ملخصات

لجنة سنافر البوليتكنك - الاتجاه الإسلامي

اسم المادة

مختبر الكيمياء العامة

بقلم الطالبة :- إسلام العيسة

تواصل معنا

Experiment "1"

* Safety *

* Safety equipments :- أدوات السلامة

[1] Fire extinguisher "طفاية الحريق"
[2] Fire alarm "منبه الحريق"
[3] Fire Blanket "بطانية"
[4] Fire aid cabenit "اسعافات أولية"
[5] Fume hood "الشفاط"
[6] safety shower "دش السلامة"

* Pictograms (labes on stock bottle) التحذيرات

[1] Explosive مادة متفجرة
[2] oxidizing مادة مؤكسدة
[3] Flammable مادة قابلة للإشتعال
[4] Toxic مادة سامة
[5] corrosive مادة كاوية
[6] Irritant مادة مهيجة
[7] Harmful مادة ضارة

حفظ مع الأشكال

* Safety rules :-

[1] Flammable liquids :- "aceton, ether, alcohols" should be heat in water bath not even direct flam.

[2] rxns that produce poisonous gases (غازات سامة) ; should be done in fume hoods.

[3] Do not return unused chemicals into stock bottles. "ما يوضع به المواد"

* Top loading balance " الميزان، ويقرأ إلى حد منزلتين "

Do not weigh cold or hot objects over balance → it give wrong measurment.

* Bunsen Burner :-

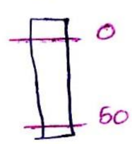
- Blue Flame :- higher temprature → complete combustion (احتراق كامل)
- Yellow Flame :- lower temprature → Incomplete combustion (احتراق غير كامل)

* Glassware equipments :- الأدوات الزجاجية

[1] Beaker  → approximate (تقريبي) volumes (not accurate for measurment).

[2] Conical Flask  → approximate volumes (not accurate for measurment)

[3] Graduated cylinder  → moderatly (باعتدال) accurate for volume measurment.

[4] Burette 

→ Accurate for volume measurments.

[5] volumetric flask  → used to prepare chemical solutions.

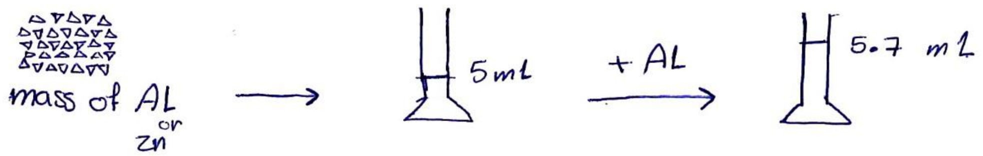
* Exp. 3.

* physical properties *

الكثافة — الذائبية

* Density and Solubility :—

* Density = $\frac{mass}{volume}$

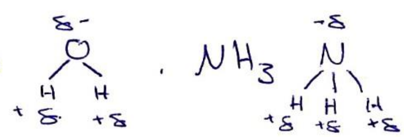


مثلاً

* Solubility :-

المركبات القطبية
* polar compounds

1. H_2O , NH_3



2. Ionic compounds (salts) هي الأملاح
$Na^{+}Cl^{-}$, $K^{+}Cl^{-}$, $Mg^{+}O_2^{-}$

3. Acids and Basses
Acids :- H_2SO_4 , HCl , H_3PO_4
Basses :- KOH , $NaOH$

4. organic compounds having O–H , N–H groubs
C_3H_7OH , CH_3OH , $C_2H_5NH_2$

5. Aceton , ethers

المركبات الغير قطبية
* nonpolar compounds

1. organic compounds المركبات العضوية
CH_4 , C_6H_{12}

2. organic compounds such as :-
$C_7H_{15}OH$, $C_8H_{17}NH_2$

* اذا زاد عدد الكربون عن 5 .
* لا يذوب الكربون في الماء

غير قطبي: CCl_4 , $CHCl_3$ قطبي ضعيف

Like disolve Like

polar - polar : soluble
nonpolar - nonpolar : soluble
polar - nonpolar : insoluble

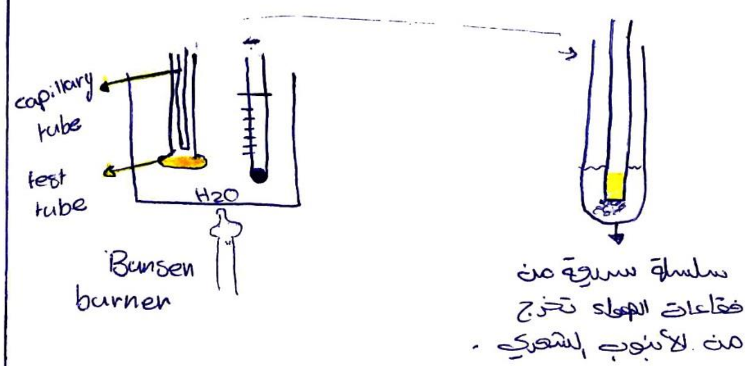
* Melting point and Boiling point :—

درجة الغليان — الضغط البخاري

* Boiling point :— tempreture at which vapor pressure of substance equals the external atmosphere pressure.

