* Name : Aya Rae'd Ismail Hasan.

ايه راعد اسماعيل حسن

* Reg. No. : [redacted]

* Section : "15"

* Experiment No. : "1"

16

* Experiment Name : Volumetric Glassware and Balances.

* Instructor's Name : Prof. Mohammed Rasheed.

* Date : 21th / Oct / 2021

Experiment 1

Data sheet and calculations

Name: Aya Raed Hasan. Section 15

Reg. No: [redacted] Date: 21th / Oct / 2021

	Trial (1)	Trial (2)	Trial (3)
Initial burette reading	20.00 ± 0.05 mL	25.00 ± 0.05 mL	30.10 ± 0.05 mL
Final burette reading	25.00 ± 0.05 mL	30.10 ± 0.05 mL	35.00 ± 0.05 mL
Apparent volume, ml	5.00 ± 0.07 mL	5.10 ± 0.07 mL	4.90 ± 0.07 mL
Weight of empty flask	6.65673 ± 0.0001	6.66183 ± 0.0001	6.68063 ± 0.0001
Weight of flask and water	11.70113 ± 0.0001	11.63953 ± 0.0001	11.61543 ± 0.0001
Weight of water, g	5.04443 ± 0.0001	4.97773 ± 0.0001	4.93483 ± 0.0001
Temperature, °C	21.0°C ± 0.5	22.0°C ± 0.5	21.0°C ± 0.5 ± 0.25
Actual (experimental) volume, ml	5.0595 mL	4.9936 mL	4.9496 mL
Correction (ml)	0.0595 mL	−0.1064 mL	0.0496 mL

Calculate the volume of water contained in each 5 ml portion from the above data

Instructor's Signature: Hana

Instructor's Name: ...Hana x Adi

21.10.2021

V_i ntial burette reading

$(0 \pm 0.05) = 5.00 \pm 0.07$

$.05) = 5.10 \pm 0.07$ m

$) = 4.90 \pm 0.07$ mL

$(0.05)^2 + (0.05)^2 = \pm 0.0$

W_i Weight of empty flas

$.0001) = 5.0444$ g ± 0.0001

$1) = 4.9777$ g ± 0.0001

$1) = 4.9348$ g ± 0.0001

$1)^2 = \pm 0.0001$

ater, I found it equals

to $21.0^\circ C \pm 0.25$ so: for 1g of water at $21.0^\circ C$ the volume is 1.0030 ml

⇒ trial 1 : 1g of water ⟶ 1.0030 ml

5.0444 g ⟶ x

$X = 1.0030 \times 5.0444$

$X = 5.0595$ ml

the actual Volume

⇒ trial 3 : 1g of water ⟶ 1.003

4.9348 g ⟶ x

$X = 1.0030 \times 4.9348$

$X = 4.9496$ ml

the actual Volume

Follow

Calculations

* Apparent Volume "ml" = Final burette reading (V_2) − Intial burette reading (V_1)

⇒ trial 1 : $V_2 - V_1 = (25.00 \pm 0.05) - (20.00 \pm 0.05) = 5.00 \pm 0.07$

⇒ trial 2 : $V_2 - V_1 = (30.10 \pm 0.05) - (25.00 \pm 0.05) = 5.10 \pm 0.07$ m

⇒ trial 3 : $V_2 - V_1 = (35.00 \pm 0.05) - (30.10 \pm 0.05) = 4.90 \pm 0.07$ ml

Uncertainty for the burette → "apparent Volume" $= \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.0$

* Weight of water "g" = Weight of flask and water (W_2) − Weight of empty flas (W_1)

⇒ trial 1 : $W_2 - W_1 = (11.7011 \pm 0.0001) - (6.6567 \pm 0.0001) = 5.0444$ g ± 0.0001

⇒ trial 2 : $W_2 - W_1 = (11.6395 \pm 0.0001) - (6.6618 \pm 0.0001) = 4.9777$ g ± 0.0001

⇒ trial 3 : $W_2 - W_1 = (11.6154 \pm 0.0001) - (6.6806 \pm 0.0001) = 4.9348$ g ± 0.0001

Uncertainty for the weight of water $= \sqrt{(0.0001)^2 + (0.0001)^2} = \pm 0.0001$

* Actual (experimental) Volume "ml" :

In trial 1 and 3 when I measured the temperature of water, I found it equals to $21.0^{\circ}C \pm 0.25$ so : for 1g of water at 21.0°C the Volume is 1.0030 ml

⇒ trial 1 : 1 g of water ⟶ 1.0030 ml

5.0444 g ⟶ X

X = 1.0030 × 5.0444

X = 5.0595 ml

the actual Volume

⇒ trial 3 : 1 g of water ⟶ 1.0030

4.9348 g ⟶ X

X = 1.0030 × 4.9348

X = 4.9496 ml

the actual Volume

Follow ⟶

In trial 2 when I measured the temperature of water, I found it equals to $22.0^{\circ}C \pm 0.25$ So: for 1 g of water ⟶ 1.0032 ml

49777 g ⟶ X

X = 4.9777 × 1.0032 = 4.9936 ml

X: the actual volume

* Correction value "ml" = actual Volume "ml" − Apparent Volume "ml"

⇒ trial 1 = 5.0595 ml − 5.00 ml = 0.0595 ml

⇒ trial 2 = 4.9936 ml − 5.10 ml = −0.1064 ml

⇒ trial 3 = 4.9496 ml − 4.90 ml = 0.0496 ml

* Source of errors

while I used the burette I notice, air bubbles appear :So I removed them by quick closing and opening the stopcock until the bubbles disappeared. Also, errors in reading a scale the value of reading, depends on the position of the eye, it should be perpendicular to the scale.

* Conclusion

Finally in this experiment, I have Learnt how to calibrate the glassware which is a burette. Also, depending on the Correction, my data was accurate and precise because it close to the actual value in table (1): Tolerances in burettes.

Question

A 25.00ml pipette was found to deliver 24.976 g of water when Calibrated against Stainless Stell weights at 25°C. Use the data in Table 2 to Calculate the volume delivered by the pipette at this temperature and at 20°C.

⇒ ① at 25°C = 1g of water ⟶ 1.0038 ml (at 25°C)

24.976g ⟶ X

X = 1.0038 × 24.976 = 25.071 ml

X = the volume delivered by the pipette at 25°C

② at 20°C = 1g of water ⟶ 1.0028 ml

24.976g ⟶ X

X = 1.0028 × 24.976 = 25.046 ml

X = the Volume delivered by the pipette

very good ☺

* Name : Aya Rae'd Ismail Hasan.

ايه رائد اسماعيل حسن .

* Reg. No. :

* Section : "15"

* Experiment No. : "2"

* Experiment Name : Sampling and Statistical Treatment of Data.

* Instructor's Name: Prof. Mohammed Rasheed.

* Date : 28th/Oct/2021.

