: الملح

highest IMF

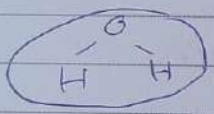
C_2H_6
C_3H_8
$\boxed{C_5H_{10}}$
C_4H_8

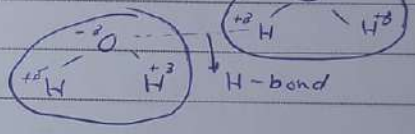
all - non polar
LDF only
M.M ↑ ⇒ LDF ↑

* Define IMF in
1) water



LDF + D-D + H-bond





IMF strength
I-D > H-bond > D-D > LDF

* Physical properties that depend on IMF

1) Vapor pressure (V.P)
how easy a material can escape from liquid phase to gas (vapor) phase (be Volatile)
2) boiling point (b.p) & melting point (m.p)

For the reaction (rxn)

$N_2 + 3H_2 \longrightarrow 2NH_3$

given 3 mol — 5 mol ← L.R

if 3 moles N_2 reated with 5 moles H_2

1- find moles NH_3 produced.

2- find moles mass NH_3 produced.

* اذا اعطى السؤال اكثر من كمية بدون ان Limiting

3- find unreated moles (excess)

only one amount needed to solve the problem.

* relative amount $\frac{3}{1} > \frac{5}{3}$

$5 \text{ mole } H_2 \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2} = 3.333 \text{ mol } NH_3$

* اكثر قليلة في الكمية

$3 \text{ mol } N_2 \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} = 6 \text{ mol } NH_3$

L.R اذا في H_2 ←

2) $3.333 \text{ mol } NH_3 \times 17 \text{ g/mole } NH_3$

$m = n \times M \cdot M_{NH_3}$

3) N_2 reacted depends on L.R (H_2)

mole H_2 ⟶ mole N_2 (Reacted)

$5 \text{ mol } H_2 \times \frac{1 \text{ mol } N_2}{3 \text{ mol } H_2} \simeq 1.7 \text{ mol } N_2$ reacted

يعني المتفاعلات فقط L.R

unreacted = total − reacted

3 − 1.7 = 1.3 mol N_2 unreacted

Percentage Yield

$$\%\,yield = \frac{Actual}{Theoretical} \times 100\% \leq 100\%$$

Actual ≤ Theoretical

متوقع : Theo

the % yield of a rxn is 75% and the expected prudect amount is found to be 22 g
Find Actual Yield

$$\%\,Yield = \frac{Actual}{Theo} \times 100\%$$

$$\frac{75}{100} = \frac{Actual}{22} \times \frac{100}{100}$$

* always use Theo amount in Calculations

الثوابت لي بعتمد عليها بالأسئلة لي ما معها MM

1) عدد افوجادرو

2) M.M

3) mole ratio

• الثالث بيعمل بس يكون عنده ذرات عالية الكهروسالبية

مراجعة.

Find IMF between

1) H_2O and CH_3OH → LDF , D-D , H-bond

2) H_2O & $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ → LDF , D-D , H-bond

3) H_2O & F^- → LDF , I-D , H-bond

4) CH_3OH & Na^+ → LDF , I-D ,

5) $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ → LDF , D-D

IMF strength 3 > 4 > 1 > 2 > 5

الضغط البخاري العكس

3 < 4 < 1 < 2 < 5

1) NH_3 → LDF , D-D , H-bond

2) $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ → LDF , D-D

3) C_4H_8 → LDF

4) C_6H_{12} → LDF

IMF 1) 2 > 4 > 3

V.P 3 > 4 > 2 > 1

B.P = Viscosity = Surface tension

سؤال الامتحان 1

$$Zn_{(s)} + 2HCl \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$$

$T = 25^\circ C = 298\,K$

$V = 9.8\,L$

$P_{Tot} = 745\ torr$

$V.P_{H_2O} = 23.8\ torr$ @ $25^\circ C$

$P_{H_2} = P_{Total} - P_{H_2O}$

$= (745 - 23.8)\ torr = 721.2\ torr \rightarrow atm$

$P_{H_2} = \left(\frac{721.2}{760}\right) atm$

$n_{H_2} = \frac{PV}{RT} = \frac{\left(\frac{721.2}{760}\right)(9.8)}{0.0821(298)} = 0.38\ mol\ H_2$

من المعادلة :

$\equiv 0.38\ mol\ Zn$

$\downarrow$ ك.م

$24.86\ g$

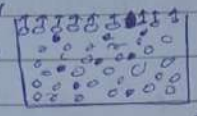
$\simeq 24.9\ g$

مادة السكر

° → pure نقي

Sugar + H_2O → will lower V.P

* ضغط بخار المحلول اعلى من ضغط بخار الماء.



$$P_{soln} = P^{\circ}_{solvent} * X_{solvent}$$

Raoult's Law

$$P_{soln} = P^{\circ}_{solvent} * X_{solvent}$$

→ Fractionation of ideal solution

$$\Sigma X = 1$$

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

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

* Find V.p of solution at 25c° made of Sugar & water if Sugar mole fraction is 0.3

