ElCoM
ELECTRICAL COMPUTER MECHATRONICS

تقدم لجنة ElCoM الاكاديمية

تلخيص لمادة:

مختبر كيمياء عامة عملية

جزيل الشكر للطالب:

نمر عودة

Chemistry Lab Summarization

Exp 1 Safety and Equipment. There is aquiz for the exp.

المطلوب: حفظ الأدوات صفحة 4 - 7 + حفظ قواعد السلامة من 1 - 13 ص 6
+ حفظ أدوات السلامة ص 8 + 9.

الترتيب حسب الدقة ←

فقط volumetric pipette & volumetric flask > pipette & Bruette > graduated cylinder > Beaker & Er. flask

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Exp 2 Empirical formula of a compound. There is a quiz for the exp.

* هذه التجربة تحتوي جانب نظري وجانب حسابي
* النظري يتعلق بالعلاقات والحسابي يتعلق بالتحويلات بناء على الجدول الدوري كما في المادة الأصلية (أساسيات الكيمياء)

Calculation Part:-

Ex) How many grams of Magnesium combine with 1.5g of chloride ions in $MgCl_2$?

Sol → الحل كاملي كما في المادة النظرية

$$1.5g\,Cl * \frac{1\ mol\ Cl}{35.4g\,Cl} * \frac{1\ mol\ MgCl}{2\ mol\ Cl} * \frac{24.31\ g\ Mg}{1\ mol\ Mg}$$

$$= 0.514\ g\ Mg$$

Ex) If 11.8 g of iron reacts with 5.06 g of Oxygen. Detrmine the empirical formula of the resulting Oxide?

Sol → الخطوات

Fe	:	O
11.8 g	:	5.06 g
$\frac{11.8}{55.8} = 0.211$ mol	:	$\frac{5.06\ g}{16} = 0.316$ mol
$\frac{0.211}{0.211} = 1$	:	$\frac{0.316}{0.211} = 1.5$
$1 * 2 = 2$	:	$1.5 * 2 = 3$

① تحويل لغرامات
② تحويل لمولات
③ القسمة على أصغر عدد
④ ضرب الرقم

$\therefore Fe_2O_3$ #

Ex) Nicotine is a compound containing C, H and N
A 2.5 g Sample of the compound is burned and Produces 6.78 g of CO_2, 1.94 g of H_2O, and 0.43 g of N_2. What is the empirical formula of nicotine?

Sol →

C	H	N
$6.78\,g\,CO_2 \times \frac{1\,mol\,CO_2}{44\,g\,CO_2} \times \frac{1\,mol\,C}{1\,mol\,CO_2}$	$1.94\,g\,H_2O \times \frac{1\,mol\,H_2O}{18\,g} \times \frac{2\,mol\,H}{1\,mol\,H_2O}$	$0.43\,g\,N_2 \times \frac{1\,mol\,N_2}{28\,g\,N_2} \times \frac{2\,mol\,N}{1\,mol\,N_2}$
$= 0.154$ mol	$= 0.216$ mol	$= 0.031$ mol

① إيجاد مولات كل عنصر

$0.154/0.031 = 5$: $0.216/0.031 = 7$; $0.031/0.031 = 1$ ③ العينة كل أصغر رقم

∴ C_5H_7N

Ex) When 0.288 g of P is burned, 0.66 g of white Phosphorus oxide is obtained, determine the empirical formula of this oxide?

Sol → we have 0.288 g P & 0.66 g of Oxide

∴ Mass of O = Mass of Oxide − Mass of P = 0.66 − 0.288
= 0.372 g

	P	O
①	0.288 g	0.372 g
②	$\frac{0.288}{31} = 0.0093$ mol	$\frac{0.372}{16} = 0.0233$ mole
③	$\frac{0.0093}{0.0093} = 1$	$\frac{0.0233}{0.0093} = 2.5$
④	$1 * 2 = 2$	$2.5 * 2 = 5$

∴ P_2O_5

Ex) A 2.00-g Sample of a bromide oxide is converted to 2.936 g of AgBr, Calculate the empirical formula of the oxide, (M.wt for AgBr = 187.78 g/mol, Br = 80 g/mol and O = 16 g/mol)

Sol→ Br نفس فكرة السؤال السابق لكن يجب أولا إيجاد كتلة

$$2.936\ g\ AgBr \times \frac{1\ mol\ AgBr}{187.78\ g\ AgBr} \times \frac{1\ mol\ Br}{1\ mol\ AgBr} \times \frac{80\ g\ Br}{1\ mol\ Br}$$

$$= 1.25\ g\ Br$$

Mass O = Mass Oxide − Mass Br = 2 g − 1.25 g = 0.75 g O

Br	:	O
$\frac{1.25}{80} = 0.0156$ mol	:	$\frac{0.75}{16} = 0.0468$
$\frac{0.0156}{0.0156} = 1$	:	$\frac{0.0468}{0.0156} = 3$

BrO_3

* أسئلة الحسابات في هذه التجربة لا تتعدى الأفكار السابقة

The Other Part:-

① أسئلة تتعلق بالتجربة :-

Why?