10

شكراً على الترتيب

Experiment 2
Data Sheet and Calculations

Name: Aya Raed Hasan. Section: 15

Reg. No.: [redacted] Date: 28th/Oct/2021

A. Homogenous sample

Result no.	V_S	V_B	$V_S - V_B$
1	11.90 ± 0.07 ml	0.30 ± 0.07 ml	11.60 ± 0.1 ml
2	9.10 ± 0.07 ml	0.30 ± 0.07 ml	8.80 ± 0.1 ml
3	9.00 ± 0.07 ml	0.30 ± 0.07 ml	8.70 ± 0.1 ml
4	10.70 ± 0.07 ml	0.30 ± 0.07 ml	10.40 ± 0.1 ml
5			

B. Non-homogenous sample

Result no.	V_S	V_B	$V_S - V_B$
1	9.70 ± 0.07 ml	0.1 ± 0.07 ml	9.60 ± 0.1 ml
2	8.50 ± 0.07 ml	0.10 ± 0.07 ml	8.40 ± 0.1 ml
3	13.90 ± 0.07 ml	0.10 ± 0.07 ml	13.80 ± 0.1 ml
4	10.00 ± 0.07 ml	0.10 ± 0.07 ml	9.90 ± 0.1 ml
5	11.70 ± 0.07 ml	0.10 ± 0.07 ml	11.60 ± 0.1 ml

Instructor's Signature: .....

Instructor's Name: .....Manar Adi.....

28.10.2021

Calculations

* A. Homogenous Sample

1) Calculation of $V_s - V_B$

trial

1 → $11.90 - 0.30 = 11.60 \pm 0.1$ ml

2 → $9.10 - 0.30 = 8.80 \pm 0.1$ ml

3 → $9.00 - 0.30 = 8.70 \pm 0.1$ ml

4 → $10.70 - 0.30 = 10.40 \pm 0.1$ ml

Uncertainty for V_s → $V_s = V_f - V_i = \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

V_B → • Uncertainty for a burette $= \frac{0.1}{2} = \pm 0.05$

• Uncertainty for reading from a burette

$= \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

$V_s - V_B \rightarrow \sqrt{(0.07)^2 + (0.07)^2} = 0.098 \simeq \pm 0.1 = \pm 0.1$

2) Apply the Q-test to the data in each group

- Homogenous Sample : [the data $11.60, 8.80, 8.70, 10.40$]
- Rearrange in increasing order : $[8.70, 8.80, 10.40, 11.60]$
- Calculate Q_{exp} for each :

→ $Q_{exp} = \frac{|\text{Suspected Value} - \text{Closest value}|}{\text{max. value} - \text{min. value}}$

(11.6) $Q_{exp} = \frac{|11.60 - 10.40|}{11.60 - 8.70} = 0.41 < 0.765$ ✓ ∴ value retained ($\because N = 4$, $\therefore Q_{critical}$ at Confidence level 90% $= 0.765$ & Q_{exp})

(8.7) $Q_{exp} = \frac{|8.70 - 8.80|}{11.60 - 8.70} = 0.03 < 0.765$ ✓ ∴ value retained

∴ All data accepted

follow →

3) Mean ($\bar{x}$) : $\bar{x} = \sum_{i=1}^{i=N} \frac{x_i}{N} \Rightarrow \bar{x} = \frac{8.70 + 8.80 + 10.40 + 11.60}{4} = \boxed{9.88}$

4) Median ($\tilde{y}$): 8.70, 8.80, 10.40, 11.60 $\Rightarrow$ Median $= \frac{8.80 + 10.40}{2} = \boxed{9.60}$

5) Average deviation from the mean "ADV" : $\frac{\sum_{i=1}^{i=N} |x_i - \bar{x}|}{N}$ (Mean)

① $|8.70 - 9.88| = \boxed{1.18}$ ③ $|10.40 - 9.88| = \boxed{0.52}$

② $|8.80 - 9.88| = \boxed{1.08}$ ④ $|11.60 - 9.88| = \boxed{1.72}$

$\Rightarrow$ ADV $= \frac{1.18 + 1.08 + 0.52 + 1.72}{4} = \boxed{1.13}$

6) Relative average deviation from the mean "RDV" : $\frac{\text{Average deviation}}{\bar{x}} \times 100\%$

$\frac{1.13}{9.88} \times 100\% = \boxed{11.4\%}$

7) Average deviation from the median : $\frac{\sum_{i=1}^{i=N} |x_i - \tilde{y}|}{N}$ (Median)

① $|8.70 - 9.60| = 0.90$ ③ $|10.40 - 9.60| = 0.80$

② $|8.80 - 9.60| = 0.80$ ④ $|11.60 - 9.60| = 2.00$

$\Rightarrow$ ADV $= \frac{0.90 + 0.80 + 0.80 + 2.00}{4} = \boxed{1.13}$

8) Relative average deviation from the Median : $\frac{\text{Average deviation from the median}}{\text{Median } (\tilde{y})} \times 100\%$

$\Rightarrow \frac{1.13}{9.60} \times 100\% = \boxed{11.8\%}$

9) Standard deviation from the mean : $S = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \bar{x})^2}{N-1}}$

① $(8.70 - 9.88)^2 = 1.39$ ③ $(10.40 - 9.88)^2 = 0.270$

② $(8.80 - 9.88)^2 = 1.17$ ④ $(11.60 - 9.88)^2 = 2.96$

$\Rightarrow \sum_{i=1}^{N} (x_i - \bar{x})^2 = 1.39 + 1.17 + 0.270 + 2.96 = 5.79$

$\Rightarrow S = \sqrt{\frac{5.79}{4-1}}$

$\boxed{S = 1.39}$

10) Relative standard deviation from the mean : $\frac{S}{\bar{x}} \times 100\%$

$\Rightarrow \frac{1.39}{9.88} \times 100\% = \boxed{14.1\%}$

Calculations

* B. Non- homogenous Sample

1) Calculation of $V_s - V_B$

trial

1 → 9.70 - 0.10 = 9.60 ± 0.1 ml

2 → 8.50 - 0.10 = 8.40 ± 0.1 ml

3 → 13.90 - 0.10 = 13.80 ± 0.1 ml

4 → 10.00 - 0.10 = 9.90 ± 0.1 ml

5 → 11.70 - 0.10 = 11.60 ± 0.1 ml

Uncertainty for V_s → $V_s = V_f - V_i = \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

V_B → · uncertainty for a burette $= \frac{0.1}{2} = \pm 0.05$

· uncertainty for reading from a burette

$= \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

$V_s - V_B$ → $\sqrt{(0.07)^2 + (0.07)^2} = 0.098 \simeq \pm 0.1 = \underline{\pm 0.1}$

2) Apply the Q-test to the data in each group

- Non-homogenous Sample : the data [9.60 , 8.40 , 13.80 , 9.90 , 11.60]
- Rearrange in increasing order : [8.40 , 9.60 , 9.90 , 11.60 , 13.80]
- Calculate Q_{exp} for each :

→ $Q_{exp} = \frac{|\text{Suspected Value} - \text{Closest Value}|}{\text{max. value} - \text{min. value}}$

(8.40) $Q_{exp} = \frac{|8.40 - 9.60|}{13.80 - 8.40} = 0.22 < 0.642$ ✓ ∴ Q_{exp} ∴ N=5 ∴ Critical at Confidence Level 90% = 0.64 ∴ value retained