$P^{\circ}_{H_2O}$ @ 25c° = 24 torr

$$P_{soln} = P^{\circ}_{H_2O} * X_{H_2O} = 24\,torr\,(0.7) = 16.8$$

$$X_{H_2O} = 1 - X_{sugar} = 1 - 0.3 = 0.7$$

$$P_{soln} = P^{\circ}_{solvent} * X_{solvent} + P^{\circ}_{solute} * X_{solute}$$

$$P_{soln} = P^{\circ}_{A} \cdot X_A + P^{\circ}_{B} X_B$$

0 c كثافة = 1 g/mL = 1 kg/L

100 c

Find the vapor pressure of water at 25C°

ΔH_{vap} = 41 kJ /mol = 41000 J /mol

* normal boiling point = 100C°

P_1 = 1 atm = 760 torr

* For a substance the normal point is 40C°

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

$$\ln \frac{760}{300} = \frac{.25000}{8.314} \left(\frac{1}{T_2} - \frac{1}{303} \right)$$

1.436

Find vp of a soln made of 20g H_2O & 15g CH_3CH_2OH (ethanol) @T $P^\circ_{H_2O} = 100$ torr @T

$P^\circ_{ethanol} = 160$ torr @T

$$n_{H_2O} = \frac{m}{M.M\ H_2O} = \frac{20}{18} = x\ 1.11$$

$$n_{ethanol} = \frac{m}{M.M_{ethanol}} = \frac{15\ g}{46\ g/mol} = y\ 0.326$$

$$\chi_{H_2O} = \frac{x}{y+x} = \frac{1.11}{0.326+1.11} = 0.77$$

$$\chi_{tot} = \chi_{H_2O} + \chi_{CH_3CH_2OH} = 1$$

$$\therefore \chi_{CH_3CH_2OH} = 0.23$$

$$P_{soln} = P^\circ_{H_2O} * \chi_{H_2O} + P^\circ_{CH_3CH_2OH} * \chi_{CH_3CH_2OH}$$

$$= (100 * 0.77) + (160 * 0.23)$$

$$= 113.8$$

$$\chi_A = \frac{n_A}{n_A + n_B}$$

Molality = $\frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$

molal — $m = \frac{mol}{kg}$

a soln of 0.1 m concentration
↓
0.1 molal
or
0.1 mol/kg

$\Delta T \propto m$

$\Delta T = K \cdot m$

$\Delta T_b = K_b \cdot m \cdot i$

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

predict vp deviation in the following

1) soln of H_2O & aceton $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

$\begin{pmatrix} LDF \\ D-D \\ H\text{-bond} \end{pmatrix}$ A-A $\begin{pmatrix} LDF \\ D-D \end{pmatrix}$ B-B

↓ A+B

LDF
D-D
H-bond

A-B > B-B ⇒ negative deviation.

IMF ↑ ⇒ V.P ↓

2) H_2O & HCl

A-A $\begin{pmatrix} LDF \\ D-D \\ H\text{-bond} \end{pmatrix}$ $\begin{pmatrix} LDF \\ D-D \end{pmatrix}$ B-B

↓ A-B

LDF
D-D

A-B < A-A

positive deviation

for the following Rxn

$$A + 2B \rightleftharpoons 3C$$

if 0.1 M A, 0.2 M B & 0.5 M C placed in 5L container at eq. it was found that B concentration is 0.3 M

- Find K_c

الجواب

$$K_c = \frac{(0.35)^3}{(0.15)(0.3)^2}$$

$NH_3 \longrightarrow C.A \rightarrow NH_4^+$

$\searrow$

$C.B \rightarrow NH_2^-$

PRENKO

Vant Hoff

solvent = H_2O

an aqueous soln of substance x has a boiling point to 104°C find its freezing point.

$$m = \frac{n_{NaCl}}{kg_{H_2O}} = \frac{1.7\ mol}{0.5\ kg} = 3.4\ m$$

$$n_{NaCl} = \frac{m}{M.M} = \frac{100\ g}{58.5\ g/mol}$$

$$n_{NaCl} = 1.7\ mol$$

$$\Delta T_b = k_b\ m.i \Rightarrow m = \frac{\Delta T_b}{k_b\ i} = \frac{4\ C^\circ}{0.51\ C^\circ/m} = 7.8\ m$$

$$\Delta T_f = k_f \cdot m \cdot i = 1.86\ C^\circ/m\ (7.8\ m)\ (1)$$

$$= 14.8\ C^\circ$$

$$\Delta T_b = |T_{b\ soln} - T_{b\ solvent}|$$

$$= |104 - 100| = 4\ C^\circ$$

depression

$$\Delta T_{b\ soln} = T_{b\ solvent} \oplus \Delta T_b \qquad \Delta T_{f\ soln} = T_{f\ solvent} \ominus \Delta T_f$$

elevation

$$= 0 - 14.6 = -14.6\ C^\circ$$

PRENKO

Reference point (standard)

P = 1 atm
T = 273 K
V = 22.4 L
n = 1 mol

PV = nRT

R = 0.0821

what is the volume of 2 mol gas at 25C° and 1.5 atm pressure

298K

PV = nRT or $\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$

استخدم كمرجع الظروف القياسية حيث

$\frac{1(22.4)}{1(273)} = \frac{1.5(V_2)}{2(298)}$

* Density (d) = $\frac{\text{mass}(m)}{\text{volume}(V)}$ ⇒ $d = \frac{m}{V}$ ⇒ g/L وحدة d

$\frac{g}{mL} \rightarrow \frac{g}{L} \Rightarrow \frac{g}{mL} \frac{10^3 mL}{1L}$

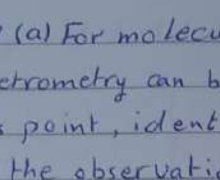
PRENKO

error المستقطب والمستقطب } ?? + سبب ترابط جزيئات Cl_2 لان ... متساوية

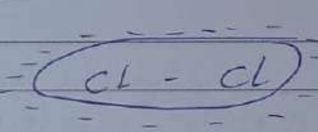
page 38.