قوة الروابط

* As bond strength between molecules increase, B.pt increase thermometer.



P_{ext} = vapor pressure of Liquid.

* Effect of external pressure on B.pt :—

As external pressure increase B.pt increas.

درجة الانصهار

* Melting point :— tempratature at which substance converts from solid

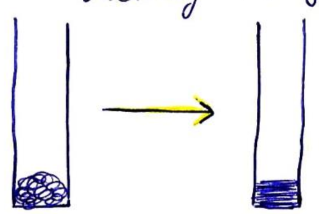
وسيلة للتعرف على المواد

* Melting point is used for identification of substance
* As bond strength between molecules increase, M.pt increase.

* To measure melting point of substance use Capillary tube الأنبوب الشعري

1. Height of sample ≤ 1 cm
2. Sample should be well packed → مرصوصة ما يكون فيها فراغات
3. Avoid rapid heating → تجنب التسخين السريع
4. Thermometer and sample should be at same level.

Melting Range



melting rang :- 110 – 112

Melting rang
- > 5 → impure
- ≤ 5 → pure.

أي يتم تحديد نقاوة المادة من خلال مدى الانصهار.

Impurities effect " تأثير الشوائب "

- ذائبة Soluble
  " decrease Mpt "
- غير ذائبة Insoluble
  " have no effect "
  example :- sand , paper.

Exp 3 أسئلة سنوات سابقة

(1) one of the following is insoluble in CH_3OH :-

a) NH_3 b) H_2O c) H_2SO_4 d) C_6H_6 e) CH_3NH_2

(2) The physical property that increases with increasing atmospheric pressure is :-

a) melting point b) boiling point c) density d) solubility e) mass

(3) CCl_4 dissolved in a certain solvent, this means that the solvent is

a) polar b) Has a high boiling point c) Has high density d) Has a low density e) Nonpolar

(4) If the density of Cu is 8.96 g/cm³, the volume (in cm³) of 1.35 Kg of Cu equals :-

a) 173.0 b) 195.0 c) 217.6 d) 150.7 e) 329.2

(5) The best solvent of CH_3CH_2OH is :-

a) HCl b) HNO_3 c) NaCl d) C_6H_6 e) H_2O

* Exp 4

* water of crystallization *

• الملح المائي •

Hydrated salts (hydrates)

General formula : $MA \cdot x\, H_2O$

MA : anhydrous salt   ملح لامائي

x :- moles of water (in one mole hydrate)   لازم تكون عدد صحيح.
وإذا طلعت معك عشري بقربه

ex :- $CaSO_4 \cdot 2\,H_2O$ → hydrated salts

($CaSO_4$ = anhydrous, 2 = x)

$$CaSO_4 \cdot x\, H_2O \xrightarrow[\text{heat}]{\Delta} CaSO_4 + H_2O \uparrow$$

1 mol ($CaSO_4 \cdot 2H_2O$) ⟷ 2 mol H_2O إذا أعطاني كتلة مركب كامل بستخدمها

or

1 mol $CaSO_4$ ⟷ 2 mol H_2O →   إذا أعطاني كتلة الملح فقط بستخدمها

حالة خاصة من الـ Hydrates

- Alums : double sulfate hydrates

$$M^{+} M^{+3} (SO_4)_2 \cdot x\, H_2O$$

حتى يسمى المركب Alum . لازم أول عنصر أحادي الشحنة ①

② وثاني عنصر ثلاثي الشحنة

* How to find (x) for a hydrated salt ?

ex 8 - $[CuSO_4 \cdot X\, H_2O]$

$$\underset{\substack{\text{الوزن قبل التسخين} \\ 1g}}{CuSO_4 \cdot X\, H_2O} \xrightarrow[\text{heat}]{\Delta} \underset{\substack{\text{الوزن بعد التسخين} \\ 0.6\ g}}{CuSO_4} + H_2O \uparrow$$ بخار.