(13.80) $Q_{exp} = \frac{|13.80 - 11.60|}{13.80 - 8.40} = 0.41 < 0.642$ ✓ ∴ value retained

∴ All data accepted

Follow →

3) Mean($\bar{x}$) : $\bar{x} = \frac{\sum_{i=1}^{N} x_i}{N} \Rightarrow \bar{x} = \frac{9.60+8.40+13.80+9.90+11.60}{5} = \boxed{10.66}$

4) Median($\tilde{y}$) : 8.40 , 9.60 , 9.90 , 11.60 , 13.80 $\Rightarrow \boxed{\text{Median} = 9.90}$

5) Average deviation from the mean "ADV" : $\frac{\sum_{i=1}^{N} |x_i - \bar{x}|}{N}$ (Mean)

① $|8.40 - 10.66| = 2.26$ ③ $|9.90 - 10.66| = 0.76$ ⑤ $|13.80 - 10.66| = 3.14$

② $|9.60 - 10.66| = 1.06$ ④ $|11.60 - 10.66| = 0.94$

$\Rightarrow ADV = \frac{2.26+1.06+0.76+0.94+3.14}{5} = \boxed{1.63}$

6) Relative avarege deviation from the mean "RDV" : $\frac{\text{Average deviation } \bar{x}}{\bar{x}} \times 100\%$

$\frac{1.63}{10.66} \times 100\% = \boxed{15.3\%}$

7) Average deviation from the median : $\frac{\sum_{i=1}^{N} |x_i - \tilde{y}|}{N}$ (Median)

① $|8.40 - 9.90| = 1.50$ ③ $|9.90 - 9.90| = 0$ ⑤ $|13.80 - 9.90| = 3.90$

② $|9.60 - 9.90| = 0.30$ ④ $|11.60 - 9.90| = 1.70$

$\Rightarrow ADV = \frac{1.50+0.30+0+1.70+3.90}{5} = \boxed{1.48}$

8) Relative average deviation from the Median : $\frac{\text{Average deviation from the median}}{\text{Median } (\tilde{y})} \times 100\%$

$\Rightarrow \frac{1.48}{9.90} \times 100\% = \boxed{14.9\%}$

9) Standard deviation from the mean : $S = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \bar{x})^2}{N-1}}$

① $(8.40 - 10.66)^2 = 5.11$ ③ $(9.90 - 10.66)^2 = 0.578$ ⑤ $(13.80 - 10.66)^2 = 9.86$

② $(9.60 - 10.66)^2 = 1.12$ ④ $(11.60 - 10.66)^2 = 0.88$

$\Rightarrow \sum_{i=1}^{N} (x_i - \bar{x})^2 = 5.11 + 1.12 + 0.578 + 0.88 + 9.86 = 17.55$

$\Rightarrow S = \sqrt{\frac{17.55}{5-1}} = \boxed{2.095}$

10) Relative Standard deviation from the mean : $\frac{S}{\bar{x}} \times 100\%$

$\Rightarrow \frac{2.095}{10.66} \times 100\% = \boxed{19.65\%}$

Qustions

1) Compare the results of the group in term of :

a) Mean ($\bar{x}$) b) Standard deviation c) Relative standard deviation

	Homogenous Sample		Non-Homogenous Sample
Mean	9.88	<	10.66
Standard deviation	1.39	<	2.095
Relative standard deviation	14.1 %	<	19.65 %

Conclusion?

2) Calculate the molar concentration of acetic acid for both groups of results.

- Homogenous

dilution

$(MV)_{NaOH} = (MV)^{?}_{CH_3COOH}$

$0.10 \times 9.88 = M \times 10.00$

$M = \frac{0.10 \times 9.88}{10.00} \Rightarrow \boxed{M_{CH_3COOH} = 0.099\ M}$

- Non-Homogenous

$(MV)_{NaOH} = (MV)_{CH_3COOH}$

$0.10 \times 10.66 = M \times 10.00$

$M = \frac{0.10 \times 10.66}{10.00} \Rightarrow \boxed{M_{CH_3COOH} = 0.11\ M}$

3) Assume the true concentration of the acetic acid is 0.1 M; make comments on the results in terms of accuracy and precision.

- Accuracy → Relative eror $= \frac{x_i - x_t}{x_t} \times 100\%$

1) For homogenous

$= \frac{0.099 - 0.1}{0.1} \times 100\% = -1\%$ → more accurate

2) For Non-Homogenous

$= \frac{0.11 - 0.1}{0.1} \times 100\% = 10\%$

- Precision

- Relative Standard deviation
  - Homogenous → 14.1 % → more precise
  - Non-Homogenous → 19.65 %

*Name : Aya Rae'd Ismail Hasan.

اية رائد اسماعيل حسن

*Reg.No. : [redacted]

* Section : "15"

10 Excellent :)

* Experiment: "3"

* Experiment Name : Neutralization Titration in Aqueous Medium.

* Instructor's Name : Prof. Mohammed Rasheed.

* Date : 4th/Nov/2021.

Experiment 3
Date Sheet and Calculations

Name: Aya Rae'd Hasan Section: 15
Reg. No.: [redacted] Date: 4th NOV/2021

Mass of Na_2CO_3			0.5094 ± 0.0001 g
(A) Vol. of Na_2CO_3			Vol. of HCl
1. 10.00 ± 0.05 ml 2. 10.00 ± 0.05 ml 3.			9.50 ± 0.07 ml 9.60 ± 0.07 ml
(B) Vol. of NaOH			Vol. of HCl
1. 10.00 ± 0.05 ml 2. 10.00 ± 0.05 ml 3.			9.80 ± 0.07 ml 9.10 ± 0.07 ml
#12 (C) Vol. of H_3PO_4		Vol. of NaOH	Indicator
1. 10.00 ± 0.05 ml 2. 10.00 ± 0.05 ml		5.60 ± 0.07 ml 5.60 ± 0.07 ml	Bromocresol Green

Calculate the molarity of Na_2CO_3, HCl and NaOH solutions, and calculate the concentration of H_3PO_4 in the unknown solution in g/L.

Instructor's Signature: .....

Instructor's name: Manar Adi 4/11/2021

Vol. of H_3PO_4	Vol. of NaOH	Indicator
1. 10.00 ± 0.05 ml	10.60 ± 0.07 ml	Phenolphthalein
2. 10.00 ± 0.05 ml	10.50 ± 0.07 ml	

Calculations

→ Part (A) : $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

* Indicator : we used Bromocresol green.

* mass of Na_2CO_3 = 0.5094 ± 0.0001 g , * Mw of Na_2CO_3 = 105.99 g/mol

* Volume of Na_2CO_3 = 10.00 ± 0.05 ml (we use a pipette) in the 2 trails.