1. Heating before starting? To remove the moisture الرطوبة
2. Don't wheight the crucible when it's hot? It gives wrong accurate
3. Don't Cover the Crucible widley? It burns Mg brightly
4. Adding a few water drops? To decompose Mg_3N_2

Postlab questions ⑤

What is the effect of Mg:O Mole ratio if :-

1. Mg_3N_2 Not decomposed completly → increased
   ← OR The formation of side Product.
2. Mg_3N_2 decomposed completly → no effect.
3. Carbon deposited on the crucible surface → decrease
4. Carbon not deposited on the crucible surface → no effect
5. Magnesium oxide ash is not dried completely → decrease
6. Magnesium oxide ash is dried completely → no effect
7. Rapid Oxidation of Magnesium → increase
8. Air is not sufficient to ~~react~~ react with all the Mg → increase
9. Air is sufficient to react with all the Mg → no effect
10. Nonvolatile and unreactive impurities in the crucible during oxidation → decrease
11. Nonvolatile and unreactive impurities in the crucible from the begining → no effect.
12. If the balance reads ±0.02g for any reading → no effect

* بالنسبة لـ 10 + 11 باختصار ← ① وجود مواد غير متطايرة قبل التأكسد لا يؤثر و أثناء التأكسد يؤثر. (dec)

② وجود مواد متطايرة قبل أو أثناء التأكسد لا يؤثر.

* لو طلب O:Mg ← نعكس العلاقات أعلاه

Eq → bef

1. The formation of Mg_3N_2 (Side reaction) → $3Mg + N_2 \rightarrow Mg_3N_2$
2. The reaction between magnesium Nitride and water → $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$
3. Heating Mg to ash → $Mg(OH)_2 \xrightarrow{\Delta} MgO + H_2O$

Exp 3 → Limiting Reactant.

* No quiz for the exp.

* الهدف من هذه التجربة هو معرفة كيفية تحديد ال L.R

(*) Calculation Part →

$$\text{Percent yield} = \frac{\text{Actual yield}}{\text{Theorical Yeild}} \times 100\%$$

Actual yield → given

Theorical Yeild → Calculated

≡ How to determine the theorical yeald ?

① we find the L.R by → [1] convert each element to moles

[2] Divide each element on it's coefficient

[3] The smallest number is the L.R.

② we use only the L.R in our normal calculation.

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*Before we start 8 -

$3Ba^{+2} + 2PO_4^{-3} \longrightarrow Ba_3(PO_4)_2$

244.2 g/mole 380.2 g/mole 602.2 g/mole.

* التجربة سوف تقوم على إجراء هذه المعادلة فقط هي حفظ

Ex) A 25 g sample of $Na_3PO_4 \cdot 12H_2O$ react with excess $BaCl_2 \cdot H_2O$. If the mass of $Ba_3(PO_4)_2$ obtained is 17.56g. Calculate the % yield of $Ba_3(PO_4)_2$?

Sol →

The eq:- $3Ba^{+2} + 2PO_4^{-3} \longrightarrow Ba_3(PO_4)_2$

[1] Determine the L.R → given Ba^{+2} excess so PO_4^{-3} is L.R

[2] use grams of PO_4^{-3} in our normal calculations:-

$$25\ g\ PO_4^{-3} * \frac{1\ mol\ PO_4^{-3}}{380.2\ g\ PO_4^{-3}} * \frac{1\ mol\ Ba_3(PO_4)_2}{2\ mol\ PO_4^{-3}} \times \frac{602.2\ g\ Ba_3(PO_4)_2}{1\ mol\ Ba_3(PO_4)_2}$$

(PO4^-3 ← Theorical; 1 mol Ba3(PO4)2 ← from the eq)

Actual yield = 19.798 → % yield = $\frac{17.56}{19.8} = 88.68\%$

Ex) A mixture containing 40 g of $Na_3PO_4 \cdot 12H_2O$ and 30 g of $BaCl_2 \cdot 2H_2O$ is dissolved in water. A precipitate of $Ba_3(PO_4)_2$ weighing 22.65 g is produced. Calculate the % yield of $Ba_3(PO_4)_2$. (22.65 g: actual yield.)

sol →

$$3Ba^{+2} + 2PO_4^{-3} \rightarrow Ba_3(PO_4)_2$$

1 Determine the L.R

$$\frac{40\ g\ PO_4^{-3}}{380.2} = 0.105\ mole \rightarrow \frac{0.105\ mole}{\text{coefficient } 2} : 0.0525$$

$$\frac{30\ g\ Ba^{+2}}{244.2} = 0.123\ mole \rightarrow \frac{0.123\ mole}{3} = 0.041 \rightarrow \text{The smallest}$$

∴ Ba^{+2} is L.R

2

$$0.123\ mol\ Ba^{+2} * \frac{1\ mol\ Ba_3(PO_4)_2}{3\ mol\ Ba^{+2}} * \frac{602.2\ g\ Ba_3(PO_4)_2}{1\ mol\ Ba_3(PO_4)_2}$$

Theorical yield = 24.69 g

% yield = $\frac{22.65}{24.69} * 100\% = 91.7\%$

Ex) 10 g of a unknown mixture containing $Na_3PO_4 \cdot 12H_2O$ and $BaCl_2 \cdot 2H_2O$ is dissolved in distilled water. The mass of $Ba_3(PO_4)_2$ Precipitated is 3.5 g. calculate the % of each salt present in the mixture. if the $BaCl_2$ is the limiting reactant?

