لجنة الهندسة الكهربائية | الجامعة الهاشمية

تلخيص

Chemistry Lab

إعداد : نمر عودة

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/groups/Electricals4You

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There is no quiz for the exp.

Exp4 Tests For Cations and Anions

* المطلوب من هذه التجربة هو فقط التكوين أدناه .
* المعادلات ليست حفظ لكن المطلوب أسماء المركبات وكيفية الكشف . والكواشف ولون الناتج والوسط الموضوع فيه فقط .

Cations →

[1] Ca^{+2} , Calicium test

$Ca(NO_3)_2 + Na_2C_2O_4 \rightarrow CaC_2O_4 + NaNO_3$

Calicium Nitrate — Sodium Oxalate — Calcium Oxalate (white ppt.)

[2] Fe^{3+} , Ferric test

$Fe_2(SO_4)_2 + KSCN \rightarrow K_2SO_4 + Fe(SCN)_2^{+3}$

Iron Sulfate — Potassium thiocayanate — red. Sol.

[3] NH_4^+ ammonium test

$NH_4NO_3 + NaOH \xrightarrow{\Delta} NaNO_3 + NH_4OH$

ammonium nitrate — وسط قاعدي Basic — convert red litmus to blue.

Anions →

[1] SO_4^{-2} (sulfate test)

$Na_2SO_4 + HCl + BaCl_2 \xrightarrow{\text{shaking gently}} NaCl + Ba(SO_4)_2$

Sodium sulfate — Acidic وسط حامضي — Barium Chloride — white ppt.

[2] HCO_3^- - test

$NaHCO_3 + HCl \rightarrow H_2CO_3 + NaCl$

Sodium hydrogen Carbonate — وسط حامضي

$H_2O + CO_2 \uparrow$ (Air bubbles)

[3] Test of Cl^- , Br^-

Sodium Chloride $NaCl + HNO_3 + AgNO_3 \rightarrow AgCl$ → white ppt.

" Bromide $NaBr + HNO_3 + AgNO_3 \rightarrow AgBr$ → yellow or Pale ppt.

وسط حامضي — Silver nitrate

Exp6:- Molar mass of a volatile liquid.

⇒ In this exp. we will compute the Molar Mass using:-

$PV = nRT$

$PV = \frac{mass}{M.M} RT$ ⇒ P = atmospheric pressure (atm) ⇒ 1 atm = 760 mmHg = 760 torr = 101.325 Kpa

V = Volume of Vapor (L) ⇒ 1L = 1000 mL. ← المذيب

n = number of moles = $\frac{mass\ (g)}{M.M\ (g/mol)}$ ← المذاب

R = gas Constant = 0.0821 [atmL / K.mol.]

T = temperature of boiling water K°

$K° = C° + 273$

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1) Calculation part:- تعويض مباشر في القانون مع مراعاة إستخدام الوحدة المذكورة في القانون أعلاه.

ExA1) A flask weighs 40.1305g when clean, dry, evacuated, 138.2410 g when filled with water (density = 0.9970 g/mL) and 40.2487g when filled with a gaseous substance at 470.4 torr and 96° C. What is the Molar mass (g/mol) of the gas? [R = 0.0821 L.atm/mol.k]

Solution ⇒ $PV = \frac{mass}{M.M} RT$

$P(atm) = 470.4\ torr \times \frac{1\ atm}{760\ torr} = 0.61895\ atm.$

$V_{(L)}$ (water) = $\frac{mass\ water}{density}$ ⇒ Mass water = Mass flask filled with water − Mass empty flask

= 138.2410 − 40.1305

= 98.1105 g

$V = \frac{98.1105\ g}{0.9970\ g/mL} = 98.4057\ mL = 0.0984057\ L.$

Mass (g) للمادة = Mass flusk with substance − Mass empty flusk

(gaseous Substance)

= 40.2487 − 40.1305 = 0.1182 g.

R = 0.0821

T = 96 + 273 = 369 K

⇒ Now:- $PV = \frac{mass}{M.M} RT \Rightarrow M.M = \frac{mass.R.T}{PV}$

$= \frac{(0.1182)(0.0821)(369)}{(0.61895)(0.0984057)}$

= 58.79 g/mole

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* We Can rearrange the equation to calculate density:-

$PV = \frac{mass}{M.M} RT \Rightarrow \frac{P.(M.M)}{RT} = \frac{Mass}{Volume} \Rightarrow D = \frac{P(M.M)}{RT}$

D: Density (g/L)

PRE LAB :-

1) For which of the following compounds can we determine it's molar Mass using the method described in this experiment? Give reasons. Benzene (b.p. 78°C), Glycerol (b.p. 180°C)

Solution → دايمًا بنختار المادة اللي درجة غليانها أقل من الماء عشان تتبخر قبل ما [redacted] يتبخر الماء.

Benzene (78°C) because it's boiling pt lower than water.b.p.

2) A cylinder contains compressed hydrogen gas and the mass of the hydrogen is 20 g. What mass of oxygen would be contained in an identical cylinder at the same temperature and pressure?

Solution →

since the cylinder is identical ⇒ $V_O = V_H$

using avogadro's principle: $\frac{n_H}{V_H} = \frac{n_O}{V_O} \Rightarrow n_H = n_O$

$$n_H = 20\,g \times \frac{1\,mol}{1\,g} = 20\,mol = n_O$$

$$\text{mass } O = 20\,mol \times \frac{16\,g}{1\,mol} = 320\,g$$

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2) procedure part :-

- why should the Erlenmyer flask be dry?

→ to avoid changing the mass of the substance.

- why we should make a small hole through the aluminum foils? to avoid the explosion of the flusk.