• Uncertainty ⇒ $\frac{1}{2} \times 0.1 = \pm 0.05$

* Volume of HCl

→ trial 1 : 9.50 ± 0.07 mL → trail 2 : 9.60 ± 0.07 ml

∴ average Volume = $\frac{9.50 + 9.60}{2}$ = 9.55 mL of HCl

• Uncertainty → (burette) → $\frac{1}{2} \times 0.1 = \pm 0.05$

$V_{HCl} = V_f - V_i$ → uncertainty = $\sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

→ moles of Na_2CO_3 = $\frac{mass}{Mw} = \frac{0.5094}{105.99}$ = 4.806×10^{-3} mol

→ $M(Na_2CO_3) = \frac{mole}{Volume(L)} = \frac{4.806 \times 10^{-3}}{100.00 \times 10^{-3}}$ = 0.04806 M

$(MV)_{Na_2CO_3} = \frac{(MV)_{HCl}}{2}$ (average Volume of HCl)

$M_{HCl} = \frac{2 \times (0.04806 \times 10.00)}{9.55}$ = 0.101 M HCl

→ Part (B) : $NaOH + HCl \longrightarrow NaCl + H_2O$

* Volume of NaOH = 10.00 ± 0.05 ml (in 2 trials)

- Uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$

* Volume of HCl

→ trial 1 : 9.80 ± 0.07 ml → trial 2 : 10.10 ± 0.07 ml

• uncertainty → (burette) → $\frac{1}{2} \times 0.1 = \pm 0.05$

$V_{HCl} = V_f - V_i$ → Uncertainty = $\sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

∴ average volume of HCl = $\frac{9.80 + 10.10}{2}$ = 9.95 ml

follow →

* Indicator : We used phenolphthalein.

$(MV)_{NaOH} = (MV)_{HCl}$ ← average volume of HCl

$M_{NaOH} = \frac{0.101 \times 9.95}{10.00} = 0.100\ M$ of NaOH

→ Part (c) : - Neutralization of one proton

$H_3PO_4 + NaOH \longrightarrow NaH_2PO_4 + H_2O \quad PH = 4.6$

* Indicator → we used Bromocresol green.

* Volume of H_3PO_4 = 10.00 ± 0.05 ml (in 2 trials)

- Uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$

* Volume of NaOH

→ trial 1 + 2 (Both) : 5.60 ± 0.07 ml

Uncertainty → (burette) → $\frac{1}{2} \times 0.1 = \pm 0.05$

$V_{NaOH} = V_f - V_i$ ↘ Uncertainty = $\sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

Average volume of NaOH = $\frac{5.60 + 5.60}{2} = 5.60$ ml

$(MV)_{H_3PO_4} = (MV)_{NaOH}$

$M_{H_3PO_4} = \frac{0.100 \times 5.60}{10.00} = 0.0560\ M$ of H_3PO_4

- molar mass (H_3PO_4) = 97.97 g/mol

→ $0.0560 \frac{mol}{L} \times 97.97 \frac{g}{mol} = 5.49$ g/L

- Neutralization of two proton

$H_3PO_4 + 2\ NaOH \longrightarrow Na_2HPO_4 + 2\ H_2O \quad PH = 9.7$

* Indicator : we used phenolphthalein.

* Volume of H_3PO_4 = 10.00 ± 0.05 ml (in 2 trials)

• Uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$

* Volume of NaOH

→ trial 1 : 10.60 ± 0.07 ml → trial 2 : 10.50 ± 0.07 ml

• Uncertainty → (burette) → $\frac{1}{2} \times 0.1 = \pm 0.05$

$V_{NaOH} = V_f - V_i$ ↘ Uncertainty = $\sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$

Average Volume of NaOH = $\frac{10.60 + 10.50}{2} = 10.55$ ml

$(MV)_{H_3PO_4} = (MV)_{NaOH}$

$M_{H_3PO_4} = \frac{1}{2}\left(\frac{0.100 \times 10.55}{10.00}\right) = 0.0528\ M$ of H_3PO_4

• molar mass (H_3PO_4) = 97.97 g/mol

→ $0.0528 \frac{mol}{L} \times 97.97 \frac{g}{mol} = 5.17$ g/L

follow →

∴ Total Concentration = $\frac{5.49 + 5.17}{2}$ = 5.33 g/L

* Questions

1) How do you determine the solubility of Calcium hydroxide by a simple acid-base titration?

- prepare a saturated solution for $Ca(OH)_2$.
- allow the undissolved $Ca(OH)_2$ to settle down in the saturated solution.
- Pipette a certain volume of saturated solution of $Ca(OH)_2$.
- $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

→ Solubility of $Ca(OH)_2 = \frac{[Ca^{+2}] = [OH^-]}{2}$

2) How do you determine the water of crystallization of washing Soda?

- we take a certain amount of certain hydrous and dissolve it in a certain amount of water.
- Add Sutible indicator. - titrate with Sutible acid.
- Calculate the mass of Na_2CO_3 (using Mw)
- Calculate the mass of H_2O = mass of $Na_2CO_3 \times H_2O$ - mass Na_2CO_3
- Calculate the mole of H_2O (using Mw).
- X water of crystallization = $\frac{\text{moles of } H_2O}{\text{moles of } Na_2CO_3}$

3) Why two indicators can be used for the determination of phosphoric acid? Because, H_3PO_4 has 3 protons in the titration with NaOH and each end point occure at a certain PH.

4) Could you make titration for NH_3 solution with a standard solution of CHC_3OOH? why?

NO, because NH_3 is weak base and CHC_3OOH is a weak acid-base, and there's no weak acid-base titration, because no sharp change in pH and we need a large amount of titrate for each equirilance point.

* Name: Aya Rae'd Ismail Hasan.

آية رائد اسماعيل حسن .

* Reg. No. : [redacted]

* Section : "15"

* Experiment No. : "4"

* Experiment Name: Precipitation Titrations (Argentometry).

* Instructor's Name: Prof. Mohammed Rasheed.

* Date : 11th / Nov / 2021

Experiment 4
Data Sheet and Calculations

Name: Aya Raed Hasan
Reg. No.: [redacted]

Section: 15
Date: 11th/Nov/2021

Mass of NaCl: 0.6097 ± 0.0001 g

(A) Mohr's method	Trial (1)	Trial (2)
Vol. of NaCl solution	10.00 ± 0.05mL	10.00 ± 0.05 mL
Vol. of $AgNO_3$ solution	10.50 ± 0.07mL	10.20 ± 0.07 mL
(B) Fajan's method		
Vol. of NaCl solution	10.00 ± 0.05 mL	10.00 ± 0.05 mL
Vol. of $AgNO_3$ solution	10.20 ± 0.07mL	10.10 ± 0.07 mL
(C) Volhard's method		
Vol. of $AgNO_3$ solution	10.00 ± 0.05 mL	10.00 ± 0.05 mL
Vol. of KSCN solution	10.20 ± 0.07mL	10.00 ± 0.07 mL

Unknown mixture ID: # 74		
(I) According to Mohr's method	Trial 1	Trial 2
Vol. of unknown solution	10.00 ± 0.05mL	10.00 ± 0.05mL
Vol. of $AgNO_3$ solution	9.70 ± 0.07mL	10.10 ± 0.07mL
(II)According to Volhard's method		
Volume of unknown solution	10.00 ± 0.05mL	10.00 ± 0.05mL
Vol. of KSCN solution	6.40 ± 0.07mL	
Vol. of $AgNO_3$ added in excess	15.00 ± 0.05mL	

Instructor's Signature: [redacted]
Instructor's Name: Manar Adi
11.11.2021

Calculations

Part (A) : Standardization of silver nitrate by Mohr's method

- equations : $Ag^+ + Cl^- \rightleftharpoons AgCl_{(s)}$

  $2Ag^+ + CrO_4^{2-} \rightleftharpoons \underset{\text{Potassium}}{Ag_2CrO_{4(s)}}$

- Indicators : First trial → ↑Chromate indicator.