1 Ba^{+2} is L.R

$$3Ba^{+2} + 2PO_4^{-3} \rightarrow Ba_3(PO_4)_2$$

we have given 3.5 g $Ba_3(PO_4)_2$ ∴

$$3.5\ g\ Ba_3(PO_4)_2 \times \frac{1\ mol\ Ba_3(PO_4)_2}{602.2\ g\ Ba_3(PO_4)_2} * \underbrace{\frac{3\ mol\ Ba^{+2}}{1\ mole\ Ba_3(PO_4)_2}}_{\text{L.R}} * \frac{244.2\ g\ Ba^{+2}}{1\ mol\ Ba^{+2}}$$

Mass Ba^{+2} = 4.25 g

% Ba^{+2} = $\frac{4.25\ g}{10\ g} * 100\% = 42.5\%$

% PO_4^{-3} = (100 − 42.5)% = 57.5%

* Procedures Part →

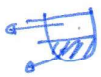
why?

1. Don't boil the solution → To minimize the lost of the mass
2. Using distilled water → To Provide the reactions of the unknowns

* What is the supernatant liquid?

It is the clear liquid above a Precipitate.

* يعني في طبقتين طبقة الراسب، طبقة السائل



* Determination of the L.R →

1. Test for excess PO_4^{-3} OR Limiting Ba^{+2} →

Add 2 drops of 0.5M $BaCl_2$ to the solution. If a precipitate is formed then PO_4^{3-} is the excess and Ba^{+2} is the l.R.. If a Precipitate is not formed the PO_4^{3-} is the L.R and Ba^{+2} is the excess.

2. Test for excess Ba^{+2} OR Limiting PO_4^{-3} →

Add 2 drops of 0.5M Na_3PO_4 to the solution. If appt. is formed then Ba^{+2} is the excess and PO_4^{-3} in the l.R

If appt. is not formed then Ba^{+2} is the L.R and PO_4^{-3} is the excess.

Post Lab Part

≡ What is the effect of heating the solution on the Particle size of $Ba_3(PO_4)_2$ ppt.? It makes a congulation

≡ what is the effect on the actual yield of the $Ba_3(PO_4)_2$ if:-

1. Using a coarse paper → decrease
2. Insufficient washing of the ppt. → increase.
3. Using Acidic to wash the solution → decrease.
4. The ppt. wasn't dried completely → increase

There is no quiz for the exp.

Exp4 Tests For Cations and Anions

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

Cations →

1. Ca^{+2} , Calicium test

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

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

2. Fe^{3+} , Ferric test

$$Fe_2(SO_4)_3 + KSCN \longrightarrow K_2SO_4 + Fe(SCN)_2^{+3}$$

Iron Sulfate — Potassium thiocayanate — red. Sol.

3. NH_4^+ ammonium test

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

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

Anions →

1. SO_4^{-2} (sulfate test)

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

Sodium Sulfate — Acidic وسط حمضي — Barium Chloride. — white ppt.

2. HCO_3^- - test

$$NaHCO_3 + HCl \longrightarrow H_2CO_3 + NaCl$$

$$H_2O + CO_2 \rightarrow \text{(Air bubbles)}$$

Sodium hydrogen Carbonate — وسط حمضي

3. Test of Cl^- , Br^-

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

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

وسط حمضي — Silver nitrate

Exp5 Identification of A compound:

Physical properties.

There is no quiz for the Exp.

* Prelab →

[1] Define

A. Solubility → The maximum mass of solute that can be dissolved in a fixed mass of Solvent at a given tempreture.

B. Boiling Point → [1] The tempreture at which the liquid starts to boil

[2] The tempreture at which bubble form spontaneously and continue to form until the entire Volume of the liquid has been converted to a gas.

[3] The tempreture where the vapor pressure is equal to the atmospheric pressure

[2] A students liquid unknown boils at approximately 69°C, is insoluble in wate but soluble in cyclohexane. It's density is 0.65 g/mole, which Chemical in table (Page 41) is the unkown?

* هذا السؤال إذا أجى بيجي معه جدول, ماعليك إلا تقارن بين المعطيات والجدول وخلاص.

The unknown is → n-hexane.

[3] What physical Property, measurable in this experiment, distinguishes cyclohexane from cyclohexene?

Boiling point.

[4] Using apparatus described in this experiment, when should the boiling point of a liquid be recorded?

When the bubbles cease to escape and before the liquid re-enters the capillary tube.

* The exp.

1. Solubility → الذائبية

Solution = Solute + Solvent
محلول = مذاب + مذيب

* Likes dissolves in Like

1. Polar - Polar → Soluble (Miscible) يذوب
2. nonpolar - nonpolar → Soluble (Miscible) يذوب
3. Polar - Salt → Soluble (Miscible) يذوب
4. nonpolar - Salt → insoluble (immiscible) لايذوب
5. Polar - nonpolar → insoluble (immiscible) لا يذوب

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* Levels of solubility →

1. Complete dissolving ذوبان كامل
2. Partial dissolving ذوبان جزئي.
3. insoluble. غير ذائب (عديم).

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2. Density = $\frac{\text{mass}}{\text{Volume}}$, $\rho = \frac{m}{V}$ 1 L = 1000 mL

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3. Boiling point , B.P

it called normal B.P if the vapor pressure = $P_{atm} = 1$

B.P Solution > B.P ~~Solute~~ Solvent → why? Because it has stronger intermolecular forces.