* moles of $CuSO_4 = \frac{0.6}{159.5} = 3.7 * 10^{-3}$ moles

(M.wt = 159.5 g/mol)

* mass of water = 1 - 0.6 = 0.4 g

* moles of $H_2O = \frac{0.4}{18} = .02 * 10^{-3}$ moles

(M.wt = 18 g/mol)

1 mol $CuSO_4 \longleftrightarrow$ x moles of H_2O

$3.7 * 10^{-3}$ $CuSO_4 \longleftrightarrow 0.02 * 10^{-3}$ H_2O

x = 5.2 ≃ 5 $CuSO_4 \cdot 5H_2O$

$$\% H_2O = \frac{\text{Mass of } H_2O}{\text{Mass of hydrate}} * 100\% = \frac{0.4\ g}{1\ g} * 100\% = 40\%$$

* Exp "5"

* Empirical Formula *

- shows the actual No. of atoms in a compound

ex: C_6H_6

- shows the simplest whole No. ratio of atoms

ex: CH

Molecular formula = (empirical formula)$_n$

n: integer عدد صحيح

* $n = \dfrac{M.wt \text{ of real compound}}{M.wt \text{ of emp. formula}} = 1 \rightarrow$ n = 1 → المركبات الأيونية.

real formula = empirical formula

* How to get empirical formula of Mg_xO_y

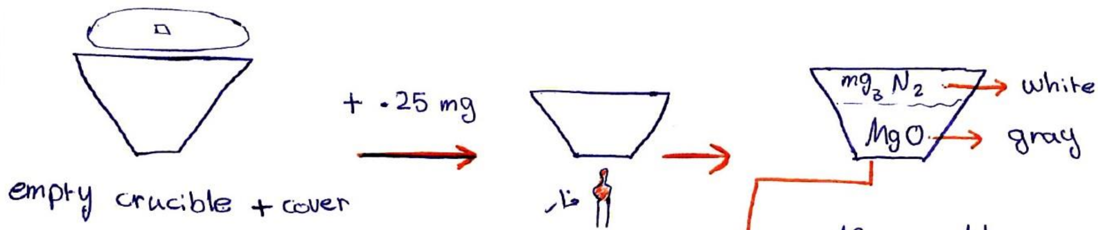
$$\underset{(.25\,g)}{Mg} + \underset{(air)}{O_2} \longrightarrow \underset{(1.1)\,g}{Mg_xO_y}$$

بعد التسخين (1.1) g

[1] mass of Mg → moles of Mg $= \dfrac{.25}{24.3} = 0.013$

[2] mass of "O" → moles of "O" $= \dfrac{1.1 - .25}{16} = 0.053$ mol

[3] Divide by smallest No. نقسم على عدد مولات الأقل



$Mg + N_2 \rightarrow Mg_3N_2$ مهم

(by product)

side rxn تفاعل جانبي

حفظ

$Mg_3N_2 + H_2O \rightarrow Mg_xO_y + NH_3 \uparrow$

ammonia

To get rid of Mg_3N_2 add few drops of water.

* أسئلة سنوات للتجربة "٥" *

1) If 1.216 g of metal "X" is burned with excess amount of oxygen yielding an oxide that weighs 1.60 g. The empirical formula for this metal oxide is (atomic wt of X = 55.0 O = 16 g/mol)

a. XO b. X_3O_4 c. X_2O_3 d. X_2O. e. XO_2

2) During the experiment of determination of the empirical formula of magnesium oxide, the by-product formed is:

a. NH_3 b. Mg_3N_2 c. MgN_2 d. MgO e. MgO_2

3) .46 g sample of nitrogen oxide contains 0.14 g of nitrogen, the empirical formula of this oxide is :-

a. N_2O b. N_2O_4 c. NO_3 d. NO_2 e. NO

4) The empirical formula of a compound is C_6H_{13}. If the molecular weight of this compound is 170, the actual formula of this compound is :-

a. $C_{12}H_{26}$ b. $C_{10}H_{22}$ c) C_4H_{10} d. C_8H_{18} e. C_6H_{14}

* Exp. 6

تحديد الكتلة الجزيئية لسائل متطاير

* Molecular Weight of Volatile Liquid *

* Volatile liquid :- Liquids that have low Boiling points $\leq 80^{\circ}C$
* These liquids vaporize easily (usually flammable) قابلة للإشتعال
* Dumas method (بعد تحويل السائل إلى غاز)

الغاز المثالي
* Ideal gas law :- $PV = nRT$

- P :- pressure of gas (atm)
- V :- volume of gas (L)
- n :- no. of moles of gas $= \frac{mass}{M.wt}$
- R :- 0.0821 atm.L / mol.k
- T :- temprature of gas in (kelvin)

$$n = \frac{mass}{M.wt}$$

$$M.wt = \frac{m \cdot R \cdot T}{P \cdot V}$$ where (m) :- كتلة الغاز

* عند تغطية الـ Flask بورق الالمنيوم نعمل ثقب صغير حتى يكون :-
الضغط الخارجي = الضغط الداخلي

$760\ mmHg = 1\ atm$

$1\ L = 1000\ mL$

$T(K) = T(C^{\circ}) + 273$

Exp .7.