- Does it effect if we change the quantity of the water? No, M.M is independent on the quantity of the water

يعني لو مكاي كان عندي 5mL من الماء و هادو 10mL بيختلف اشي؟

الجواب لا، لأني ما باخذ الحجم من الماء الموجود، بستناه ليتبخر و بس

يخلص تبخر باخذ حجم البخار ولس السائل.

- Why we are putting a few boiling stones (boiling chips) in the liquid? to decrease the bubbles of the boiling so we can avoid explosion.

- why should we heat the beaker slowly?

To avoid fast evaporation (عشان ما نخلص المادة بسرعة

وبالتالي ما تتم عملية ال vaporization كاملة.

- why should we dry the outside of the aluminum foil completely, after finish heating?

To have an accurate reading of the mass.

Questions:-

Q1) Describe the effect of the following factors (whether increase, decrease, or has no effect) on the calculated molar mass of the volatile liquid.

a- If the flask was not dried well before the weighing.

a- decrease ~~b- increase~~ c- No effect.

$M.M = \frac{Mass}{PV} . RT$ ⇒ was not dried well ⇒ mass ↑ ∴ M.M ↑

b- If the volume of the flask is bigger than the recorded volume.

يعني V المحسوبة أقل.

V ↓ , M.M ↑

~~a- increase~~ b- decrease c- No effect.

c- If the temperature of the boiling water was mistakenly less than the true value.

a- increase ~~b- decrease~~ c- No effect.

T ↓ , M.M ↓

d- If the density of the volatile liquid was mistakenly greater than the true value.

$M.M = \frac{D}{P} RT$, D ↑ , M.M ↑

~~a- increase~~ b- decrease c- No effect.

Q2) what is the mass of vapor of volatile liquid (M.Wt. = 85 g/mol) which completely fill a 184 ml flask at 94.0° C and 675.0 torr ?

a- 0.211 g b- 0.632 g ~~c- 0.461 g~~ d) 0.344 g.

Solution ⇒ $Mass = \frac{PV M.M}{RT} = \frac{(\frac{675.0}{760})(0.184)(85)}{0.0821(94+273)} = 0.461 g$

Exp 8:- Colligative properties:- Molar Mass Determination.

Objective:- To determine the molar mass of a non-Volatile, non electrolyte by observing the difference between the freezing points of a solvent and a solution.

non-Volatile → غير متطايرة , non-electrolyte → غير متفككة.

→ when we add a non-Volatile Solute to a Solvent it changes the physical properties of the Solvent:-

1) freezing pt (f.p) → decreasing (Freezing pt depression) انخفاض
2) Boiling pt (B.p) → increasing (Boiling pt elevation) ارتفاع
3) Vapor pressure (V.P) → decreasing (Vapor pressure Lowering) انخفاض

⇒ Freezing pt depression, Boiling pt elevation & Vapor pressure Lowering are called Colligative properties.

⇒ And they are governed by number, rather than type يعني دائما Quantitive يعتمد على الكمية وليس على النوع.

$$\Delta T_f = K_f\, m = K_f \cdot \frac{(g\ mass_{solute})}{M.M_{solute} \cdot kg\ Solvent} = \frac{K_f * \text{وزن المذاب بالغرامات}}{\text{وزن المذيب بالكغ} \times \text{مولالية المحلول}}$$

$$\Delta T_b = K_b\, m$$

Freezing pt depression تعتمد التجربة دج تركز على أكثر من Boiling pt elevation.

⇒ K_f and K_b are the molar Freezing pt and boiling pt constants for the Solvent. (Given)

⇒ m: molality = $\frac{\text{moles Solute (mole)}}{\text{mass Solvent (Kg)}}$

* If we have an electrolyte solute → مذاب يتفكك
we will have a Van't hoff factor (i) → معامل التفكك.
which Leads to:- for non electrolyte $i = 1$.

$\Delta T_f = i\, K_f\, m$ ⇒ بمعنى لو كانت المادة متفككة يعني إنو الفرق في درجة الحرارة (الانخفاض) يزداد.

* لازم نميز بين درجة الحرارة T_f وبين الانخفاض في درجة الحرارة ΔT_f

$T_{solution} \leftarrow \Delta T_f$

$\Delta T_f = T_i - T_f$ ⇒ ازدياد الانخفاض في درجة الحرارة ⇒ ΔT_f ↑ ⇒ T_f ↓ يعني النقصان في درجة الحرارة النهائية

$T_{solvent} \leftarrow$

Pre Lab:-

1) Students prepared two cyclohexane solutions having the same mass of solute. However student 1 used 13 g of cyclohexane, student 2 used 15 g. which student will observe the larger freezing pt. change? Explain

$$\Delta T_f = K_f \frac{\text{Mass (Solute)}}{M.M\ (\text{Mass Solvent})}$$

كلما زادت نقل ΔTf ← نسبة

$$\Delta T_f \text{ Student 1} > \Delta T_f \text{ student 2}$$

Since Mass solvent 1 < Mass solvent 2.

2) A 0.597 g sample of a non-electrolyte dissolves in 20.0 g of cyclohexane. The freezing point depression is 3.62 °C. What is the molar mass of the non-electrolyte? (K_f for cyclohexane is 20.0 °C Kg/mol).