---

we are dealing with 3 solvents in this expiremnt.

① Water (H_2O) → Polar

② Cyclohexane → C_6H_{12} → non-Polar

③ Ethanol (C_2H_5OH) → Polar.

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*Post Lab →

1. How does atmospheric pressure affect the boiling point of a liquid?

directly → طردياً

* Also →

How does Intermolecular forces affect the boiling point of a liquid?

directly

[2] If several drops of liquid unknown cling (إلتصق) to the pipette wall after delivery will the density of the unknown be reported too high or too low?

too low because mass will decrease then due to the relation $\rho = \frac{m}{v}$, the density will decrease.

[3] A. If the Boiling pt. is recorded when bubbles are rapidly escaping the capillary tube, will it be recorded too high or too low? Explain.

* إذا قرأنا بعد ما طلع الماء من الأنبوب ← القراءة > الأصلية

temp > true B.P , because V.p > Patm

B. If the Boiling pt. is recorded after the liquids enters the capillary tube (after the heat is removed), will it be recorded too high or too low? Explain.

* إذا قرأنا بعد ما دخل الماء إلى الأنبوب ← القراءة < الأصلية.

temp. < true B.P , because V.P < Patm.

C. If the Boiling pt. is recorded when the liquids cease to escape and before the liquids re-enters the Capillary tube?

* إذا قرأنا أثناء الخروج وقبل الدخول إلى الأنبوب ← القراءة = الأصلية.

temp = true B.P , because V.p = Patm.

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* إذا أجا أي سؤال بيحكيلك أي المواد الآتية تصلح للتجربة إختار اللي درجة غليانها أقل من 100 (أقل من درجة غليان الماء).

* إذا أجا أي سؤال بيحكيلك أي المواد الآتية لا تصلح للتجربة إختار اللي درجة غليانها أكبر من 100 (أكبر من درجة غليان الماء).

Can you predict when the V.p = Patm, theoritically? No

Test banks

Exp 1

Q1) The correct statement concerning handling of chemicals in Lab is:-

1. Direct contact with chemicals is allowed.
2. No need to read the label on the reagent bottles.
3. Smelling and tasting chemicals are not allowed.
4. Toxic chemicals can be used outside the fume hood.
5. All of the above.

Ans: 3

Q2) which of the following is not a safety tool?

1. First aid Equipment.
2. Fire distinguisher
3. Graduated cylinder
4. Fume hood
5. Fire blanket.

Ans: 3

Q3) Which of the following is not a safety equipment?

1. Beaker 2. Goggle 3. First aid equipments 4. Fire blanket

Ans: 1

Q4) Write down T or F:.

T - Do not point your test tube at your face when heating anything to watch what happening exactly.

F - Open sandals, short skirts and shorts are allowed in the lab.

Q5) when a metal (M) with atomic mass 56 g/mol was oxidized to a metal oxide that contains 36.4% by mass O (Atomic weight O=16 g/mol), the empirical formula of the metal oxide is:-

1. MO_2
2. MO_3
3. M_2O_3
4. M_3O_4
5. M_2O_5

Sol → 36.4 % O → 36.4 g O

%M = (100 − 36.4)% = 63.6 % → 63.3 g M } → تحويل لغرامات

	M :	O
	$\frac{63.3\ g}{56}$	$\frac{36.4\ g}{16}$
	$\frac{1.13\ mol}{1.13}$:	$\frac{2.275\ mol}{1.13}$
	1 :	2

تحويل لمولات

اقسم كل أصغر رقم

So MO_2

Ans: 1

Q6) In the empirical formula experiment which statement below is incorrect :-

1. (Mg to O) mole ratio will not affect, if the balance is always read 0.05 g higher than the actual value.
2. The side product that formed is Mg_3N_2.
3. If the magnesium oxide is not dried completely the reported value of (Mg to O) mole ratio will decrease.
4. (Mg to O) mole ratio will increase if air is not sufficient to react with all the magnesium.
5. (Mg to O) mole ratio will decrease if a rapid oxidation is occur and some of the magnesium is lost.

Ans: 5

Q7) A compound of iridium, Ir (M.wt = 192.2 g/mol), and oxygen, O (M.wt = 16 g/mol), was produced in a Lab by heating iridium in a crucible, the data was collected:

Mass of crucible 38.26 g
Mass of crucible and iridium 39.63 g
Mass of crucible and iridium oxide 39.74 g
What is the empirical formula of this compound?

1. IrO_2 2. IrO 3. Ir_2O_3 4. Ir_3O_4

Sol →

Mass Ir = 39.63 g − 38.26 g = 1.37 g

Mass iridium oxide = 39.74 g − 38.26 = 1.48 g

Mass O = 1.48 − 1.37 = 0.11 g

Ir	:	O
$\frac{1.37\ g}{192.2}$		$\frac{0.11\ g}{16}$
$\frac{7.12 \times 10^{-3}}{6.87 \times 10^{-3}}$	:	$\frac{6.87 \times 10^{-3}}{6.87 \times 10^{-3}}$
1	:	1

∴ IrO

Ans: 2

Q8) A 0.1000 g sample containing C (FM = 12), H (FM = 1) and O (FM = 16) only, and produced 0.1910 g of CO_2 and 0.1172 g of H_2O, what is the empirical formula of the compound?