* Acid - Base Tirration * المعايرة

* Vinegar الخل Solution contains acetic acid (CH_3COOH)
* In this experiment we'll Find concentration of CH_3COOH in Vinegar, by performing a neutralization حمض وقاعدة reaction.

* In tirration technique, we should react the unknown concentration solution, with a solution of known molarity which is called titrant.

* In this experiment 8→

weak acid حمض ضعيف ↑ strong Base قاعدة قوية ↑

$$1\,CH_3COOH + 1\,NaOH \longrightarrow 1\,CH_3COONa + 1\,H_2O$$

(in vinegar) (in Burette) titrant (0.1M)

* when rxn is complete 8→

$$moles_{(CH_3COOH)} = moles\ (NaOH)$$

$$= M * V\,(L)$$

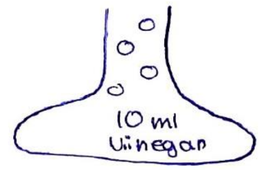
$$= 0.1\ (V_f - V_i)$$

* To Find concentration of CH_3COOH in vinegar we ~~we~~ should use an (indicator) كاشف here it is phenolphthellein (weak acid) حمض الاساس (حمض)

* Steps :

[1] read Vi of NaOH

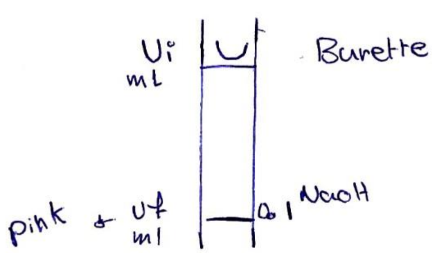
[2] add 9 ml water to 1 ml concentrated vinegar to get → 10 ml diluted (مخفف) vinegar



[3] add 4 drops (قطرات) of phenolphthalein

[4] start titration with 0.1 M NaOH soln until color changes from colorless to pink : this is the end point so read Vf.

* At the end →
  - rxn is complete
  - moles of NaOH = moles of CH_3COOH
  - color changes from colorless to pink.



phenolphthalein:
- colorless (Acidic medium) وسط حمضي
- pink (Basic)

* molarity of CH_3COOH = $\frac{\text{moles of } CH_3COOH}{V \text{ of vinegar}}$

* % CH_3COOH = $\frac{\text{mass } CH_3COOH}{\text{mass of vinegar}} \times 100\%$

* أسئلة سنوات للتجربة "7" *

1. A 2.0 mL of vinegar sample was titrated with 0.135 M NaOH solution, if it required 15.4 mL of NaOH to reach the end point, the CH_3COOH in vinegar solution equals :-

a) 8 %   b) 4 %   c) 6%   d) 4.5%   e) 5%

2. which of the following statements is correct concerning the experiment of vinegar analysis

a- At the end point the color changes from pink to colorless

b- The indicator used is pink in the acidic medium.

c- The titrant NaOH is filled in the burette.

d- The indictor is methyl orange

e- At the end point, moles of acetic acid > moles of NaOH

3. A 2.0 mL sample of vinegar solution diluted to 20.0 mL required 40.0 mL of 0.09 M NaOH solution. The mass of acetic acid (in g) in 2.0 L of this vinegar is :-

~~a) 8667~~   ~~b) 480~~   ~~c) 0.867~~

a) 13.5   b) 18.9   c) 16.2   d) 216.0   e) 189.0

4. The mass (in grams) of water in 47.4 g of $KAl(SO_4)_2 \cdot 12H_2O$ equals :   a) 2.16   b) 21.6   c) 0.216   d) 216   e) 4.16

* Exp "8"

* Redox titration *

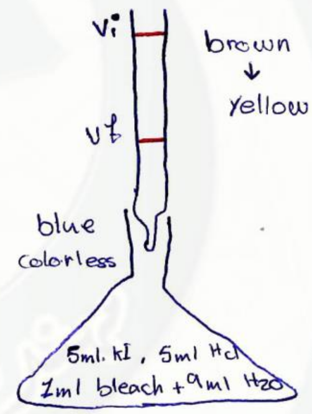
* Bleach analysis :-

[1] Molarity = $\frac{\text{moles solute (NaCl)}}{\text{V soln (Bleach)}}$

[2] % NaCl = $\frac{\text{moles NaCl}}{\text{mass of bleach soln}}$ x 100 %

d Bleach = 1.08 g/mL

V Bleach = 1 mL



* procedure :-

[1] To a clean conical flask add 1 mL bleach + 9 ml H_2O + 5 mL KI + 5mL HCl → a brown colored soln.