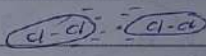
3.149 (a) For molecules having small moleculer masses mass spectrometry can be used to identify their for mulas. To illustrate this point, identify the molecule which most Likely accounts for the observation

* E.N الكهروسالبية



$E.N_{Cl} > E.N_{H}$





يحدث تشتت يؤدي إلى تكوين قطب موجب أحد الطرفين لتكوين الرابطة

① London Dispersion Forces (LDF)
or
London Forces (LF)
or
Dispersion Forces (DF)

كلهم نفس الرابطة شو ما اعطاني اسم ما بتفرق

The Value of K_c for the equilibrium

① $H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$

is 794 at 25C°. What is the value of K_c for the equilibrium below?

② $\frac{1}{2} H_{2(g)} + \frac{1}{2} I_{2(g)} \longrightarrow HI_{(g)}$

A) 397

B) 0.035

C) 28

D) 1588

E) 0.0013

① $K_c = \frac{[HI]^2}{[H_2][I_2]} = 794$

397

② $K_c = \frac{[HI]}{[H_2]^{\frac{1}{2}}[I_2]^{\frac{1}{2}}}$

2) The value of K_c for the equilibrium

① $H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$

is 794 at 25C°. At this temperature, what is the value of K_c for the equilibrium below?

① $HI_{(g)} \longrightarrow \frac{1}{2} H_{2(g)} + \frac{1}{2} I_{2(g)}$

② $K_c' = \frac{1}{K_c}$

$K_c'' = \sqrt{\frac{1}{K_c}} = \frac{1}{\sqrt{794}}$

0.035

A) 1588

B) 28

C) 0.035

D) 397

E) 0.0013

3) Consider the following chemical reaction:

$$H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$$

At equilibrium in a particular experiment, the concentrations of H_2, I_2 and HI were $0.15\,M$ (H_2) $0.033\,M$ (I_2) and $0.55\,M$ (HI) respectively

A) 23

B) 111

C) $9 * 10^{-3}$

D) 6.1

E) 61

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

$$= \frac{[0.55]^2}{[0.15].[0.033]}$$

$$= 61.11$$

4) The equilibrium-constant expression depends on the _____ of the reaction

A) stoichiometry

B) mechanism

C) stoichiometry and mechanism

D) the quantites of reactants and products initially

E) temperature

5) Given the following reaction at equilibrium if $K_c = 6.44 * 10^5$ at 230.0C°, K_p = _____.

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

A) $3.67 * 10^{-2}$

B) 15614

C) $6.44 * 10^5$

D) $2.66 * 10^6$

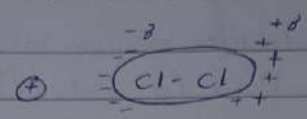
E) $2.67 * 10^7$

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

$$= 6.44 * 10^5 ((0.082)(503))^{-1} = 15613.63$$

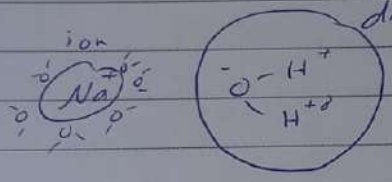
PRENKO

12 سؤال ← 2,5 علامة لكل سؤال
60 دقيقة



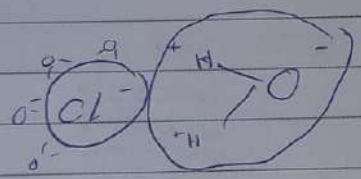
Ion-induced dipole

③ Ion - ~~Dipole~~ dipole IMF (I-D)
between ions (+ or -) & polar molecules



* يحدث تغليف للأيون

or



$F_{2(g)}$ LDF
$Cl_{2(g)}$ "
$Br_{2(l)}$ "
$I_{2(s)}$ "

non-polar

V. important

as M.M ↑ LDF ↑

* علاقة طردية

* الفلور غير قادر على تكوين اقطاب لأنه ~~كبير~~ صغير جداً
حجمه

* اليود الاستقطاب له عالي لأن حجمه كبير وقوى التجاذب بعده أعلى لأن مساحة سطحه أكبر

$H_3O^+ = H^+_{aq}$

Hydroxide

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

$HF + H_2O \rightleftharpoons F^- + H_3O^+$ ← Hydronium ion (proton H^+)

Bronstead
Bases produce OH^- in water
Acid " H^+ "

Auto ionization of water — تأين الماء الذاتي (تفاعل الماء مع نفسه)

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

ما يخص K

$K_w = [OH^-][H_3O^+] = 1 * 10^{-14}$ at 25 C°

as $[H^+] \uparrow \Rightarrow [OH^-] \downarrow$

* الماء النقي متعادل كهربائياً

* $PH = -\log[H_3O^+]$ ✓

$PH + POH = 14$ ✓

same

P Function

$P(X) = -\log(X)$

$P(X) \frac{1}{2} (X) \Rightarrow$ * علاقة عكسية

$P k_w = POH + PH = 14$

PRENKO

5) Which of the following statements is true?