1. C_3H_8O
2. $C_5H_{12}O$
3. $C_4H_{10}O$
4. C_2H_6O
5. C_2H_4O

Sol →

Mass C → $0.1910\ g\ CO_2 \times \frac{1\ mol\ CO_2}{44\ g\ CO_2} \times \frac{1\ mol\ C}{1\ mol\ CO_2} \times \frac{12\ g\ C}{1\ mol\ C}$

$= 4.34 \times 10^{-3}\ mol\ C = 0.052\ g\ C$

Mass H → $0.1172\ g\ H_2O \times \frac{1\ mol\ H_2O}{18\ g\ H_2O} \times \frac{2\ mol\ H}{1\ mol\ H_2O} \times \frac{1\ g\ H}{1\ mol\ H}$

$= 0.013\ mol\ H = 0.013\ g\ H$

Mass O → $0.100 - (0.052 + 0.013) = 0.035\ g\ O = 2.1875 \times 10^{-3}\ mol\ O$

C : H : O

$\frac{4.34 \times 10^{-3}}{2.1875 \times 10^{-3}}$: $\frac{0.013}{2.1875 \times 10^{-3}}$: $\frac{2.1875 \times 10^{-3}}{2.1875 \times 10^{-3}}$

2 : 6 : 1

C_2H_6O

Ans: 4

For exp 1

Q9) Which of the following statement is not correct?

1. Open Sandals, short skirts and shorts are not allowed in the lab.
2. When dealing with flammable material, don't heat with direct flame.
3. You should return excess chemicals to their reagent bottles
4. Never taste or smell chemicals or solutions in the lab.
5. Laboratory work can't be started as soon as you enter the lab, unless the teacher is present.

Ans: 3

Q10) Given the equation $A + 3B \rightarrow C + D$ by reacting 1 moles of A with 2 moles of B, which of the following is true?

1. A is Limiting reactant because of it's higher molar mass.
2. B is limiting reactant because of it's higher molar mass
3. A is Limiting reactant because you have fewer moles of A than B
4. B is Limiting reactant because you have fewer moles of A than B
5. B is Limiting reactant because you need 3 moles of B and you have 2.

Sol → $\frac{1\ A}{1} = 1\ A$ $\qquad$ $\frac{2\ B}{3} = 0.67\ B$ $\qquad$ B is LR

(3 ← coefficient)

Ans: 5

Q11) If 3.28 g unknown mixture containing $Na_3PO_4.12H_2O$ (M.wt = 380.2 g/mol) and $BaCl_2.2H_2O$ ((M.Wt) = 244.2 g/ml) is dissolved in distilled water, The mass of $Ba_3(PO_4)_2$ (M.Wt = 602.2 g/ml) precipitate is 1.75 g. Calculate the % of $Na_3PO_4 \cdot 12H_2O$ in the mixture if the $BaCl_2$ is the limiting reactant.

1. 44.19%
2. 35.09%
3. 65.58%
4. 57.42%
5. 75.00%

Sol → $3Ba^{+2} + 2PO_4^{-3} \rightarrow Ba_3(PO_4)_2$

(L.R)

$$1.75\ g\ Ba_3(PO_4)_2 \times \frac{1\ mol\ Ba_3(PO_4)_2}{602.2\ g\ Ba_3(PO_4)_2} \times \frac{3\ mol\ Ba^{+2}}{1\ mol\ Ba_3(PO_4)_2} \times \frac{244.2\ g\ Ba^{+2}}{1\ mol\ Ba^{+2}} = 2.128\ g\ Ba^{+2}$$

Mass $PO_4^{-3} = 3.28 - 2.128 = 1.15\ g$

$$\%\ Na_3PO_4.12H_2O = \frac{1.15}{3.28} \times 100\ \% = 35.09\%$$

Ans: 2

Q12) A mixture containing equal masses (x) of $Na_3.PO_4.12H_2O$ (M.wt = 380.2 g/mole) and $BaCl_2.2H_2O$ (M.Wt = 244.2 g/mole) is dissolved in water, A ppt. of $Ba_3(PO_4)_2$ ((M.Wt) = 602.2 g/mole) was produced with a mass 0.2 x of the starting materials. Then the Percentage yield of $Ba_3(PO_4)_2$ is :-

1) 37.9 % 2) 63.1 % 3) 88.3 % 4) 25.3 %

Sol → $3Ba^{+2} + 2PO_4^{-3} \rightarrow Ba_3(PO_4)_2$

$$\%\text{ yield} = \frac{\text{actual yield}}{\text{theorical yield}} \times 100\%$$

mass Ba^{+2} = mass PO_4^{-3} = x g

II Find the L.R

Ba^{+2} → $\frac{x\text{ g}}{244.2\text{ g/mole}} = \frac{x}{244.2}$ mole / 3 (coefficient) $= \frac{x}{732.6}$