Solution →

$$\Delta T_f = i K_f \frac{\text{mass solute (g)}}{M.M \text{ solute} \times \text{Mass Solvent (kg)}}$$

$$M.M = \frac{20 \times 0.597}{3.62\ (20 \times 10^{-3})} = 164.92 \text{ g/mol}$$

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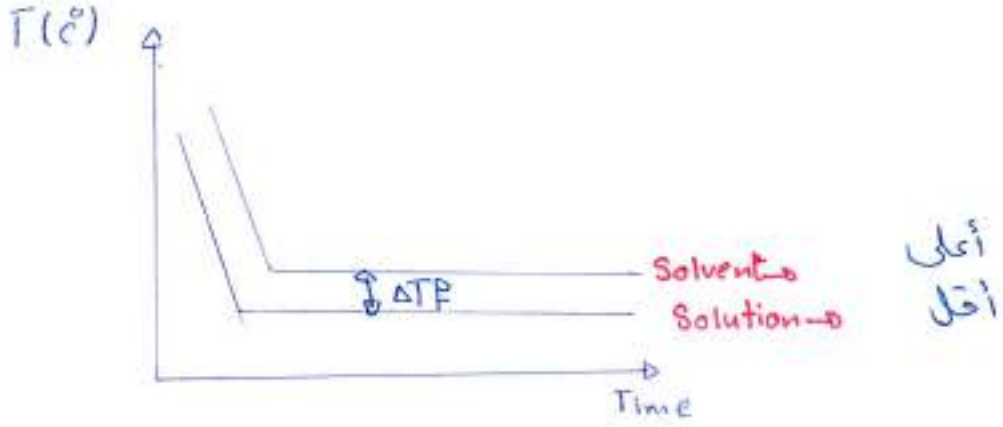
i for some Solutes:- NaCl → i = 2
$MgCl_2$ → i = 3
$AlCl_3$ → i = 4

Procedures part:-

- Why should we Keep Moving the solution when it freezes?
  To avoid Super Cooling. عشان ما تنخفض درجة الحرارة كثير.
- Cooling curve :- freezing pt depression as a function of time.
- The temperature remains constant at the freezing pt. untill the freezing is almost complete..



Post Lab:-

1) If the solution's freezing pt is erroneously read 0.2°C lower than it should be, will the unknown's calculated molar mass be too high or too low? Explain!

Solution ⇒ $\Delta T_F = T_{solven} - T_{solution} = \frac{K_f \text{ mass solute}}{M.M \text{ solute} * \text{mass solvent}}$

$T_{solution} \downarrow \Rightarrow \Delta T_f \uparrow$

$\Delta T_f \uparrow \Rightarrow M.M \downarrow$ ∴ Molar Mass will decrease.

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2) How will the freezing pt. change of cyclohexane be affected (compared with the freezing pt. chang by a non-Volatile, non-associating and non-dissociating solute) by:-

(a) A non-Volatile solute that dissociates? Explain!

Solution ⇒ $\Delta T_f = i\, K_f\, m$ ⇒ $i \uparrow \Rightarrow \Delta T_f$ increase.

(b) Two solutes that react according to the equation.

$A + B \rightarrow C$? Explain!

1 1 1

$i=2$ $i=1$ ⇒ هون صار ترابط كانت $i=2$ صارت $i=1$

$\Delta T_f = i K_f m$ ⇒ $i \downarrow \Rightarrow \Delta T_f$ decrease.

3) If some solute adheres to the test tube's wall in Part B.1, is the freezing point change greater or less than it should be? Explain!

في التجربة لما صطينا المذاب عشان يذوب و نقيس درجة التجمد بيسألني إذا التصق جزء من المذاب شو رح يأثر على مقدار الانخفاض؟

Solution → $\Delta T_f = \frac{i K_f (\text{Mass solute})}{M.M\ (\text{Mass solvent})}$ ⇒ Mass solute ↓ ∴ ΔT_f will decrease. (Be less than it should be).

* ما بنسى نميز بين ΔT_f و T_f.

Questions:-

Which statements of the following statements are T and which of them are F?

1- (T) If the test tube contains an insoluble impurity, then the calculated Molar Mass will be no effected.

لأنه

$\Delta T_f = \frac{i K_f \times \text{Mass}_{solute}}{M.M \times \text{Mass Solution}}$

هون بس بحسب الكتلة اللي ذابة اللي ما ذابت ما إلي فيها.

2- (T) If the thermometer reading is always 1.5 c° higher than the correct temperature, the calculated Molar Mass will be not effected.

لأنه رح تقرأ 1.5 أعلى لما أقيس المذيب لحال و 1.5 أعلى لما أقيس المحلول لما أخذ الفرق رح يطلع صح بعض المشكلة لو اختلف القراءة عند وحدة فتهم بس.

3- (F) The freezing pt of the solution had been incorrectly read 0.6 °C higher than the true freezing pt, the calculated Molar Mass will be lower than actual..

$\Delta T_f = T_{solvent} - T_{solution}$

$T_{solution} \uparrow \rightarrow \Delta T_f \downarrow$

$\Delta T_f = \frac{K_f \cdot \text{mass(g)}}{M.M \quad \text{mass(kg)}}$

$\Delta T_f \downarrow \rightarrow M.M \uparrow$

4) (F) The freezing pt. depression of 0.20 mole of NaCl in 10 g of water is lower than the freezing pt depression of 0.20 mole $C_{10}H_8$ in 10.0 g of water.

$\Delta T_f = i k_f \frac{\text{moles}}{\text{mass}_{\text{solvent}}}$ ثابت

i NaCl = 2
i $C_{10}H_8$ = 1 ⟶ ΔT_f NaCl > ΔT_f $C_{10}H_8$

Q_2) A solution of 3.33 g (mass solute) of unknown in 50 g (mass solvent = 0.05 kg) of water freezes at -0.773°C (T_f solution), What is the Molecular weight of the unknown ? $k_f = 1.86$ °C/molal

M.M ؟

T_f solvent = T_f water = 0

$\Delta T_f = 0 - (-0.773) = i \frac{K_f \text{ (mass solute)}}{M.M_{\text{solut}} * \text{mass solvent}}$

$M.M = \frac{1 \ (1.86) \ (3.33)}{0.773 \ (0.05)} = 160$

a) 120
b) 160 ✓
c) 80
d) 100

→ ΔT_f is always +ve
وإذا ما كانت موجبة باخذ لها العتبة المطلقة

Exp 9 Calorimetry

Objective: To measure heat of reaction.