A) Q does not change with temperature

B) K_c does not change with temperature, whereas Q is temperature dependent

C) K_c does not depend on the concentrations or partial pressures of reaction components

D) Q does not depend on the concentrations or partial pressures of reaction components

E) Q is the same as K_c when a reaction is at equilibrium

Dareen Khaled

E.X 16.11 حل

Find PH of $5*10^{-4}$ M HCl Soln
S.A

$PH = -Log\ [H^+] = -Log\ 5*10^{-4} = 3.3$

$[H^+] = [HCl] = 5*10^{-4}$

* في تفاعلات التعادل الماء هو الناتج الأساسي
الحمض والقاعدة يلغيان بعضهما (: الحصلة هي الماء)

$\Delta H = H_f - H_i$

$= H_{prod} - H_{react}$

$= \sum n_p (H_{prod}) - \sum n_R (H_R)$

Nool 5

Write formation equation of

1) H_2O

$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O$

لما بدي اكتب معادلة التكوين بحافظ على النواتج انها 1mol

2) CH_3OH

$2H_{2(g)} + \frac{1}{2}O_{2(g)} + C_{(s)(grapeat)} \longrightarrow CH_3OH$ //

$\Delta H^\circ_{f\,graphite} = 0$

اي مادة تتكون من نوع واحد من الذرات : عنصر

*element : one type of atoms

$\Delta H^\circ_f\ N_{2(l)} \neq 0$

لانه N_2 بالظروف القياسية موجود غاز

اذا اعطاني درجة الحرارة مثلا 70 بقدر استخدمها (اختار الجدول) لانها بيعطي الحرارة 1atm

$\Delta H^\circ_f\ N_{2(g)} = 0$

$\Delta H^\circ_f\ O_{3(g)} \neq 0$

E.x

6.10 $= \ominus 15.25\ KJ/g$

انتبها مش موجودة بالشابتر

Error

as PH ↑ ⇒ $[H^+]$ ↓
$[OH^-]$ ↑

neutral soln
$[H^+] = [OH^-] = 1*10^{-7}$
PH = POH = 7 ← important

Acidic Soln
$[H^+] > [OH^-]$
$[H^+] > 10^{-7}$
PH < 7

Basic
$[H^+] < [OH^-]$
$[H^+] < 10^{-7}$
$OH^- > 7$

For Soln that has H^+ conc equals to $3*10^{-3}$ M
- is the Soln A or B. A
- find PH
- find POH ≈ 11.5
- find $[OH^-] = \frac{1*10^{-14}}{3*10^{-3}} = 0.33*10^{-11}$ M

$[H^+] = 3*10^{-3}$
$PH = -\log [H^+]$
$= -\log 3*10^{-3}$
$= 3 - \log 3$
$= 3 - 0.477$
$= 2.523$

PRENKO

* entropy change ⇒ ΔS

18.3

a) S↓ ΔS (-) ΔS < 0

b) S↑ ΔS (+) ΔS > 0

c) ΔS ≈ 0

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

4 mol → 2 mol

Δn = 2 ↓ S↓ ΔS (-) ΔS < 0

مع الغازات

* في البلورة المثالية العشوائية صفر

S = zero at $-273c^\circ = \underset{\text{الصفر المطلق}}{0K}$

* جداول الـ entropy دائماً موجبة

standard conditions

$S^\circ > 0$ دائماً

ΔS° ⇒ +, -, zero

$\Delta G = \Delta H - T\Delta S$ ⇒ Gibbs free energy

$\Delta G < 0$ (−) spont

$\Delta G > 0$ (+) non-spont

ΔG = zero at eqm

ΔH	ΔS	spont or non ΔG
−	+	spont at all T
favored	✓	ΔG < 0 (−)
+	−	non-spont at all T
not favored	✗	ΔG > 0 (+)
−	−	spont at Low T
✓	✗	$T < T_{eq} \Rightarrow T < \frac{\Delta H}{\Delta S}$
+	+	spont at heigh T
not favored	✓	

* Error

For physical phase change $\Delta G = 0$ at melting or freazing or boiling points

Ch. 18

* كل نظام يفضل انه يفقد طاقة

Spontaneous تلقائي

↳ doesn't need energy to happen → lose energy ΔU (-)

non-spontaneous

↳ Requires energy to happen → gain energy ΔU (+)