  Second trial → mixed indicator (Potassium Chromate and potassium dichromate)

  - Color Change in 2 trials from : yellow $\xrightarrow{to}$ red to brown.

- Mass of Sodium Chloride "NaCl" = **0.6097 g** → Using analytical balance.
  - Uncertainty = $\pm$ 0.0001

- Volume of NaCl Solution → trial 1 and 2 → 10.00 ml → using a pipette
  - Uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$

- Volume of $AgNO_3$ Solution → using a burette → Uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$

  → trial 1 : **10.50** $\pm$ 0.07 ml trial 2 : **10.20** $\pm$ 0.07 ml
  - Uncertainty → $v_{AgNO_3} : v_f - v_i \rightarrow \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- Average volume of $AgNO_3$ Solution ("$\bar{V}$") = $\frac{10.50 + 10.20}{2}$ = **10.35** ml
  - No. of moles of NaCl = $\frac{\text{mass of NaCl}}{\text{molar mass of NaCl}}$, Mr (NaCl) = 58.44 g/mol

    $= \frac{0.6097}{58.44}$

    $n_{NaCl} = 0.01043$ mole
  - $M_{NaCl} = \frac{n}{V(l)} = \frac{0.01043}{100 \times 10^{-3}} =$ **0.1043 mol/L**

(?) $(M\bar{V})_{AgNO_3} = (M\bar{V})_{NaCl}$

$M_{AgNO_3} = \frac{0.1043 \times 10.00}{10.35} =$ **0.1008 M of $AgNO_3$**

$0.1008 \frac{mol}{L} \times 169.87 \frac{g}{mol} =$ **17.12 g/L** , (molar mass of $AgNO_3$ = 169.87 g/mol)

Part (B) : Standardization of silver nitrate by Fajan's method.

- equation : $NaCl + AgNO_3 \rightleftharpoons AgCl_{(s)} + NaNO_3$

follow →

- Indicator : dichlorofluoresceine indicator.
  - Color Change from : Pale green $\xrightarrow{Eq}$ Pink
- Volume of NaCl Solution → trial 1 and 2 → 10.00 ml → using a pipette
  - Uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of $AgNO_3$ Solution → using a burette → uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
  → trial 1 : 10.20 ± 0.07 ml → trial 2 : 10.10 ± 0.07 ml
  - Uncertainty → $V_{AgNO_3} = V_f - V_i$ → $\sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- average volume of $AgNO_3$ Solution "$\bar{V}$" = $\frac{10.20 + 10.10}{2} = 10.15$ ml

$(M\bar{V})_{AgNO_3} = (M\bar{V})_{NaCl}$

$M_{AgNO_3} = \frac{0.1043 \times 10.00}{10.15} = 0.1028$ M of $AgNO_3$

$0.1028 \frac{mol}{L} \times 169.87 \frac{g}{mol} = 17.46\ g/L$, molar mass of $AgNO_3 = 169.87\ g/mol$

- Average of M(mol/L) and M(g/L) for $AgNO_3$ from part (A+B)

1) $\bar{M}(mol/L) = \frac{0.1008 + 0.1028}{2} = 0.1018$ mol/L

2) $\bar{M}(g/L) = \frac{17.12 + 17.46}{2} = 17.29\ g/L$

Part (C) : Standardization of potassium Thiocyanate by Volhard's Method

- equations : $Ag^+ + SCN^- \rightleftharpoons AgSCN_{(s)}$ (white precipitate)

$Fe^{3+} + SCN^- \rightleftharpoons [Fe(SCN)]^{2+}$ (blood red Solution)

- Indicator : ferric indicator
  - Color change : Colorless → red
- Volume of $AgNO_3$ Solution → trial 1 and 2 → 10.00 ml → using a pipette
  - Uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of KSCN Solution → using a burette → uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
  → trial 1 : 10.20 ± 0.07 ml → trial 2 : 10.00 ± 0.07 ml
  - Uncertainty → $V_{KSCN} = V_f - V_i$ → $\sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- Average Volume of KSCN Solution "$\bar{V}$" = $\frac{10.20 + 10.00}{2} = 10.10$ ml

From part A+B → $M_{AgNO_3} = 0.1018 \frac{mol}{L}$

$(M\bar{V})_{AgNO_3} = (M\bar{V})_{KSCN}$

$M_{KSCN} = \frac{0.1018 \times 10.00}{10.10} = 0.1008$ M of KSCN

$0.1008 \frac{mol}{L} \times 97.18 \frac{g}{mol} = 9.796\ g/L$, molar mass of KSCN = 97.18 g/mol

follow →

Part (D) : Determination of an unknown Mixture of Halides (NaCl + KCl)

I : According to Mohr's method

- Volume of unknown solution → trial 1 and 2 → 10.00 ml → using a pipette
  - uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of $AgNO_3$ solution → using a burette → uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.0$
  → trial 1 : 9.70 ± 0.07 ml → trial 2 : 10.10 ± 0.07 ml
  - uncertainty → $V_{AgNO_3} = V_f - V_i$ → $\sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- average volume of $AgNO_3$ solution "$\bar{V}$" = $\frac{9.70 + 10.10}{2}$ = 9.90 ml
- Indicator : potassium Chromate indicator , Color Change : yellow to red to brown

Calculations :

moles of $AgNO_3$ = moles of Cl^-

Suppose that X : mass of NaCl , Y : mass of KCl

then $X + Y = 0.065$ g → (1)

moles $Cl^- = \frac{X}{58.5} + \frac{Y}{74.5}$ (58.5 ← M.mass NaCl, 74.5 ← M.mass KCl)

moles of $AgNO_3 = \frac{X}{58.5} + \frac{Y}{74.5}$

$(M\bar{V})_{AgNO_3} = \frac{0.065 - Y}{58.5} + \frac{Y}{74.5}$

$0.1018 \times 9.90 \times 10^{-3} = \frac{74.5(0.065 - Y) + 58.5Y}{4358.3}$

$1.01 \times 10^{-3} = \frac{4.8 - 74.5Y + 58.5Y}{4358.3}$

$4.40 = 4.8 - 16Y$

$-16Y = -0.4$ → $Y = 0.025$ g (mass of KCl)

$\because X + Y = 0.065$

$\therefore X = 0.065 - 0.025$

$X = 0.040$ g (mass of NaCl)

Note that → X mass of NaCl found in 10 ml , Y mass of KCl found in 10 ml

then : Conc. of NaCl in g/l = $\frac{0.040 \times 1000}{10} = 4.0$ g/l (1 l = 1000 ml)