Calorimetry → It's the measurment of heat change.
Calorimeter → It's a device that used to measure the heat of the (reaction) (rxn).

↳ There are several kinds of "heats of reactions" such that → 1) heat of solution
2) heat of neutralization.

$$\Delta H_{reaction} = \Delta H_{Solution} + \Delta H_{neutralization}$$
$$\Delta H_{rxn} = \Delta H_{sol} + \Delta H_n$$

- heat of solution → heat flows during a process of Solution OR → amount of heat required all released to form a solution.

heat of neutralization → amount of heat required all released to make a nutralization

heat of reaction → It's the total heat $\Delta H_n + \Delta H_{sol}$.

ΔH_{rxn} → يمكن حسابها عملياً

ΔH_n → لا يمكن حسابها عملياً

ΔH_{sol} → يمكن حسابها عملياً.

* توضيح للي بصير فوق :.

$NaOH + HCl \rightarrow NaCl + H_2O$

قاعدة + حمض → ملح + ماء

أنا بدي أعمل تفاعل التعادل اللي هو
و بدي أحسب الحرارة الناتجة من هذا التفاعل بس ما بقدر أحسبها مباشرة.

كيف نحسبها ؟

EXAMPLE)

$NaOH_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + OH^-_{(aq)} + Heat$ (ذوبان)

① لحسب الحرارة الناتجة من تكوين المحلول → Heat of solution (ΔH_{sol}) (KJ)

② لحسب الحرارة الناتجة من تفاعل مادة مع محلول الثانية

مادة — محلول الثانية

$NaOH_{(s)} + H^+_{(aq)} + Cl^-_{(aq)} \rightarrow H_2O + Na^+_{(aq)} + Cl^-_{(aq)} + Heat \rightarrow \Delta H_{rxn}$ (KJ)

ΔH_{rxn} ← حرارة التفاعل المتعادل + حرارة تفاعل المحلول

$\Delta H_n = \Delta H_{rxn} - \Delta H_{sol}$, $\Delta H_{rxn} > \Delta H_n$, $\Delta H_f > \Delta H_{sol}$

$\Delta H = (-)$ Mass of Solution (g) $\times$ specific heat $\left(\frac{J}{g.c}\right) \times \Delta T\,(c)$

Solution ← Solute + Solvent

$\Delta H = (\quad)$ J

or $\Delta H = (-)$ Moles of Solute $\times$ specific heat $\times \Delta T(c) \times 10^{-3}$ ← $\frac{\text{mass solution}}{M.M}$

$\Delta H = (\quad)$ KJ/mol

ΔH → -Ve ($T_f > T_i$) → exothermic (طارد للحرارة) → flows out of the system (بالنواتج)

ΔH → +Ve ($T_f < T_i$) → endothermic (ماص للحرارة) → flows into the system. (بالمتفاعلات)

* Specific heat :- Amount of heat required to raise the temperature of 1 g mass by 1°C.

* ΔT → change in temperature.

Example 1) A 2.00 g sample of solid CsOH is dissolved in 200.0 mL of water in a Colorimeter. The temperature of the water was raised from 22.3 to 23.4 °C, Calculate the heat of the solution in KJ/mol. (assume the specific heat of the solution to be 4.184 J/g°C and the density of the solution to be 1 g/mL)?

solute → ΔH_{sol}

Solution → $\Delta H = -$ Mass solution(g) * specific heat * ΔT

$\Delta T = T_f - T_i = 23.4 - 22.3 = 1.1$°C

Specific heat = 4.184

Mass Solution = mass Solute + Mass Solvent.

$= 2g + 200g = 202g$ ← $m = d/v$ أي $= 1(200) = 200g$

$\Delta H = -(202)(4.184)(1.1) = -930$ J

in KJ/mol → $\Delta H = \frac{-930}{(2/149.9)} \times 10^{-3} = -70$ KJ/mol. ← ΔH_{sol}

Mass CsOH/M.M

Example 2) A 2.00 g sample of solid CsOH reacted with 200.00 mL of aqueous solution of hydrgine chloride (HCl) in a Calorimeter, the temperature of the solution increased from 22.3 to 24.3 °C. Calculate the heat of reaction in KJ/mol? (Assume the specific heat of the solution to be 4.184 J/g°C and the density of the solution to be 1.00 g/mL)

Sol → $\Delta H = -$ mass solution * Specific heat * ΔT

$= -(2 + 200) * 4.184 * (24.3 - 22.3)$

$= -1700$ J

in KJ/mol $= \dfrac{-1706}{\left(\frac{2}{149.9}\right)} = -130$ KJ/mol → ΔH_{rxn}

→ From the previous 2 examples:

$\Delta H_{rxn} = \Delta H_{rxn} - \Delta H_{sol} = -130 - (-70) = -60$ KJ/mol.

Exp10 Electrochemistry

→ Any chemical rxn. involves the transfer of e's from One substance to another is an Oxidation – Reduction Rxn.

← التفاعلات التي يتم فيها إنتقال الإلكترونات من مادة إلى أخرى تسمى تفاعلات التأكسد و الإختزال.

↳ Oxidation → loss of e's

↳ Reduction → gain of e's.