* is exothermic process (ΔH(-)) Spontaneous?? No

" endothermic " (ΔH(+)) non-spontaneous?? No

$NaCl_{(s)} + H_2O_{(l)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ ΔH + (spont)

enthalpy

الي خلى هاي العملية تلقائية هو العشوائية وليس الـ ΔH

* entropy (S) = Randomness

-increas as

1) Tempereature ↑
2) Δn or ΔV ↑
3) Substance phase gas >> Liqued > solid

* اي نظام يفضل العشوائية وليس الترتيب
* الترتيب دائماً بده طاقة

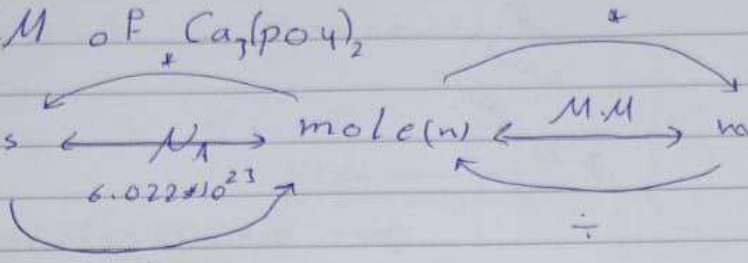
* any system prefers exothermic process (Lose heat ΔH(-)) and increase in entropy ΔS (+)

التلقائية بيتحكم فيها ① الحرارة
② العشوائية
③ عدد المولات

PRENKO

كيمياء

* Find M.M of $Ca_3(PO_4)_2$



$moles = \frac{\#\ of\ units}{N_A}$ $\quad n = \frac{m}{M.M}$

$3 * Ca + 2 * P + (4 * 2 * O) \Rightarrow$ الجواب النهائي 310.18 g/mol

M.M from per الجدول الدوري

* Find M.M of $C_6H_5NH_2$

$6 * C = 6 * 12$ g/mol

$1 * N = 1 * 14$ g/mol

$5 * 2 * H = 7 * 1$ g/mol

$O = (3 * 2 = 6)$ $\quad O = 6 * 1 = 6$

* Find M.M of $Co(NO_3)_2 \cdot 6H_2O$

$1 * Co$

$2 * N$

$12 * O$

$12 * H$

PRENKO

لازم اجد ① الوحدة
② المطلوب
③

القيمة
الوحدة
جبتخلص من الوحدة

* لما احل احافظ على الوحدة مع كل خطوة

* Find the mass of a carbon atom
* Find how many grams in amu

Mass to Mass Conversion

Mass A ⟶ Mass B

Mole A ⟶ Mole B (mole ratio)

× Required / given (calculated) mole $\frac{B}{A}$

mole $\frac{A}{B}$ ·

E.X
- same molecular Formula نفس المركب
- same Balanced Equation نفس التفاعل الكيميائي

H_2O

1 mole H_2O ⟶ 2 mole H

1 mole H_2O ⟶ 1 mole O

1 mole O ⟶ 2 mol H

* How many atoms are in $1.00 * 10^{-9}$ g of U (1 ng)?

M.M → Molar mass U = 238.03 g/mole.

A. $6.02 * 10^{14}$ atoms

B. $4.20 * 10^{11}$ atoms

C. $2.53 * 10^{12}$ atoms

D. $3.95 * 10^{-31}$ atoms

E. $2.54 * 10^{21}$ atoms

mass (m) ← ÷ M.M → moles (n) ← × N_A → number of units

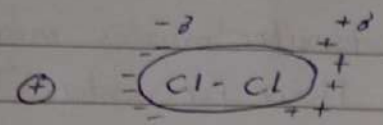
× ÷

$$\frac{m}{M.M} = \frac{1 * 10^{-9}}{238.03} = 4.201 * 10^{-12}\ n$$

number of units = $n * N_A = 4.201 * 10^{-12} * 6.022 * 10^{23}$

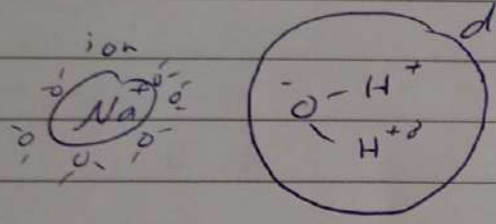
$= 2.529 * 10^{12} \approx 2.53 * 10^{12}$ atoms

PRENK



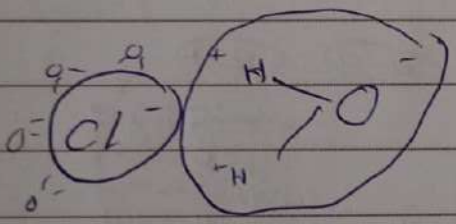
Ion - induced dipole

② Ion - ~~Dipole~~ dipole IMF (I-D)
between ions (+or-) & polar molecules



* يحدث تغليف للأيون

or



$F_{2(g)}$ LDF
$Cl_{2(g)}$ "
$Br_{2(l)}$ "
$I_{2(s)}$ "

non-polar

V. important

as M.M ↑ IDF ↑

* علاقة طردية

* الفلور غير قادر على تكوين اقطاب لأنه حجمه صغير جداً
* اليود الاستقطاب له عالي لأن حجمه كبير وقوى التجاذب معه أعلى لأن مساحة سطحه أكبر

For the reaction (rxn)

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

given 3 mol, 5 mol ← L.R

if 3 moles N_2 reated with 5 moles H_2

① - find moles NH_3 produced.

② - find moles mass NH_3 produced.

* اذا اعطى السؤال اكثر من كمية بدون ان Limiting

③ - find unreated moles (excess)

only one amount needed to solve the problem.