[2] place the brown soln in dark to avoid photo-oxidation (For 5 minutes)

[3] Fill the burette with $Na_2S_2O_3$ (0.1 M) read vi .

[4] Start titration with Na_2SO_3 until, brown turns to yellow, stop titration and add starch a blue color should appear.

[5] Continue titration until you reach the end point blue to colorless (white), then read (Vf)

moles Na_2SO_3 → moles I_3^- → moles OCl^-

* In this experiment we will analyze sodium hypochlorite NaOCl in 1 ml bleach sample ($NaOCl = OCl^-$)

* Indirect titration will be done
Titrant filled in burette : $Na_2S_2O_3 \equiv S_2O_3^- = 0.1\,M$

* Indicator is starch (نشا)
* volume of bleach = 1 ml
mass of bleach = d * v = 1.08 * 1 = 1.08 g

* moles of $S_2O_3^{-2}$ = M * V = 0.1 M * (Vf - Vi) L.
* moles of NaOCl = $\frac{1}{2}$ moles $S_2O_3^-$

Exp 9..

Thermodynamics (Heat of dissociation)

* Heat of reaction (at constant pressure) : ΔH
* Enthalpy of reaction (ΔH) is determind by cup-calorimeter

* ΔH rxn
  - → (-ve) :- exothermic rxn
  - → (+ve) :- endothermic rxn

* To determine ΔH of rxn, you should determine (q) First. (q rxn)

  q = mass * specificheat * Δt

or q = heat capacity * Δt

* $q_{rxn} = -q_{sur}$

* Reactions in this experiment, contain solutions so we will use a cup calorimeter.

  $q_{cup} = 0$

  and so $q_{surr} = q$ (new soln)

* Reaction (1) :- $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O$

  $OH^- + H^+ \rightarrow H_2O$ $\boxed{\Delta H_1}$

* Reaction (2) :- $NaOH + CH_3COOH \rightarrow CH_3COO^- Na^+ + H_2O$

  $\boxed{\Delta H_2}$ $OH^- + CH_3COOH \rightarrow CH_3COO^- + H_2O$

Reaction (1)

$NaOH + HCl \longrightarrow NaCl + H_2O$

(25 ml, 2 M) (25 mL, 2 M)

1. weigh empty cup (cup (1))
2. add 25 mL (2 M NaOH) in cup (1)
3. take another cup (cup (2)) and add in it 25 mL (2M) HCl.

• Note :- moles of NaOH = $M * V_L$ = $2 \times 25 \times 10^{-3}$ = 0.05 mol

moles of HCl = $M * V_L$ = $2 \times 25 \times 10^{-3}$ L = 0.05 mol

• moles of NaCl = mole of H_2O = 0.05 mol

من المعادلة الموزونة

4. Take ti (initial temp) which represents temp of NaOH, and HCl (average temp)
5. add HCl to NaOH (cup (1)) , and read the maximum temperature after rxn (tf = tmax)
6. Weigh cup with NaCl solution and substract mass of cup to get mass of new solution

[7] make steps (1), (2), (3)

- $q_{surr} = q(NaCl_{soln}) = \underset{g}{mass} * \underset{4.184\ J/g.C°}{sp.ht} * \underset{C°}{(tf - ti)}$

IF Δt : +ve → q_{surr} : +ve

IF Δt : -ve → q_{surr} : -ve

- $q_{rxn} = -q_{surr}$ (J → kJ)
- $\Delta H_1\ (kJ/mol_{H_2O}) = \dfrac{q_{rxn}}{n_{H_2O}}$

* Reaction (2)

Repeat steps (1) to (7) done for rxn (1) but replace the acid (HCl) by (CH_3COOH)

- note : in step (7)

$q_{surr} = q(CH_3COO^-Na_{soln}) = mass * \underset{3.95\ J/g.c°}{sp.ht} * \Delta t$