↳ A galvanic cell exists when the Oxidation & reduction steps in the rxn takes place, so that e's transfer from the reducing agent (substance which is oxidized) to the Oxidizing agent

↳ ε_{cell} consists of cathode (مهبط +), anode (مصعد −), salt bridge (قنطرة ملحية) & Voltmeter.

Cathode: electrode at which ~~oxidation~~ reduction Occurs (+ve electrode)

Anode: electrode at which oxidation Occurs (-ve electrode)

↳ e's flow from anode to cathode.

← لما يصير عندي تفاعل تأكسد و إختزال رح تنتقل عندي الإلكترونات من:

القطب السالب إلى القطب الموجب.

المصعد إلى المهبط.

العامل ~~المؤكسد~~ المختزل إلى العامل المؤكسد.

القطب يلي صار عليه التأكسد الى القطب يلي صار عليه الإختزال.

داخل ما يسمى بالخلية الجلفانية.

Example) أقل ٥٥ نعكس المعادلة ونغير الإشارة

$Zn^{+2} + 2\bar{e} \rightarrow Zn_{(s)}$ $\quad \varepsilon^{o} = -0.76\ V$

$Cu^{+2} + 2\bar{e} \rightarrow Cu_{(s)}$ $\quad \varepsilon^{o} = +0.34V$

هون دائما بيعطيني جهد الإختزال
أنا بتطلع على الأصغر و بعكس إشارته
و معادلته تكون هاد هو طرف التأكسد
و الثاني تكون طرف الإختزال

الإلكترونات بالمتفاعلات تعني التأكسد

Lo ① $Zn_{(s)} \longrightarrow Zn^{+2} + 2\bar{e}$ $\varepsilon^\circ = 0.76\ V$ (Anode)

② $Cu^{+2} + 2\bar{e} \longrightarrow Cu_{(s)}$ $\varepsilon^\circ = 0.34\ V$ (cathode)

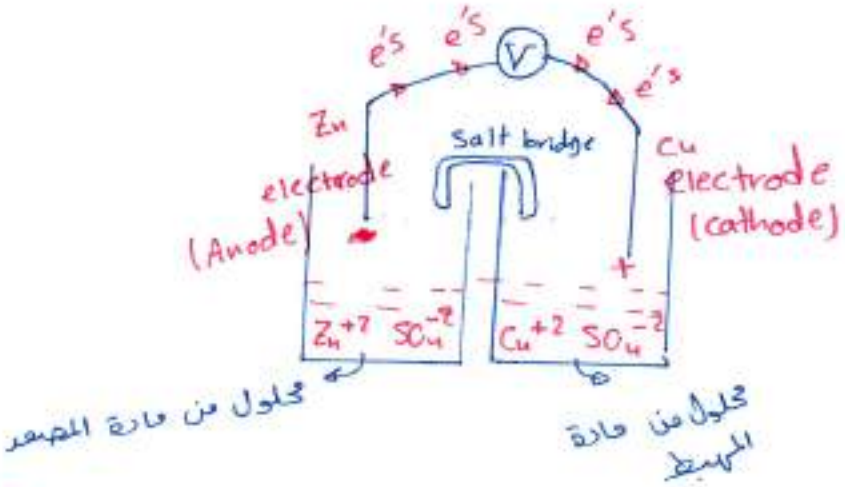
الإلكترونات بالمنتجات تعني الاختزال

∴ Cell rxn: $Cu^{+2} + Zn_{(s)} \longrightarrow Zn^{+2} + Cu_{(s)}$, $\varepsilon^\circ_{cell} = 0.76 + 0.34 = 1.1\ V$

Lo ① The first half-reaction is the oxidation half cell

Lo ② The second half-reaction is the reduction half cell.

→ The galvanic cell:-



In the previous example.

$\varepsilon^\circ_{Cu^{+2}/Cu} > \varepsilon^\circ_{Zn^{+2}/Zn}$

لأن اختزال Cu^{+2}/Cu أكبر من جهد اختزال Zn^{+2}/Zn

∴ Cu^{+2}/Cu → reduction half

Zn / Zn^{+2} → Oxidation half.

Also we should note:-

if $\varepsilon^\circ_{cell} > 0$ ⇒ Rxn is spontaneous in the written direction

if $\varepsilon^\circ_{cell} < 0$ ⇒ Rxn is non-spontaneous in the written direction

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The previous cell rxn. can be represented by the following Line cell:-

$$Zn_{(s)} / Zn^{+2}\ (1.00M) \ // \ Cu^{+2}\ (1.00M) / Cu_{(s)}$$

Anode — salt bridge — Cathode.

→ The salt bridge is usually a tube that is filled with standard electrolyte Soln. Such as KCl, KNO_3 --- etc and the purpose of it is to componsate the ions migration by providing the soln. that has a cation migration by cations.

- تعوض النقص في أيونات المحلول.

L→ In the Previous example ($\mathcal{E}^\circ$ value were taken from a standard potential table at standard conditions: 25°C, 1 atm & 1M)

L→ $\mathcal{E}_{cell}$ at conditions rather than the standard conditions can be calculated. by Nernst equation:-

$$\mathcal{E}_{cell} = \mathcal{E}^\circ_{cell} - \frac{2.303RT}{nF} \ln Q$$

$$= \mathcal{E}^\circ_{cell} - \frac{0.0592}{n} \log Q \quad (\text{at } 25^\circ C) \leftarrow \text{هاي اللي بتهمنا}$$

($R = 8.314\ J.mol^{-1}.K^{-1}$, F: Faraday's Const = 96500 C/mole $\bar{e}$
n = no of $\bar{e}$'s mole)

Q :- The product of molar Concentration of products devided by the product of molar Concentrations of reactions, if there was a gas So we use the Partial pressure of that gas.

$$Q = \frac{[\text{حاصل ضرب تركيز النواتج}]}{[\text{حاصل ضرب تركيز المتفاعلات}]}$$

← ① لو كان عندي غاز ← باخذ P بدل من التركيز.