* relative amount $\frac{3}{1} > \frac{5}{3}$

$$5 \text{ mole } H_2 \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2} = 3.333 \text{ mol } NH_3$$

* الاقل قيمة هي الحد

$$3 \text{ mol } N_2 \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} = 6 \text{ mol } NH_3$$

L.R اذن H_2 :

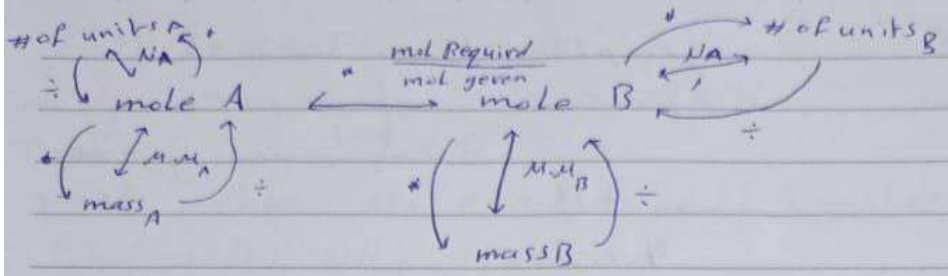
② $3.333 \text{ mole } NH_3 \times 17 \text{ g/mole } NH_3$

$m = n \times M \times M\, NH_3$

3) N_2 reacted depends on L.R (H_2)

mole H_2 ⟶ mole N_2 (Reacted)

$$5 \text{ mol } H_2 \times \frac{1 \text{ mol } N_2}{3 \text{ mol } H_2} \simeq 1.7 \text{ mol } N_2 \text{ reacted}$$



For N_2O_5

* a sample of N_2O_5 has $3*10^{21}$ atom of N

2- Find O mass in the Sample

1- Find the sample mass - 1.62g

3- Find total number of atoms

4- Find mass of O atoms

4g * 16g/mol

* نسبة الذرات نفس نسبة المولات
* نسبة المولات تتناسب مع الأعداد

1) $\frac{3*10^{21}\ \text{atoms } N}{6.022*10^{23}\ \text{atoms } N/\text{mole}} * \frac{1\ \text{mol } N_2O_5}{2\ \text{mol } N} * \frac{108\ \text{g } N_2O_5}{\text{mol } N_2O_5}$

$= 1.62\ g$

2) $3*10^{21}\ \text{atoms } N * \frac{5\ \text{atom } O}{2\ \text{atom } N}$

$= 7.5*10^{21}\ \text{atoms } O$

N	O
2	5

# of atom N + # of atom O

$3*10^{21}$ atom + $7.5*10^{21}$ atom

$= 1.05*10^{22}$ atom

PRENKO

group A
4 persons

group B
6 persons

→ Team of 2.
one person from each group

1A + 1B → AB
4 teams
Max

L.R

Excess Reagent
زيادة / فائض

① اقل كمية
② يستهلك بالكامل
③ هو المعيار الذي يستخدم لتحديد كمية المواد الباقية

$3H_2 + 1N_2 \longrightarrow 2NH_3$

Reaction Coefficients

3 : 1 : 2

stoichrometra equivalent (mole Ratio)

$3 mol\ H_2 \longleftrightarrow 2 mol\ NH_3$

$1 mol\ N_2 \longleftrightarrow 2 mol\ NH_3$

$3 mol\ H_2 \longleftrightarrow 1 mol\ N_2$

* If 1.5 mol H_2 Reacted

- how many NH_3 moles produced
- how many N_2 " will react
- find NH_3 molecules produced

given = 1.5 mol H_2 → different substances → use mole Ratio

* $\frac{2}{3}$

Required = ? mol NH_3

* دائماً بحط المعطى بالمقام (عشان تروح)

* بالرجوع للمعادلة الموزونة فوق

$$1.5\ mol\ H_2 * \frac{2\ mol\ NH_3}{3\ mol\ H_2}$$

$= 1\ mol\ NH_3$

$$1.5\ mol\ H_2 * \frac{1\ mol\ N_2}{3\ mol\ H_2} = \frac{1.5}{3}\ mol\ N_2$$

في أي تفاعل كيميائي حتى اطلع كمية أي مادة بحتاج كمية واحدة فقط

$2A + 3B + C \longrightarrow 2D + 3F$

PRENKO

Find vp of a soln made of 20g H_2O & 15g CH_3CH_2OH (ethanol) @T $P^\circ_{H_2O} = 100$ torr @T

$P^\circ_{ethanol} = 160$ torr @T

اذا اعطاني P° بروح اله

اجاوب مباشرة

$$n_{H_2O} = \frac{m}{M.M\ H_2O} = \frac{20}{18} = x\ 1.11$$

$$n_{ethanol} = \frac{m}{M.M_{ethanol}} = \frac{15\ g}{46\ g\ mol} = y\ 0.326$$

$$\chi_{H_2O} = \frac{x}{y+x} = \frac{1.11}{0.326+1.11} = 0.77$$

$$\chi_{tot} = \chi_{H_2O} + \chi_{CH_3CH_2OH} = 1$$

$$\therefore \chi_{CH_3CH_2OH} = 0.23$$

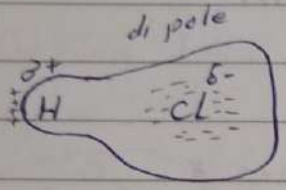
$$P_{soln} = P^\circ_{H_2O} * \chi_{H_2O} + P^\circ_{CH_3CH_2OH} * \chi_{CH_3CH_2OH}$$

$$= (100 * 0.77) + (160 * 0.23)$$

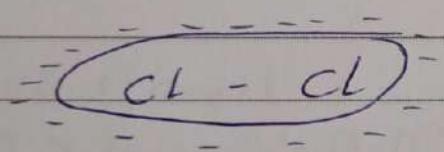
$$= 113.8$$

3.149 (a) For molecules having small molecular masses mass spectrometry can be used to identify their formulas. To illustrate this point, identify the molecule which most likely accounts for the observation