PO_4^{-3} → $\frac{x\text{ g}}{380.2\text{ g/mole}} = \frac{x}{380.2}$ mole / 2 $= \frac{x}{760.4}$ /// smaller than

∴ PO_4^{-3} is L.R

$$\frac{x}{380.2}\text{ mole } PO_4^{-3} \times \frac{1\text{ mole } Ba_3(PO_4)_2}{2\text{ mole } PO_4^{-3}} \times \frac{602.2\text{ g } Ba_3(PO_4)_2}{1\text{ mol } Ba_3(PO_4)_2}$$

$= 0.791\ x$ g ≡ Theorical yield, Actual yield = 0.2 x g

$$\%\text{ yield} = \frac{0.2x}{0.791x} \times 100\% = 25.3\ \%$$ Ans: 4

Q13) In the Limiting reactant of salt mixture exp. to test for Limiting Ba^{+2} ion:- Ans: 1

1. Add few drops of Barium ion (0.5 M) to the supernatant and ppt. will appear
2. Heat the mixture solution in the water bath for 30 minutes.
3. Add few drops of phosphate ion (0.5 M) to the supernatant and ppt. will appear
4. Add few drops of Barium ion (0.5 M) to the supernatant and ppt. will not appear
5. none of the above.

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 ~~the~~ treated with hydrochloric acid solution and Carbon dioxide evolved immediately as a result of reaction, The unknown is:- (H_2CO_3)

1. $CaCl_2$ 2. $Ca(HCO_3)_2$ 3. NH_4Cl 4. NH_4HCO_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.

Q19) which of the following Pair of liquids are miscible?

1. Polar + Salt
2. non-Polar + non-Polar
3. a and b will be miscible
4. Non-polar + Polar
5. Non-polar + Salt.

Ans: 3

Q20) which of the following statement is correct?

1. The boiling point is the tempreture at which the vapor pressure of the liquid is higher than the atmospheric pressure
2. If the boiling point is recorded while the bubble escaping from the capillary tube (and the heat is removed), the recorded Boiling point will be too low
3. The boiling point of the substance increase as the intermolecular forces between molecules decrease.
4. If the boiling point is recorded after the liquid enters the capillary tube (after the heat is removed), the reorded boiling point will be too high.
5. As the tempreture increases the vapor pressure of the liquid increases.

Ans: 5

* Relations →

[1] Inter molecular forces ↑ Vapor pressure ↓

[2] Tempreture ↑ Vapor pressure ↑

[3] Boiling point ↑ Vapor pressure ↓

And So on ---.

Q21) If you need 10 ml pipette to weight 10 ml of three unknowns liquid substances A, B and C. you find that the weight of the 10 ml of each substance is the following A=9.2 g, B= 9.0 g, C=8.9 g. The order of density decreasing of these liquids is:-

1. C>A>B 2. B>C>A 3. A>B>C 4. A>C>B

Ans: 3

Q22)

A students liquid unknown boils at approximately 79°C, is insoluble in water but soluble in cyclohexane and ethanol. The mass of 2ml of the unknown = 1.75 g, from the table below the unkown is!

Compound	Density g/ml	Boiling Point (C°)	Solubility S: Soluble, i: insoluble		
			H_2O	C_6H_{12}	C_2H_5OH
X	0.79	68	SlS	S	i
Y	0.90	60	S	S	S
Z	0.59	78	i	S	S
R	0.89	80	i	S	S
Q	0.89	79	i	S	i
P	0.79	59	S	S	S

1. X 2. Z 3. Q 4. R

Density = $\frac{m}{V} = \frac{1.75}{2} = 0.88$ g/ml Ans: 4

exp4

Q23) The following results were obtained for an unknown containing a cation and an anion . .

Cation test	Sodium oxalate	Potassium thyocanate	Sodium hydroxide (with litmus paper test)
	-ve	+ve	-ve
Anion test	Barium chloride (in acidic medium)	Silver nitrate (in acidic medium)	Hydrochloric acid (immediate reaction)
	+ve	-ve	-ve

1. $FeCl_3$ 2. $(NH_4)_2SO_4$ 3. $Fe_2(SO_4)_3$ 4. NH_4Cl

Ans: 3

Exp6:- Molar Mass of a volatile Liquid.

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

$$PV = nRT$$

$$PV = \frac{mass}{M.M} RT \Rightarrow$$

P = atmospheric pressure (atm) ⇒ 1 atm = 760 mmHg = 760 torr = 101.325 kpa

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

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

R = gas Constant = 0.0821 [atm.L / K.mol.]

T = temprature of boiling water K°

$K^\circ = C^\circ + 273$

---

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 → $PV = \frac{mass}{M.M} RT$

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

$$V_{(L)\ \text{للسائل (water)}} = \frac{\text{Mass water}}{\text{density}} \Rightarrow$$

Mass water = Mass flusk filled with water − Mass empty flusk

= 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 (gaseous Substance) = Mass flusk with substance − Mass empty flusk

= 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

---

* 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] يخلص 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:. $\frac{n_H}{V_H} = \frac{n_O}{V_O} \Rightarrow n_H = n_O$

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

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

---

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 مكاني كان عندي 5mL من الماء و صارو 10mL بيختلف اشي؟

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

يخلص تبخر باخذ حجم البخار وليس 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 تخلص 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) إنخفاض
2) Boiling pt (B.p) ⇒ increasing (Boiling pt elevation) إرتفاع
3) Vapor pressure (V.p) ⇒ decreasing (Vapor pressure Lowering) إنخفاض

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

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

$$\Delta T_f = K_f\, m = K_f \cdot \frac{(g\ \text{mass}_{\text{solute}})}{M.M_{\text{solute}} \cdot \text{Kg Solvent}} = \frac{K_f * \text{وزن المذاب بالغرامات}}{\text{وزن المذيب بالKg} \times \text{مولالاس المذاب}}$$

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

freezing pt depression في التجربة ح نركز 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 (الإنخفاض) ⇐ يزداد.