② ← المواد اللي باخذلها التراكيز بين $\begin{pmatrix} aq \\ g \end{pmatrix}$ أو الضغط

Note → A cell may be constructed From two half cells have the same Soln. but differ. in Conc of both

↳ In this case the cell is Called → Concentration Cell

المصعد والمهبط نفس المادة بس المحاليل مختلفة بالتراكيز .

$\mathcal{E}^{\circ}_{cell} = 0$

$A^{+n}_{conc} \longrightarrow A^{+n}_{dil}$

(conc: مركز ، dil: مخفف)

$$\mathcal{E}_{cell} = 0 - \frac{0.0592}{n} \log \frac{[A_{dil}^{n+}]}{[A_{conc}^{n+}]} \qquad (T = 25^{\circ}C)$$

Example) $H_{2(g)}\ (0.25\ atm) \,/\, H^{+}\ (0.02\ M) \,//\, Cu^{+2}\ (0.05) \,/\, Cu_{(s)}$ (don't care.)

Find $\mathcal{E}_{cell}$

$\mathcal{E}^{\circ}_{H^+/H_2} = 0$ ، $\mathcal{E}^{\circ}_{Cu^{+2}/Cu} = 0.34$

(نصف التأكسد ، نصف الإختزال)

n

$Cu^{+2} + \underbrace{2}_{2}\bar{e} \longrightarrow Cu_{(s)} \qquad \mathcal{E}^{\circ} = 0.34\ V$

$H_{2\,(g)} \longrightarrow 2H^{+} + 2\bar{e} \qquad \mathcal{E}^{\circ} = 0\ V$

$Cu^{+2} + H_{2\,(g)} \longrightarrow 2H^{+} + Cu_{(s)} \qquad \mathcal{E}^{\circ}_{cell} = 0 + 0.34 = 0.34\ V$

$$\mathcal{E}_{cell} = \mathcal{E}^{\circ}_{cell} - \frac{0.0592}{n} \log \frac{[H^{+}]^{2}}{P_{H_2}\,[Cu^{+2}]} = 0.34 - \frac{0.0592}{2} \log \frac{(0.02)^2}{0.25\,(0.05)}$$

$$= 0.384\ V$$

---

n: عدد الإلكترونات لو كانو مختلفات بأخذ المضاعف المشترك الأصغر بعد ما أوجد المعادلات

↳ $2Al^{+3} + 6\bar{e} \rightarrow 2Al$
$3Mg \rightarrow 3Mg^{+2} + 6\bar{e}$ ← $n = 6$

Example) $Al^{+3}_{(aq)} + Mg_{(s)} \rightarrow Al_{(s)} + Mg^{+2}_{(aq)}$

$Al^{+3} + 3\bar{e} \rightarrow Al$, $E^{\circ} = -1.66\ V$ ← اختزال

$Mg^{+2} + 2\bar{e} \rightarrow Mg$, $E^{\circ} = -2.34\ V$ ← تأكسد ، $\mathcal{E}^{\circ}_{cell} = 2.34 - 1.66 = 0.69\ V$

Exp7. Determination of the Molar Volume of Hydrogen gas.

Molar Volume = $\bar{v} = \left(\frac{\text{Volume of gas (L)}}{\text{moles of gas (mole)}}\right) = \frac{V}{\text{moles}}$

L/mole

الظروف المعيارية

STP → T = 0°C = 273 K , P = 1 atm = 760 torr
V = 22.4 L → For water (only)

$\bar{v}$ = 22.4 L/mole → STP

Gases Laws:-

1) Boyle's Low → $P_1V_1 = P_2V_2$ (درجة الحرارة ثابتة)

$P \propto \frac{1}{V}$

2) Charle's low → $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (الضغط ثابت)

$V \propto T$

3) The Combined gas Low →

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

← لما بدي أعمل حساباتي باستخدام عملية التجربة ● بوجود الماء دح أحسب الضغط الكلي يلي هو ضغط الماء + ضغط الغاز يلي بدي أجمعه

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

← بس أنا بحساباتي دح أستخدم ال P_{gas} مشان الطلع أي شي إلو علاقة فيه اللي هو

$P_{gas} = P_{total} - P_{H_2O}$.

PreLab :-

A student at the Hashemite university wants to determine experimentally the Volume occuped by One mole of H_2 gas at STP. She reacts 0.1471 g of Zn with excess $HCl_{(aq)}$ and collects 56.09 ml of gas over water at 22°C and 757.8 torr. The vapor pressure of water at 22°C is 19.8 torr.

1- Use data given above to calculate

(i) The volume occupied by one mole of dry H_2 at 22°C, 760 torr

(ii) The volume occupied by on mole of dry H_2 at STP

This is Molar Volume $\bar{V}$

Sol → (i)

① حتى نحسب $\bar{V} = \frac{V_{gas}}{n_{gas}}$ لازم نجيب n ← من المعادلة
V ← من قانون الغازات

← المعادلة لازم تكون موزونة, هكذا بالسؤال

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2(g)$$

الغازات دائمًا X_2

بطلع مولات H_2

$$0.1471\ g\ Zn \times \frac{1\ mol\ Zn}{65.4\ g\ Zn} \times \frac{1\ mol\ H_2}{1\ mol\ Zn}$$