~~q surr = q (CH3C~~ new soln is sodium actetate solution

- Finally apply Hess's law on rxn (1) and (2) to Find ΔH_{diss} of CH_3COOH

$\Delta H_{diss} = \Delta H_2 - \Delta H_1$

• Reaction (3) : dissociation reaction

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+ \qquad \Delta H_3 = \Delta H_{diss}$

we will apply Hess's law on rxn (1), and rxn (2) to find value of ΔH_3 (ΔH_{diss})

$OH^- + H^+ \longrightarrow H_2O \qquad (\Delta H_1)$

$OH^- + CH_3COOH \longrightarrow CH_3COO^- + H_2O \qquad (\Delta H_2)$

$\Delta H_{diss} = -\Delta H_1 + \Delta H_2$

$- \quad H_2O \longrightarrow OH^- + H^+ \qquad (-\Delta H_1)$

$OH^- + CH_3COOH \longrightarrow CH_3COO^- + H_2O \qquad (\Delta H_2)$ +

$CH_3COOH \longrightarrow CH_3COO^- + H^+$ =

كيف نجد قيم ΔH_1 و ΔH_2 ؟

1. $q_{surr} = q_{new\ soln} = (mass \times sp.ht \times \Delta t)_{new\ soln}$
2. $q_{rxn} = -q_{surr}$ ($J \rightarrow kJ$)
3. ΔH_{rxn} (kJ/mol) $= \dfrac{q_{rxn}}{n}$

n : no. of moles of any reactant or product.

Exp "10"

* Thermodynamics (2) *
(Heat of formation of MgO)

- In this experiment, we will apply Hess's law on three equations, to find ΔH_f (MgO)

- Reaction : $Mg_{(s)} + H_3O^+_{(aq)} \longrightarrow Mg^{+2}_{(aq)} + H_2O_{(l)} + H_{2(g)}$
- rxn (2) : $Mg_{(s)} + 2H_3O^+_{(aq)} \longrightarrow Mg^{+2}_{(aq)} + 3H_2O_{(l)}$
- rxn (3) : $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$

ΔH_1, ΔH_2 are to be determined by calculating

$q_{surr} \longrightarrow q_{rxn} \longrightarrow \Delta H_{rxn}$

ΔH_3 for rxn (3) = -286 KJ

- To get ΔH_f of MgO :

$Mg_{(s)} + \frac{1}{2}O_{2(g)} \longrightarrow MgO_{(s)}$

$$\boxed{\Delta H_f = \Delta H_1 - \Delta H_2 + \Delta H_3}$$ مهم

لإيجاد (ΔH_1) و (ΔH_2) يجب عمل التجربة بنفس طريقة تجربة (9)

using a cup calorimeter.

- rxn (1) $Mg_{(s)} + H_3O^+ \rightarrow Mg^{+2} + H_2O + H_2$

  - Mg ↓ 0.1 g
  - H_3O^+ ↓ 25 m, 0.5 M (HCl soln)
  - Mg^{+2} ↓ $MgCl_2$ Solution (new soln)

- moles of Mg = $\frac{mass}{At.wt} = \frac{0.1}{24.3} =$

- t_i = temp of HCl befor rxn.
- t_f = t maximum after mixing.
- mass of $MgCl_2$ solution → وزن المحلول الجديد بعد الخلط (أي بعد التفاعل)

- specific heat of solution ($MgCl_2$ solution) = 4.07 J/g·c°

1. $q_{surr} = q_{(MgCl_2\ soln)}$ = mass * specific heat * Δt ($t_f - t_i$)
2. $q_{rxn} = -q_{surr}$ (J → kJ)
3. ΔH_{rxn} (kJ/mol Mg) = $\frac{q_{rxn}}{n_{mg}}$ = -----

- rxn (2)

$MgO_{(s)} + H_3O^+_{(aq)} \rightarrow Mg^{+2} + H_2O$

  - MgO ↓ 0.2 g MgO
  - H_3O^+: 25 mL, 0.5 M (HCl sol)
  - Mg^{+2} ↓ $MgCl_2$ solution (new soln)

- moles of MgO = $\frac{mass}{M.wt} = \frac{0.2}{40.3}$

- t_i = temp of HCl befor rxn

- $t_f = t_{max}$ after mixing
- mass of $MgCl_2$ solution → محلول المحلول الجديد بعد الخلط (أي بعد التفاعل)
- specific heat of solution = 4.07 J/g.C° ($MgCl_2$ solution)

[1] $q_{surr} = q(MgCl_2 \text{ soln}) = \text{mass} * \text{sp.ht} * \Delta t$

[2] $q_{rxn} = -q_{surr}$ (J → kJ)

[3] ΔH_{rxn} (kJ/mol MgO) $= \frac{q_{rxn}}{n_{MgO}}$

* Exp "11"

* Chemical Kinetics *

Kinetics of reaction means rate of rxn.