Conc. of KCl in g/l = $\frac{0.025 \times 1000}{10} = 2.5$ g/l (1 l = 1000 ml)

follow →

Part (D) : II : Acording to Volhard's method

-equations: $Ag^+ + SCN^- \rightleftharpoons AgSCN_{(s)}$ "white precipitate"

$Ag^+ + Cl^- \rightleftharpoons AgCl_{(s)}$ "white"

- Volume of unknown Solution → trial I → 10.00 ml → using a pipette
  - uncertainty $= \frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of $AgNO_3$ added in excess → trial I → **15.00 ml** → using a pipette
- Volume of KSCN Solution → using a burette → uncertainty $= \frac{1}{2} \times 0.1 = \pm 0.05$
  → trial 1 : **6.40** $\pm$ 0.07 ml
  - uncertainty → $V_{KSCN} = V_2 - V_1 \rightarrow \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- Indicator : ferric ion indicator , Color Change : Colorless $\xrightarrow{to}$ Red

Calculations :

→ moles of $AgNO_3 = MV = 0.1018 \times 15.00 \times 10^{-3} = 1.527 \times 10^{-3}$ mole

→ wt of mixture $= 0.065\,g\ (SCN^- + Cl^-)$

$X + Y = 0.065\ g$

moles of $AgNO_3$ = moles Cl^- + moles SCN^-

$$(MV)_{AgNO_3} = \left(\frac{X}{58.5} + \frac{Y}{74.5}\right) + (MV)_{SCN^-}$$

$$1.527 \times 10^{-3} = \left(\frac{0.065 - Y}{58.5} + \frac{Y}{74.5}\right) + (0.1008 \times 6.40 \times 10^{-3})$$

$$1.527 \times 10^{-3} = \frac{74.5(0.065 - Y) + 58.5Y}{4358.3} + 6.45 \times 10^{-4}$$

$$8.82 \times 10^{-4} = \frac{48 - 74.5Y + 58.5Y}{4358.3}$$

$$3.84 = 4.8 - 16Y$$

$$-0.96 = -16Y \rightarrow Y = 0.06\ g$$

mass of KCl

$\because X + Y = 0.065\ g \rightarrow X = 0.065 - 0.06 \rightarrow X = 0.005\ g$

mass of NaCl

$\Rightarrow$ Conc. of NaCl in g/l $= \frac{0.005 \times 1000}{10} = 0.5$ g/l

$\Rightarrow$ Conc. of KCl in g/l $= \frac{0.06 \times 1000}{10} = 6$ g/l

$\Rightarrow$ Comparison between 2 results from Step I and II :

part	mass NaCl	mass KCl
I	0.040g	0.025 g
II	0.005 g	0.06g

follow →

Questions

1) Why precipitation titrations by the Mohr's method requires a neutral solution?

Because in basic media (Ag^+) will react with (OH^-) from the base producing ($AgOH$) and this will increase the volume needed of $AgNO_3$ to titrate NaCl solution, as well as in acidic media ($Cr_2O_3^{2-}$) will be formed which means that active errors will occur. So the neutral media is the best media.

2) What is the effect of using acidic solution in the Fajan's method?

Because in Fajan's method we use Fluresen indicator which in acidic media solution will react with (H^+) from the acid to form (HF), so the indicator will be consumed to form the acid, so we need to add more of the titrant which is "$AgNO_3$" to reach the end point (until the solution became pink) so will have positive error.

3) What is the effect of using $K_2Cr_2O_7$ instead of K_2CrO_4 as an indicator on the titration results?

the K_{sp} of $K_2Cr_2O_7$ is greater than K_{sp} for K_2CrO_4 So it is more soluble. So reasing to the end point will need less volume of titrant. so the volume of $AgNO_3$ would increase.

4) What is the effect of using basic solutions on the results in precipitation titration

the volume of $AgNO_3$ will increase because of the reaction of Ag^+ with OH^- from the base (in Mohr's and Fajan's methods). So $AgOH_{(s)} \rightarrow Ag_2O_{(ppt)}$ (very large positive error). but in Volhard's method: Fe^{3+} will react with OH^- to form $Fe(OH)_3 \rightarrow Fe\downarrow$ So, we need more Ag^+ so positive error.

5) Why nitrobenzene is added in case of titration of Cl^- by the Volhard's method

Because nitrobenzene will cover the surface of $AgCl_{ppt}$, and prevent the following reaction between AgCl and the titrant SCN^- and prevent the formation of AgSCN.

$$AgCl + SCN^- \rightleftharpoons AgSCN^- + Cl^-$$

- AgCl is more soluble than AgSCN.
- K_{sp} AgCl > K_{sp} AgSCN.

* Name : Aya Rae'd Ismail Hasan.

ايه رائد اسماعيل حسن

* Reg. No. : [redacted]

* Section : "15"

8.5

* Experiment No. : "5"

* Experiment Name : Redox Titrations (Dichromate Titrations)

* Instructor's Name: Prof. Mohammed Rasheed.

* Date : 18th / Nov / 2021.

Experiment 5
Data Sheet and Calculations

Name: Aya Raed Hasan
Reg. No: [redacted]

Section: 15
Date: 18th / Nov / 2021

Unknown ID No.: 60	
(A) Determination of Fe^{2+} in a mixture	
Vol. of unknown solution	Vol. of $K_2Cr_2O_7$
1) 10.00 ± 0.05 ml	4.70 ± 0.07 ml
2) 10.00 ± 0.05 ml	4.20 ± 0.07 ml
3)	
(B) Determination of Fe^{3+} after reduction	
Vol. of unknown solution	Vol. of $K_2Cr_2O_7$
1) 10.00 ± 0.05 ml	5.50 ± 0.07 ml
2)	

Wt. of Fe^{2+} per liter = 2.98 g/L
Wt. of Fe^{3+} per liter = 0.704 g/L

Instructor's signature: .....

Instructor's Name: .....

18.11.21

Calculations

Part A: Determination of Fe^{2+} in a mixture

Note: No. of unknown 60

- Indicator: 2-4 drops of diphenylamine indicator.
  - Color Change: Colorless $\xrightarrow{to}$ violet-blue.
- equations: $(Fe^{2+} \longrightarrow Fe^{3+} + e) \times 6$

$$Cr_2O_7^{2-} + 14H^+ + 6e \longrightarrow 2Cr^{3+} + 7H_2O$$

net equation: $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

- Volume of unknown solution = $\boxed{10.00} \pm 0.05$ ml [using a pipette] → in 2 trials.
  - uncertainty: $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of H_2SO_4 = 10.00 ml
- Volume of H_3PO_4 = 5.00 ml (using a graduated cylinder)
  - uncertainty $= \frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of $K_2Cr_2O_7$ (titrant) → (using a burette)
  - → trial 1 = $\boxed{4.70} \pm 0.07$ ml
  - → trial 2 = $\boxed{4.20} \pm 0.07$ ml
  - uncertainty → $V_{K_2Cr_2O_7} = V_f - V_i \rightarrow \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- average volume of $K_2Cr_2O_7$ (V_1) = $\frac{4.70 + 4.20}{2} = \boxed{4.45}$ ml
- Molarity of $K_2Cr_2O_7$ = 0.02 M