من المعادلة

من الجدول الدوري

$$= 2.249 \times 10^{-3}\ mol\ H_2$$

$V_1H = 0.05609\ L$

$T_1 = 22 + 273 = 295\ K$

$$\frac{P_1 gas\ V_1 gas}{T_1} = \frac{P_2 gas\ V_2 gas}{T_2}$$ ← V هي نجيب ←

← السؤال أعطاني الضغط البخاري (over water) المجموع فوق الماء.
يلي هو

$$P_{total} = P_{H_2O} + P_{H_2}$$

↓

عطاني ياها 19.8 torr

$$P_{H_2} = 757.8 - 19.8 = \underline{\underline{738}}\ torr.$$

هاي يلي ح أستخدمها

$$\frac{P_1H_2\ V_1H_2}{T_1} = \frac{P_2H_2\ V_2H_2}{T_2}$$, $P_2H_2 = 760$ torr

$T_2 = 295\ K$.

$$\frac{738\ (0.05609)}{295} = \frac{760\ (V_2)}{295} \rightarrow V_2 = 54.4\ mL.$$

$$\overline{V} = \frac{54.4 \times 10^{-3}}{2.249 \times 10^{-3}} = 24.188\ L/mole$$

Sol 2 (ii) →

$P_1H = 738$ torr

$V_1H = 0.05609\ L$

$T_1 = 295\ K$

$P_2H = 760$ torr

$V_2H = ?$

$T_2 = 273$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow V_2 = \frac{738\ (0.05609)\ (273)}{295\ (760)}$$

$$= 50.4 \times 10^{-3}\ L = 50.4\ mL$$

$$\overline{V} = \frac{V}{n} = \frac{50.4}{2.249} = 22.4\ L/mol$$

↳ at stp

2) Name the gas laws which you used in your calculations?

1- Boyle's low , 2- Charle's Low

3- The combined gas low.

Example) Sample of $KClO_3$ decomposed producing O_2 gas that collected overwater, The volume of the gas is 0.25 L at 26°C and 765 mmHg as total pressure, How many grams of $KClO_3$ wass decomposed?, M.M of $KClO_3$ = 122.6

P_{H_2O} at 26°C = 25 mmHg

Sol → $PV = nRT$

(P: O_2, V: O_2, n: O_2)

$P_{O_2} = P_{total} - P_{H_2O} = 765 - 25 = 740$ mmHg $= \frac{740}{760}$ atm

$V_{O_2} = 0.25$ L

$\frac{740}{760}(0.25) = n_{O_2}(0.0821)(26+273)$

$n_{O_2} = 9.916 \times 10^{-3}$ mol O_2

9.916×10^{-3} mol $O_2 \times \frac{2 \text{ mol O}}{1 \text{ mol } O_2} \times \frac{1 \text{ mol } KClO_3}{3 \text{ mol O}} \times \frac{122.6 \text{ g } KClO_3}{1 \text{ mol } KClO_3} = 0.81$ g

3 mol O

1 mol $KClO_3$ ← ← ما إحتجت معادلة بس اهتجت المعلومة

1 mol K, 1 mol Cl

→ Test banks :-

Q1) A solution of 1.25 g of erythritol in 50 g of water freezes at -0.773°C, what is the molecular weight of erythritol? $K_f = 1.86$ °C/molal

1) 120 ✓2) 60 3) 80 4) 100 5) 160

$$\Delta T_f = K_f \cdot \frac{\text{mass Solute (g)}}{M.M \times \text{mass Solvent (kg)}} \rightarrow M.M = \frac{1.86\,(1.25)}{(0+0.773)(0.05)}$$

$$= 60.15$$

Q2) In which of the following cases, the calculated molar mass of a volatile liquid will be lower than the actual value :- M.M↓

1) The measured volume of the vapor was mistakenly larger than the true value. V↑ M.M↓

2) The temperature used in the calculations was higher than the actual boiling pt. of water under lab. conditions T↑ M.M↑

3) The flask was not dried well before weighing mass↑ M.M↓

4) The measured atmospheric pressure wass less than the actual pressure. P↓ M.M↑

5) The measured density of the vapor was more than the actual one. D↑ M.M↑

$$M.M = \frac{\text{mass } RT}{PV} = \frac{DRT}{P}$$

Q3) A conical flask weighs 40.1305 g when clean, dry, evacuated, 138.2410 g when filled with water at 25 C and 40.2487 g when filled with a gaseous substance at 300 torr and 96 C. What is the molar mass (g/mol) of the gas?

1) 92.2 2) 63.2 3) 27.4 4) 35.7 5) 42.5

mass solute = 40.2487 - 40.1305 = 0.1182 g / $P = \frac{300}{760}$

Volume water = 138.2410 - 40.1305 = 98.1105 ml

Assume density 1g/ml

$$M.M = \frac{\text{mass } RT}{PV} = 92.2$$

Q4) Among the following, which element can reduce X (+0.16)

لـ صار إختزال لـ X
سؤ العنصر اللي تأكسد؟

1) Cu^{+2} (+0.34) V 2) Al^{+3} (+1.66 V) 3) Pb^{+2} (-0.13 V)

✓ 4) Zn^{+2} (-0.76) V 5) Cr^{+2} (+0.45) V

← هون بدي أدور على العنصر اللي جهد إختزاله أقل من جهد إختزال X

لأنه E° الإختزال الأكبر هي اللي رح تكون نصف الإختزال والأصغر رح تكون نصف التأكسد بس بدي أنتبه

X (+0.16) V —(نحوله جهد إختزال / صورته: أيون وجهد)→ X^{+n} (-0.16) V

لما يعطيني عنصر وجهد يكون عاطيني جهد التأكسد

هاد جهد الإختزال Zn^{+2} أكبر فقط من جهد إختزال

Q5) Calculate the amount of heat liberated by dissolving 0.03 mol of $AlCl_3$ (M.wt = 133.33 g/mol) in 100 g water? If you know that the heat of solution is -321 kJ/mol