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

$T_{solution}$ ← ΔT_f

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

$T_{solvent}$

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

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

نسبة عكسية مع ΔT_f كلما زادت تقل

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

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? (Kf for cyclohexane is 20.0 °C Kg/mol).

Solution ⇒

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

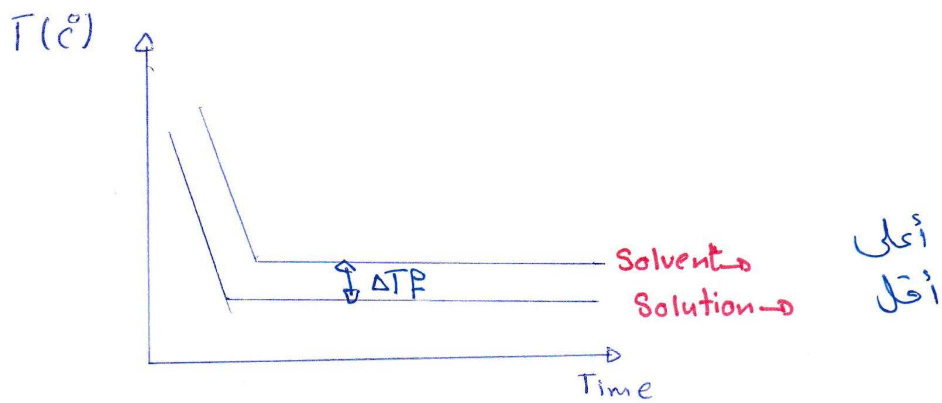
$$M.M = \frac{20 \times 0.597}{3.62\ (20 \times 10^{-3})} = 164.92 \text{ g/mol}$$

---

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

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

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

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:-

← غير مرتبط (الوصار عندي ارتباط رح يقل i)

← غير متفكك. $i=1$

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

يعني إنو رح يتفكك إذا رح يكون عندي معامل تفكك i

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 ⟶ C? Explain!

$A + B \rightarrow C$
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 حطينا الذاب شان يذوب و نقيس درجة التجمد بيسألني إذا التصق جزء من الذاب سوف 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 ننسى نفرق 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 $\Delta T_f = \frac{i K_f * \text{Mass solute}}{M.M * \text{Mass Solution}}$

هون بس بحسب الكتلة اللي ذابت 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 نقرأ 1.5 أعلى لما أقيس المذيب لحال و 1.5 أعلى لما أقيس المحلول لما أخذ الفرق رح يطلع مع بعض المشكلة لو اختلف القراءة عند وحدة منهم 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.

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

$i_{NaCl} = 2$
$i_{C_{10}H_8} = 1$ ⟶ $\Delta T_f\ NaCl > \Delta T_f\ C_{10}H_8$

Q2) A solution of 3.33 g (mass solute) of unknown in 50 g (mass solvent = 0.05 kg) of water freezes at $-0.773^\circ C$ ($T_{f\,solution}$), What is the Molecular weight of the unknown ? $K_f = 1.86^\circ C/molal$

M.M ؟

$T_{f\,solvent} = T_{f\,water} = 0$

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

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

a) 120
b) 160 ✓
c) 80
d) 100

→ ΔT_f is always +ve

وإذا ما كانت موجبة باخذ لها القيمة 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 + H_2O

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

كيف نحسبها ؟

EXAMPLE)

① حساب الحرارة الناتجة من تكوين المحلول

$$NaOH_{(s)} \xrightarrow{H_2O} H_2O \xrightarrow{\text{تكون}} Na^+_{(aq)} + OH^-_{(aq)} + Heat \rightarrow \text{Heat of solution } (\Delta H_{sol})\ (KJ)$$

② حساب الحرارة الناتجة من تفاعل مادة مع محلول المادة (محلول الثانية)

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

ΔH_{rxn} ← حرارة المحلول + حرارة تفاعل التعادل

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

ΔH = (-) Mass of Solution (g) × specific heat $\left(\frac{J}{g.c}\right)$ × ΔT (c)

Solution ← Solute + Solvent

ΔH = ( ) J

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

ΔH = ( ) 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)?

ΔH_{sol}

Solution → ΔH = - 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

$m = d V$ لأن
$= 1(200) = 200g$

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

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

Expl0 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.

Lo Oxidation → loss of e's Lo Reduction → gain of e's.

Lo 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

Lo $\mathcal{E}_{cell}$ consists of Cathode, Anode, salt bridge & Voltmeter. (مهبط، مصعد، قنطرة ملحية)

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

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

Lo 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 المختزل إلى العامل المؤكسد.
القطب يلي صار عليه التأكسد إلى القطب يلي صار عليه الإختزال.
داخل ما يسمى بالخلية الجلفانية.