Calculations:

$$M V_1(K_2Cr_2O_7) \times 6 = M V(Fe^{2+})$$

$$0.02 \times 4.45 \times 6 = M \times 10.00$$

$$M_{Fe^{2+}} = \frac{0.534}{10.00} = \boxed{0.0534\ M}$$

$$0.0534 \frac{mol}{L} \times 55.85 \frac{g}{mol} = \boxed{2.98\ g/L}$$

Mw of Fe = 55.85 g/mol

-0.5

very nice :)

reducing agent (Zn/Hg)

$Fe^{2+} + Fe^{3+} \rightarrow Fe^{2+} + Fe^{2+}$

$K_2Cr_2O_7$ (V_1): $K_2Cr_2O_7$ Oxidize Fe^{2+} only

$K_2Cr_2O_7$ (V_2): $K_2Cr_2O_7$ Oxidize total amount of Fe^{2+}

Part B: Determination of ($Fe^{2+} + Fe^{3+}$) as Fe^{2+}

- Indicator: 2-4 drops of diphenylamine indicator (in titration)
- equations: $Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

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

- Volume of $K_2Cr_2O_7$ (V_2) = $\boxed{5.50} \pm 0.07$ ml
  - uncertainty: $V_{K_2Cr_2O_7} = V_f - V_i \rightarrow \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- Volume of unknown solution = $\boxed{10.00} \pm 0.05$ ml (using a pipette)

follow →

Calculation:

→ $M \times (V_2 - V_1)\, K_2Cr_2O_7 \times 6 = M V(Fe^{2+})$

$0.02 \times (5.50 - 4.45) \times 6 = M \times 10.00$

$M_{Fe^{2+}} = \frac{0.126}{10.00} = \boxed{0.0126\ M}$ wow!

Solve it ✓ in two steps:-
1. M of Fe^{2+} total
2. M Fe^{2+} total − Fe^{2+} (part A)
OK? ^^

$0.0126 \frac{mol}{L} \times 55.85 \frac{g}{mol} = \boxed{0.704\ g/L}$, Mw of Fe : 55.85 g/mol

great!

-1

Questions

[1] What is the role of H_3PO_4 in determination of Fe^{2+} by titration with $K_2Cr_2O_7$?

H_3PO_4 forms colorless mixture with Fe^{3+}, so the yellow color of Fe^{3+} will not appear in the solution, so while titration we will detect the end point easily. and also it has lower potential difference.

[2] Can you determine iron in ores using $K_2Cr_2O_7$?

yes, because iron contains Fe_2O_3 and Fe_3O_4 which can be dissolved in acidic solutions to yet $Fe^{3+} \rightarrow Fe^{2+}$ by Johne's reductor, then titrate with $K_2Cr_2O_7$ using H_3PO_4 and diphenylamine sulfuric acid as indicator.

[3] How could you check that Fe^{3+} has been completely reduced to Fe^{2+}?

After preparing zinc amalgam (John's reductor) we add zinc amalgam to an erlenmeyer flask that contain a [10.00 ml of the unknown] and H_2SO_4 and boil it we add a drop of this mixture and 1 drop of NH_4SCN on apallete; if the color is blood red so, the reduction is not complete and we need to boil more to ensure that the reaction is completed and watch it until the color becomes colorless.

* Name : Aya Rae'd Ismail Hasan.

اية رائد اسماعيل حسن

* Reg. No. : [redacted]

* Section : "15"

* Experiment No. : "6"

* Experiment Name : Redox Titrations (Iodine Titrations).

* Instructor's Name : Prof. Mohammed Rasheed.

* Date : 25th / Nov / 2021.

Experiment 6
Data Sheet and Calculations

Name: Aya Rae'd Hasan. Section: 15
Reg. No: [redacted] Date: 25th / Nov / 2021

(A) Standardization of 0.1M thiosulfate			
Wt of KIO_3 = 0.3364 ± 0.0001g			
Volume of KIO_3		Volume of $Na_2S_2O_3$	
1- 10.00 ± 0.05	ml	10.20 ± 0.07	ml
2- 10.00 ± 0.05	ml	10.00 ± 0.07	ml
3-	ml		ml
(B) Standardization of 0.1M iodine:			
Volume of I_2		Volume of $Na_2S_2O_3$	
1- 10.00 ± 0.05	ml	18.00 ± 0.07	ml
2- 10.00 ± 0.05	ml	17.90 ± 0.07	ml
3-	ml		ml
(C) Determination of tin in the unknown:			
Unknown ID # : 70			
Volume of I_2	volume the unknown solution	Volume of $Na_2S_2O_3$	
1- 15.00 ± 0.05 ml	10.00 ± 0.05 ml		ml 18.10 ± 0.07 ml
2- 15.00 ± 0.05 ml	10.00 ± 0.05 ml		ml 15.70 ± 0.07
3- ml	ml		ml

Instructor's Signature: .....
Instructor's Name: .....
25.11.2021

Calculations

Part (A): Standardization of 0.1 M Sodium Thiosulfate

- Chemical equations: $KIO_3 + 5KI + 6HCl \longrightarrow 3I_2 + 3H_2O + 6KCl$

  $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$

- Indicator : iodine (acts as a self-indicator) Color will change from red-brown to yellow and then in back titration, we add starch solution the color will change from blue to colorless.
- Volume of KIO_3 in 2 trials = 10.00 ± 0.05 mL (using a pipette)
  - uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of $Na_2S_2O_3$:

  trial 1 : 10.20 ± 0.07 mL trial 2 : 10.00 ± 0.07 mL
  - uncertainty → $V_{Na_2S_2O_3} = V_f - V_i \rightarrow \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- Average volume of $Na_2S_2O_3$ ($\bar{V}$) = $\frac{10.20 + 10.00}{2}$ = 10.10 mL
- Wt of KIO_3 = 0.3364 ± 0.0001 g
- Mw of KIO_3 = 214.00 g/mol
- Mw of $S_2O_3^{2-}$ = 158.11 g/mol

No. of mol of KIO_3 = $\frac{m}{Mr} = \frac{0.3364}{214.00}$ = 1.572×10^{-3} mol

M of KIO_3 = $\frac{n}{V(L)} = \frac{1.572 \times 10^{-3}}{100.00 \times 10^{-3}}$ = 0.01572 mol/L

- for each 1 mole of KIO_3 there's 3 moles of I_2

$$n_{KIO_3} = \frac{1}{3} n\, I_2$$

$$n_{I_2} = 4.716 \times 10^{-3} \text{ mol } I_2$$

- for each 1 mole of I_2 there's 2 moles of $S_2O_3^{2-}$

$$n_{I_2} = \frac{1}{2} n_{S_2O_3^{2-}}$$

$$n_{S_2O_3^{2-}} = 9.432 \times 10^{-3} \text{ mol } S_2O_3^{2-}$$

∴ So $n_{KIO_3} = \frac{n_{S_2O_3^{2-}}}{6}$

$$\frac{M_1 V_1}{6}$$

$$0.01572 \times 10.00 = \frac{M_2 \times 10.10}{6} \rightarrow M_{2(S_2O_3^{2-})} = 0.09339 \text{ mol/L}$$

$$0.09339 \frac{mol}{L} \times 158.11 \frac{g}{mol} = 14.77 \text{ g/L}$$

Follow →

Part B: Standardization of 0.1 M Iodine

Chemical equation ⟶ ($I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2I^-$)

- Indicator : Iodine works as a self-indicator. (Color will change from red-brown to pale yellow, then we add 2 ml of starch (back titration) the color will change from blue to colorless.