1) -7.38 kJ 2) -12.84 kJ 3) -6.42 kJ ✓ 4) -9.63 kJ

5) -5.33 kJ

سؤال مباشر أعطاك ΔH بوحدة kJ/mol
حولها لـ ΔH (kJ)

$$\Delta H_{kJ} = \Delta H_{kJ/mol} \times mol$$

$$= -321 \times 10^3 \times 0.03 = -9.63\ kJ$$

(kJ) (mol)

Q6) In the freezing point depression experiment, which of the following factors will increase the calculated molar mass of the solute:-

1) The solute has been totally dissolved → No effect. in the solvent.
2) The solution freezing pt was erroneously lower than it should be. $\Delta T_f = T_{solvent} - T_{solution} \rightarrow \Delta T_f \uparrow$, M.M ↓
3) ✓ Some of the solvent evaporated during the experiment $mass_{solvent} \downarrow$ M.M ↑
4) Some solute adheres to the test tube. Mass ↓ M.M ↓
5) None of the above.

$$M.M = \frac{K_f \cdot mass_{solute}}{Mass_{solvent} \cdot \Delta T_f}.$$

Q7) In the concentration cell, which of the following statements is not correct?

1) Electrons will flow from the lower concentration to the higher one.
2) The anode is the lower concentration electrode.
3) ✓ The standard potential is one. → zero
4) The two half cells contain the same solution that differ in the concentrations only
5) The cathode is the higher concentration electrode.

* هاد السؤال مهم ركزو على الخيارات الصحيحة 1, 2, 4, 5.

Q8) A 1g sample of solid (NaOH, Mwt. = 40 g/mol) is dissolved in 100 mL of water in a calorimeter the temperature of water was raised from 22.3°C to 23.8°C, Calculate the heat of the solution in kJ/mol (Sp = 4.184 J/g°C, and density of the solution 1g/mL)

1) ✓ -25.46 2) -9.19 3) -12.07 4) -17.97 5) -35.5

$$\Delta H = \frac{-Mass_{solution} \times Sp \times \Delta T}{Moles_{solute}} = \frac{-(100+1) \times 4.184 \times (23.8-22.3)}{1/40}$$

$= -25.46$

Q9) If the freezing point of the solution had been incorrectly read 0.3°C higher than it's true freezing point and the freezing point of the pure solvent was correctly read, the effect on, the calculated molar mass of the unknown

1) Too high because change in temperature direct propotional to molar mass.
2) Too low because change in temperature direct propotional to molar mass.
3) Too low because change in temperature inversly propotional to molar mass
4) ✓ Too high because change in temperature inversly propotional to molar mass.
5) No effect because the temperature does not change significantly

$\downarrow \Delta T_f = T_{solvent} - T_{solution} \uparrow$

so $\Delta T_f \downarrow$

$$M.M = \frac{mass_{solute} \cdot K_f}{\Delta T_f \cdot mass_{solvent}}$$

inversly

$\Delta T_f \downarrow , M.M \uparrow$

Q10) Among the following, the weakest oxidizing agent is:

1) Cu^{+2} (+0.34V)
2) AL (−0.66V)
3) Pb^{+2} (−0.13V)
4) Zn^{+2} (−0.76V)
5) ✓ Cr^{+2} (−1.45 V)

[illegible]

Cu^{+2} (+0.34 V)
Al^{+3} (+0.66 V)
Pb^{+2} (−0.13V)
Zn^{+2} (−0.76V)
Cr^{+2} (−1.45)

أضعف عامل مؤكسد أقل ميل اختزال.

Exp 4
Q14)

The Sulfate ion can be detected by:-

1. Adding $BaCl_2$ Solution in acidic media and a white ppt. will appear.
2. Adding $BaCl_2$ Solution in basic media and a whit ppt. will appear.
3. Adding HCl Solution, a gas will change the wet red litmus to blue.
4. Adding NaOH Solution, a gas will change the wet blue Litmus to red
5. Adding NaOH Solution, ammonia smell can be detected.

Ans: 1

Q15) The Cl^- can be detected by:-

1. Sodium oxalate
2. Potasium thiocyanate
3. Silver nitrate + acid
4. Barium chloride + acid
5. Hydrochloric acid.

Ans: 3

Q16) When an unknown react with Sodium hydroxide (NaOH) Solution, it evolved a gas which convert the wet red litmus paper to blue. The resulted aqueous layer from the previous reaction was treated with hydrochloric acid solution and Carbon dioxide evolved immediately as a result of reaction, The unknown is:-

1. $CaCl_2$ 2. $Ca(HCO_3)_2$ 3. NH_4Cl 4. NH_4HCO_3 (H_2CO_3)

Ans: 4

Q17) An unknown Salt give a gas that convert the Litmus Paper from red to blue when deteted with Sodium hydroxide and a Pale yellow precipitate when reacted with Silver nitrate in acidic media. The formula of the salt is:-

1. $CaBr_2$ 2. $Fe_2(SO_4)_3$ 3. NH_4HCO_3 4. $FeBr_3$ 5. NH_4Br

Ans: 5

Q18) The iron (III) ion can be detected by:- Ans: 2

1. Adding $BaCl_2$ Solution, in acidic media and a white ppt. will appear
2. Adding KSCN Solution, and a red color will appear
3. Adding HCl solution, a gas will change the wet red litmus paper to blue
4. Adding NaOH Solution, a gas will change the wet blue litmus paper to red
5. Adding KSCN solution, and a white color will appear.