Rate of rxn depends on the following factors :-

1. Temperature : As "T" increase, rate of rxn increase.
2. presence of catalysts : catyists usually speed up reactions (وجود عامل مساعد)
3. Nature of reactants.
4. concentration of reactants : rate usually increase as concentration of reactants increase.

$$\text{Rate of rxn} = \frac{[A]_f - [A]_i}{t_f - t_i}$$ when "A" is a reactant

السرعة تمثل تغير تركيز إحدى المواد المتفاعلة أو الناتجة بالنسبة للزمن
(وحدة السرعة هي M/s) وهي موجبة دائماً.

Example : For the rxn

$$2A + \frac{1}{2}B \rightarrow C + 3D$$

rate of rxn represents :

rate of disappearance (consumption) of A

$$= \frac{-\Delta[A]}{2\Delta t} \quad (M/s) \text{ or } (mol \cdot L^{-1} \cdot s^{-1})$$

كذلك سرعة التفاعل السابق يمكن تمثيلها بأكثر من طريقة :-

$$\text{rate of rxn} = \left(\text{rate of disappearance of B}\right) = \frac{-2\Delta[B]}{\Delta t}$$

سرعة اختفاء B

or

$$\text{rate of rxn} = \left(\text{rate of formation appearance of C}\right) = \frac{+\Delta[C]}{\Delta t}$$

سرعة ظهور (C)

or

$$\text{rate of rxn} = \left(\text{rat of formation of D}\right) = \frac{\Delta[D]}{3\Delta t}$$

سرعة تكوين (D)

So : rate of rxn =

$$\frac{\Delta[A]}{2\Delta t} = \frac{-2\Delta[B]}{\Delta t} = \frac{\Delta[C]}{\Delta t} = \frac{\Delta[D]}{3\Delta t}$$

* rate is always positive.

example : rate of formation of "D" $= \frac{(\text{rate of A}) \times 3}{2}$

Rate law : rate law correlates rate of rxn to concentration of reactants.

For the previous reaction

$$Rate = k [A]^n [B]^m$$

k : rate constant ثابت السرعة

n : order of reaction with respect to "A" رتبة التفاعل بالنسبة للمادة (A)

m : order of reaction with respect to "B" رتبة التفاعل بالنسبة للمادة (B)

overall order of rxn = n + m الرتبة الكلية

ملاحظات هامة :-

- n, m could equal zero, integer, fraction.
- unit of "k" depends on overall order of rxn.
- orders of rxn is not necessarily equal to coefficients of the balanced equation.

example : For the previous rxn

$n \neq 2$ $m \neq \frac{1}{2}$

- n, m are evaluated experimentally تحدد قيمها بالتجربة

In this experiment, you should evaluate (determine) orders of reaction, and value of "k" for a certian reaction.

The reaction is :-

$$H_2O_2 + 2I^- + 2H^+ \rightarrow I_2 + 2H_2O$$

This rxn is a redox rxn, in which :

H_2O_2 : is the oxidizing agent.

I^- : is the reducing agent.

H^+ : represents a buffer solution which has a constant concentration of $[H^+]$ (pH is constant) → For a buffer solution.

Now : rate law of the above rxn is

$$Rate = k [H_2O_2]^n [KI]^m [H^+]^x$$

because (H^+) represents a buffer solution, in which $[H^+]$ is constant, so we can say that $x = 0$, because $[H^+]$ will not affect the rate of reaction.

so rate law will minimize to :-

$$Rate = k [H_2O_2]^n [KI]^m$$

* How to find n, m, K (experimentally) *

* لتحديد قيم الرتب، وثابت السرعة، يجب عمل نفس التفاعل أكثر من مرة بحيث نثبت تركيز أحد المتفاعلات وتغيير الآخر.

* في كل مرة نحسب الزمن، وذلك لنحسب من خلاله السرعة.

* سيتم حساب السرعة من خلال $(S_2O_3^{-2})$

(1) $H_2O_2 + I^- + H^+ \longrightarrow I_2 + H_2O$

(2) $I^- + I_2 \longrightarrow I_3^-$

(3) $I_3^- + 2S_2O_3^{-2} \longrightarrow S_4O_6^{-2} + 3I^-$

* التفاعلات السابقة سيتم عملها في نفس اللحظة لحساب الزمن اللازم لظهور اللون الأزرق.