* E.N الكهروسالبية



$E.N_{Cl} > E.N_{H}$



Cl-Cl Cl-Cl

يحدث تشتت يؤدي إلى تكوين قطب موجب أو قطبين لتكوين الرابطة

(2) London Dispersion Forces (LDF)
or
London Forces (LF)
or
Dispersion Forces (DF)

كلهم لنفس الرابطة حوا عطاني اسم ما بتوع

Boyle's Law

$P \propto \frac{1}{V}$ بثبات n و T

$K_1 = P_1V_1 = P_2V_2$

Charles's Law

$T \propto V$ بثبات n و P

$K_2 = \frac{T_1}{V_1} = \frac{T_2}{V_2}$

Gay-Lussac's Law

$T \propto P$ بثبات n و V

$K_3 = \frac{T_1}{P_1} = \frac{T_2}{P_2}$

Avogadro's Principle

$n \propto V$ بثبات P و T

$K_4 = \frac{n_1}{V_1} = \frac{n_2}{V_2}$

Dalton's Law

$n \propto P$

$K_5 = \frac{n_1}{P_1} = \frac{n_2}{P_2}$

Mixed Gas Law

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

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

L.R يخص المتفاعلات فقط

unreacted = total − reacted

3 − 1.7 = 1.3 mol N_2 unreacted

Percentage Yield

$$\%\ \text{yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100\% \leq 100\%$$

Actual ≤ Theoretical

متوقع : theo

the % yield of a rxn is 75% and the expected prudect amount is found to be 22 g
Find Actual Yield

$$\%\ \text{Yield} = \frac{\text{Actual}}{\text{Theo}} \times 100\%$$

$$\frac{75}{100} = \frac{\text{Actual}}{22} \times \frac{100}{100}$$

* always use Theo amount in Calculations

الثوابت الي بنعتمد عليها بالأسئلة الي ما بيها M.M

1) عدد افوجادرو

2) M.M

3) mole ratio

• الثالث بيجمع بس بيكون عندي ذرات عالية الكهروسالبية

مراجعة.

Find IMF between

1) H_2O and CH_3OH → LDF , D-D , H-bond
2) H_2O & $CH_3\overset{\overset{O}{\|}}{C}-CH_3$ → LDF , D-D , H-bond
3) H_2O & F^- → LDF , I-D , H-bond
4) CH_3OH & Na^+ → LDF , I-D ,
5) $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ → LDF , D-D

IMF strength 3 > 4 > 1 > 2 > 5

الضغط البخاري العكس

3 < 4 < 1 < 2 < 5

1) NH_3 → LDF , D-D , H-bond
2) $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ → LDF , D-D
3) C_4H_8 → LDF
4) C_6H_{12} → LDF

IMF 1) 2 > 4 > 3

V.P 3 > 4 > 2 > 1

B.p = Viscosity = Surface tension

0 c
100 c

كثافة = 1 g/mL = 1 kg/L

Find the vapor pressure of water at 25C°

ΔH_{vap} = 41 kJ/mol = 41000 J/mol

* normal boiling point = 100C°

P_1 = 1 atm = 760 torr

* For a substance the normal point is 40C°

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

$$\ln \frac{760}{300} = \frac{25000}{8.314} \left(\frac{1}{T_2} - \frac{1}{303} \right)$$

sugar + H_2O

will lower V.P

$P_{soln} = P^{\circ}_{solvent} * X_{solvent}$ → pure

$P_{soln} = P^{\circ}_{solvent} * X_{solvent}$ → fractionation

$\Sigma X = 1$

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

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

* Find V.P of solution at 25c° made of sugar & water if sugar mole fraction is 0.3

$P^{\circ}_{H_2O}$ @ 25c° = 24 torr

$P_{soln} = P^{\circ}_{H_2O} * X_{H_2O} = 24 torr (0.7) = 16.8$

$X_{H_2O} = 1 - X_{sugar} = 1 - 0.3 = 0.7$

$P_{soln} = P^{\circ}_{solvent} * X_{solvent} + P^{\circ}_{solute} * X_{solute}$

$P_{soln} = P^{\circ}_{A} . X_A + P^{\circ}_{B} X_B$

ME	EF	N
$C_6H_{12}O_6$	CH_2O	6
C_4H_8	CH_2	4
$C_{11}H_{22}$	CH_2	11
C_3H_6	CH_2	3
$C_{20}H_{40}$	CH_2	20
H_2O	H_2O	
N_2O_5	N_2O_5	