Example) أقل مو نعكس المعادلة ونغير الإشارة

$Zn^{+2} + 2e^- \rightarrow Zn_{(s)}$ $\mathcal{E}^\circ = -0.76\ V$

$Cu^{+2} + 2e^- \rightarrow Cu_{(s)}$ $\mathcal{E}^\circ = +0.34\ V$

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

الإلكترونات بالنواتج تعرف التأكسد

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

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

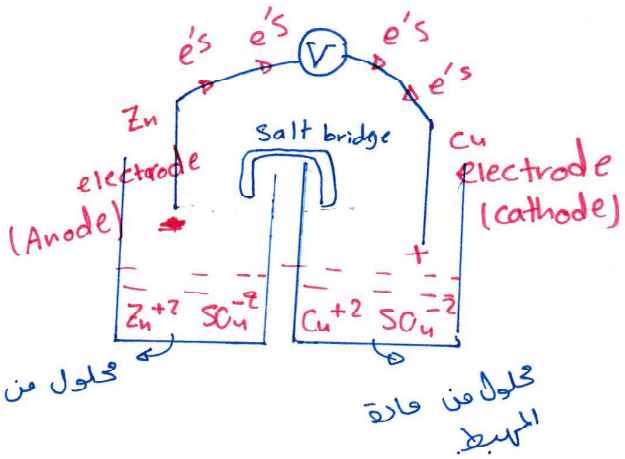
الإلكترونات بالمتفاعلات تعرف الإختزال

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

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

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

→ The galvanic cell:-



In the previous example.

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

بسبب إختزال Cu^{+2}/Cu أكبر من إختزال 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 followin 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 solu. that has a cation migration by cations.

← تعوض النقص في أيونات المحلول.

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

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

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

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

($R = 8.314\ J.mol^{-1}.K^{-1}$, 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 .

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

A^{+n}_{conc} (مركز) $\longrightarrow$ A^{+n}_{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 $\mathcal{E}_{cell}$

$\mathcal{E}^{o}_{H^+/H_2} = 0$ (نصف التأكسد) , $\mathcal{E}^{o}_{Cu^{+2}/Cu} = 0.34$ (نصف الإختزال)

n

$Cu^{+2} + \underline{2}e^{-} \longrightarrow Cu_{(s)} \qquad \mathcal{E}^{o} = 0.34\ V$

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

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

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

$$= 0.384\ V$$

---

n:- عدد الإلكترونات لو كانو مختلفات باخذ المضاعف المشترك الأصغر بعد ما أوحد المعادلات

↳ $2Al^{+3} + 6e^{-} \rightarrow 2Al$, $3Mg \rightarrow 3Mg^{+2} + 6e^{-}$ ⟩ $n = 6$

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

$Al^{+3} + 3e^{-} \rightarrow Al$, $E^{o} = -1.66\ V$ → اختزال

$Mg^{+2} + 2e^{-} \rightarrow Mg$, $E^{o} = -2.34\ V$ → تأكسد , $\mathcal{E}^{o}_{cell} = 2.34 - 1.66 = 0.69\ V$

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 البخر ● بوجود الماء رح أحسب الضغط الكلي يلي هو ضغط الماء + ضغط الغاز يلي بدي أجمعه

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

← بس أنا حساباتي رح أستخدم ال P_{gas} مشان الغاز 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 $\overline{V}$

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, حكاي بالسؤال

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

H_2 الغازات دائماً 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

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

$V_1H = 0.05609\ L$

$T_1 = 22+273 = 295\ K$

$$\frac{P_1 gas\ V_1 gas}{T_1} = \frac{P_2 gas\ V_2 gas}{T_2} \leftarrow V \text{ هي تجيب}$$

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

هو يلي

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

↳ أعطاني ياها

$19.8\ torr$

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

هاي يلي رح أستخدمها

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

$T_2 = 295\ K$.

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

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

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 over water, 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)

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

$V_{O_2} = 0.25 \text{ L}$

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

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

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

3 mol O

1 mol $KClO_3$ ↗

1 mol K ↙ ↘ 1 mol Cl

← ما اعتبت معادلة بس اعتبت المعلومة ←

→ 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

Volume water = 138.2410 - 40.1305 = 98.1105 ml / $P = \frac{300}{760}$

Assume density 1g/ml

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

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

صار إختزال لـ X
شو 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)

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

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

(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. $\Delta Tf = T_{solvent} - T_{solution}$ → $\Delta Tf \uparrow$, $M.M \downarrow$
3) Some of the solvent evaporated during the experiment $mass_{solvent} \downarrow$ $M.M \uparrow$
4) Some Solute adheres to the test tube. Mass ↓ M.M ↓
5) None of the aboue.

$$M.M = \frac{Kf \cdot mass_{solute}}{mass_{solvent} \cdot \Delta Tf}$$

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 صح وكزه على انها ان الاجابة 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 $\Delta T_f \downarrow$

$M.M = \frac{\text{mass}_{solute} \cdot K_f}{\Delta T_f \cdot \text{mass}_{solvent}}$ (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} (-1.45V)

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