$[S_2O_3^{-2}]_i = 0.001\ M \rightarrow t_i = 0$

$[S_2O_3^{-2}]_f = \text{zero} \rightarrow t_f = \text{time for blue color}$

$$\text{rate of rxn (3)} = \frac{\text{rate of } S_2O_3^{-2}}{2}$$ ← مهم

$$= \frac{[S_2O_3^{-2}]_f - [S_2O_3^{-2}]_i}{2(t_f - t_i)}$$

rate of rxn (3) = rate of rxn (2) = rate of rxn (1)

so rate of our redox rxn (rxn (1)) =

$$\frac{[S_2O_3^{-2}]_f - [S_2O_3^{-2}]_i}{2(t_f - t_i)}$$ → مهم جداً

* ماذا يحدث في الدورق حتى يظهر اللون الأزرق ؟

عند خلط مكونات التفاعلات السابقة (١)، (٢)، (٣)

مع (starch)، يظهر لدينا محلول شفاف طوال الوقت ، وبعد

زمن معين ، يتغير اللون إلى الأزرق ، وذلك لأن تركيز ($S_2O_3^{-2}$)

أصبح صفراً (أي استهلك بالكامل) وعندما يستهلك فإن I_2

تتحد مع النشا (starch) ليكون مركب معقد لونه أزرق (I_2 - starch)

* (I_2 - starch complex is blue colored)

* الان بعد حساب الزمن اللازم لظهور اللون الأزرق يمكننا حساب

سرعة التفاعل (١)

$$\text{rate of rxn (1)} = \frac{[S_2O_3^{-2}]_f - [S_2O_3^{-2}]}{2\,(t_f - t_i)}$$

$[S_2O_3^{-2}]_f = 0$ → لأنه استهلك بالكامل

$[S_2O_3^{-2}]_i = 0.001$ → وقد تتغير القيمة حسب السؤال

$t_i = 0$ → الوقت عند بداية التفاعل

t_f = blue color appearance time

* الجداول صفحة (٦٤) لحساب n, m, k

لحساب الرتب نقسم اي خطوتين على بعض

مثال ٤ ←

Trial no	$[H_2O_2]$ (M)	[KI] (M)	time (s)	Rate M/s
(1)	0.02	0.03	125	4×10^{-6}
(2)	0.02	0.015	500	1×10^{-6}
(3)	0.04	0.015	62.5	8×10^{-6}

$$Rate = k\,[H_2O_2]^n\,[KI^-]^m$$

To Find (m) → order of KI :

divide trial (1) by trial (2)

$$\frac{rate\ (1)}{rate\ (2)} = \frac{k\,[0.02]^n\,[0.03]^m}{k\,[0.02]^n\,[0.015]^m} = \frac{4\times10^{-6}}{1\times10^{-6}}$$

$$(2)^m = 4$$

$$m = 2$$

To get (n) → order of H_2O_2 :

divide trial (3) by trial (2)

$$\frac{rate\ (3)}{rate\ (2)} = \frac{k\,(0.04)^n\,(0.015)^m}{k\,(0.02)^n\,(0.015)^m} = \frac{8\times10^{-6}}{1\times10^{-6}}$$

$$(2)^n = 8 \rightarrow n = 3$$

* To Find (k) use any trial 1, 2, or 3

$Rate = k\,[H_2O_2]^3\,[KI]^2 \longrightarrow$ (K) عوض في معادلة لإيجاد

To find activation energy of reaction (Ea)
طاقة تنشيط التفاعل

$$\ln\left(\frac{K_2}{k_1}\right) = \frac{-Ea}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$ (مهم)

* $R = 8.314$ J / mol . k (ثابتة)
* T_1 : low temp (kelvin) ← k_1
* T_2 : higher temp (kelvin) ← k_2
* Ea : activation energy : (J / mol)

في الجدول صفحة (٦٤) المحاولة الأخيرة هي عند درجة حرارة منخفضة T_1 (أقل من درجة حرارة الغرفة) وقمنا بعمل المحاولة الاخيرة للحصول على قيمة لثابت السرعة (k_1). حيث أن (k_2) هي قيمة ثابت السرعة عند درجة حرارة الغرفة (T_2)

إذن نحن هنا حصلنا على ← k_1 at T_1, k_2 at T_2
وذلك لنحسب قيمة طاقة تنشيط التفاعل.

Arrhenius equation .

$$\ln A = \ln k - \frac{Ea}{RT}$$ to find "A"

Arrhenius constant

في هذه العلاقة عليك تعويض (k_1 , T_1) أو (K_2 , T_2)
والأفضل تعويض (K_2 , T_2) للحصول على قيمة أدق لثابت أرهينيوس (A)