1- Find moles of each atom

2- Find simplest ratio between atoms moles (تبسيط)

3- Convert to a whole number if necessary

* Salt of Ba & Cl was reacted and converted to 2.34g $BaSO_4$ and 2.86g AgCl

$M.M = 233\ g/mol$ $M.M = 143\ g/mol$

Find E.F of the salt $BaCl_2$ المطلوب

Reference point (standard)

$P = 1\ atm$

$T = 273\ K$

$V = 22.4\ L$

$n = 1\ mol$

$PV = nRT$

$R = 0.0821$

what is the volume of 2 mol gas at 25C° (298K) and 1.5 atm pressure

$PV = nRT$ or $\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$

استخدم كمرجع الظروف القياسية حيث

$\frac{1(22.4)}{1(273)} = \frac{1.5(V_2)}{2(298)}$

* Density (d) $= \frac{mass(m)}{volume(V)} \Rightarrow d = \frac{m}{V} \Rightarrow$ g/L وحدة d

$\frac{g}{mL} \rightarrow \frac{g}{L} \Rightarrow \frac{g}{mL} \frac{10^3 mL}{1L}$

solvent = H_2O

an aqueous soln of substance X has a boiling point to 104°C find its freezing point.

$$m = \frac{n_{NaCl}}{kg_{H_2O}} = \frac{1.7\ mol}{0.5\ kg} = 3.4\ m$$

$$n_{NaCl} = \frac{m}{M.M} = \frac{100\ g}{58.5\ g/mol}$$

$$n_{NaCl} = 1.7\ mol$$

$$\Delta T_b = k_b\ m.i \Rightarrow m = \frac{\Delta T_b}{k_b\ i} = \frac{4\ C^\circ}{0.51\ C^\circ/m} = 7.8\ m$$

$$\Delta T_f = k_f . m . i = 1.86\ C^\circ/m\ (7.8\ m)\ (1)$$

$$= 14.8\ C^\circ$$

$$\Delta T_b = |T_{b\ soln} - T_{b\ solvant}|$$

$$= |104 - 100| = 4\ C^\circ$$

depression

$$\Delta T_{b\ soln} = T_{b\ solvent} \oplus \Delta T_b \qquad \Delta T_{f\ soln} = T_{f\ solvent} \ominus \Delta T_f$$

elevation

$$= 0 - 14.6 = -14.6\ C^\circ$$

highest IMF

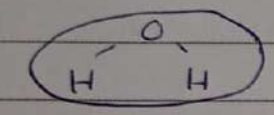
C_2H_6
C_3H_8
C_5H_{12}
C_4H_8

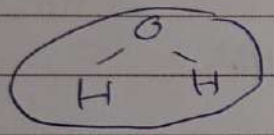
all - non polar
LDF only
M.M ↑ ⇒ LDF ↑

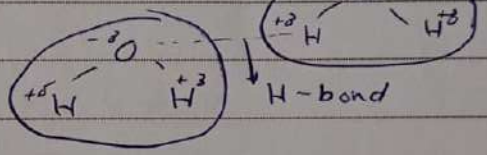
* Define IMF in
1) water

* اذا اول شرطين تحققوا ماخذ دايمن اروح للثالث

LDF + D-D + H-bond







IMF strength

* جدًا مهم تركيز v.important

I-D > H-bond > D-D > LDF ~ صحيح لما اقارن بشكل عام حسب بادئتنا

* Physical properties that depend on IMF

1) Vapor pressure (V.P)
how easy a material can escape from Liquid phase to gas (vapor) phase (be Volatile)
2) boiling point (b.p) & melting point (m.p)

predict V.P deviation in the following

1) soln of H_2O & aceton $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

(LDF, D-D, H-bond) A-A (LDF, D-D) B-B

↓ A+B

LDF
D-D
H-bond

A-B > B-B ⇒ negative deviation

I.M.F ↑ ⇒ V.P ↓

2) H_2O & HCl

A-A (LDF, D-D, H-bond) (LDF, D-D) B-B

↓ A-B

LDF
D-D

A-B < A-A

positive deviation

Molality = $\frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$

molal = $m = \frac{\text{mol}}{\text{kg}}$

a soln of 0.1 m concentration

↓

0.1 molal

or

0.1 mol/kg

$\Delta T \propto m$

$\Delta T = K \cdot m$

$\Delta T_b = K_b \cdot m \cdot i$

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

مثال الاختبار 1

$$Zn_{(s)} + 2HCl \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$$

$T = 25^\circ C = 298\,K$

$V = 9.8\,L$

$P_{Tot} = 745\ torr$

$V.P_{H_2O} = 23.8\ torr$ @ $25C^\circ$

$P_{H_2} = P_{Total} - P_{H_2O}$

$= (745 - 23.8)\ torr = 721.2\ torr \rightarrow atm$

$P_{H_2} = \left(\frac{721.2}{760}\right) atm$

$$n_{H_2} = \frac{PV}{RT} = \frac{\left(\frac{721.2}{760}\right)(9.8)}{0.0821(298)} = 0.38\ mol\ H_2$$

النسبة المولية :

$\approx 0.38\ mol\ Zn$

$\downarrow$ ك.م

$24.86\ g$

$\approx 24.9\ g$