- Volume of I_2 in 2 trials = 10.00 ± 0.05 ml
  - uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of $Na_2S_2O_3$ =

Trial 1: 18.00 ± 0.07 ml Trial 2: 17.90 ± 0.07 ml

- uncertainty → $V_{Na_2S_2O_3} = V_f - V_i \rightarrow \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- Average Volume of $Na_2S_2O_3$ ($\bar{V}$) = $\frac{18.00 + 17.90}{2} = 17.95$ ml
- Mw I_2 = 253.81 g/mol
- for each 1 mole of I_2 there's 2 moles of $S_2O_3^{2-}$

$$n_{I_2} = \frac{n_{S_2O_3^{2-}}}{2}$$

$$M_1V_1 = \frac{M_2V_2}{2} \rightarrow M_1 \times 10.00 = \frac{0.09339 \times 17.95}{2} \rightarrow M_1 = 0.08382\ M \text{ of } I_2$$

$$0.08382 \frac{mol}{L} \times 253.81 \frac{g}{mol} = 21.2791 L$$

Part C: Determination of Tin in an Unknown Sample

- Unknown ID# : 70
- Chemical equations: $Sn^{2+} + I_2 \rightarrow Sn^{4+} + 2I^-$

  $I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2I^-$
- Indicator : Starch : at the begining we will titrate until the color changes from red brown to pale yellow, then add 2 ml of starch and titrate (color change from blue → colorless)
- Volume of I_2 in the 2 trials = 15.00 ± 0.05 mL (using a pipette)
  - uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of unknown solution in 2 trials = 10.00 ± 0.05 mL (using a pipette)
  - uncertainty = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Volume of $Na_2S_2O_3$:

Trial 1 = 18.10 ± 0.07 ml Trial 2 = 15.70 ± 0.07 ml

- uncertainty → $V_{Na_2S_2O_3} = V_f - V_i \rightarrow \sqrt{(0.05)^2 + (0.05)^2} = \pm 0.07$
- Average Volume of $Na_2S_2O_3$ ($\bar{V}$) = $\frac{18.10 + 15.70}{2} = 16.90$ ml

follow →

Mw Sn^{2+} = 118.71 g/mol

. For each 1 mole of I_2 there's 1 mole of Sn^{2+}

$$n_{I_2} = n_{Sn^{2+}}$$

$$[n_{I_2 \text{ total}} - n_{I_2 \text{ react with } S_2O_3^{2-}}] = n_{Sn^{2+}}$$

$$\left[M_{I_2}V_{I_2} - \frac{M_{S_2O_3^{2-}}V_{S_2O_3^{2-}}}{2}\right] = M_{Sn^{2+}}V_{Sn^{2+}}$$

$$\left[0.08382 \times 15.00 - \frac{0.09339 \times 16.90}{2}\right] = M_{Sn^{2+}} \times 10.00 \rightarrow M_{Sn^{2+}} = \boxed{0.04682\ M}$$

$$0.04682 \frac{mol}{L} \times 118.71 \frac{g}{mol} = \boxed{5.558\ g/L}$$

Questions :

1) Iodine titration, must be carried out in neutral, slightly acidic or slightly alkaline solution, what would happen if strong acidic or strong alkaline solutions are used ?

In acidic media, air oxidize I_2 and a hydrolysis of starch occure :

$$4\ I^- + O_2 + 4H^+ \rightarrow 2\ I_2 + 2\ H_2O \quad [+ve \text{ error}]$$

In alkaline media : $I_2 + 2\ OH^- \rightarrow I^- + IO^- + H_2O$ [-ve error].

2) $Na_2S_2O_3$ solution must be prepared in recently boiled distilled water, why ?

To be sure there are no bacteria or air that may oxidize $Na_2S_2O_3$.

3) In standardization of $Na_2S_2O_3$ against KIO_3, the titration solution must be continuou stirred and the titration must be carried out immediately, why ?

To : 1) prevent oxidation of I^- by O_2.

2) prevent locate of thiosulfate, because it's decomposed to produce sulfe

4) In Iodine titration, Sodium bicarbonate or dry ice must be added Sometimes, why ?

It's from blanket of CO_2 over the solution, which contains I^- to avoid oxidation.

* Name : Aya Rae'd Ismail Hasan.

آية رائد اسماعيل حسن

* Reg. No. : [redacted]

* Section : "15"

* Experiment No. : "7"

* Experiment Name: Complexometric Titration using EDTA.

* Instructor's Name: Prof. Mohammed Rasheed.

* Date : 9th / Dec / 2021.

Experiment 7
Data Sheet and Calculations

Name: Aya Rae'l Hasan Section: 15

Reg. No: [redacted] Date: 9th / Dec / 2021

(A) Standardization of EDTA

Mass of $ZnSO_4.7H_2O$: 0.3237 ± 0.0001 g

Data	Trial 1	Trial 2	Trial 3	Average
Volume of $ZnSO_4.7H_2O$ Solution	10.00 ±0.05	10.00 ±0.05		10.00 ±0.05
Volume of EDTA solution	13.30 ±0.07	13.10 ±0.07		13.45 ±0.07
Molarity of EDTA solution	8.372×10^{-2}	8.372×10^{-2}		8.372×10^{-2}

(B) Determination of Water Hardness

Data	Trial 1	Trial 2	Trial 3	Average
1- Vol. of tap water	50.00 ±0.25	50.00 ±0.25		50.00 ±0.25
2- Vol. of EDTA solution (V_1) (corresponding to Ca and Mg)	13.10 ±0.07	13.40 ±0.07		13.25 ±0.07
3- Vol. of tap water	50.00 ±0.25	50.00 ±0.25		50.00 ±0.25
4- Vol. of EDTA (V_2) (corresponding to Ca)	7.20 ±0.07	6.70 ±0.07		6.95 ±0.07

Data	Trial 1	Trial 2	Trial 3	Average
Volume of EDTA Corresponding to Mg (V_1-V_2)	5.90 ± 0.10	6.70 ± 0.10		6.30 ± 0.14
ppm Ca	46.65 ppm	46.65ppm		46.65 ppm
ppm Mg	25.5 ppm	25.5ppm		25.5 ppm
Water hardness (mg $CaCO_3$/L)	222.1 mg/L	222.1 mg/L		222.1 mg/L

(C) Unknown solution

Unknown ID No. 19

Data	Trial 1	Trial 2	Trial 3	Average
1. Vol. of unknown solution	10.00 ± 0.05	10.00 ± 0.05		10.00 ± 0.05
2. Vol. of EDTA solution	26.90 ± 0.07	27.20 ± 0.07		27.05 ± 0.07
3. ppm Ca and Mg	—	—		626 mg Ca^{2+} and Mg^{2+}
4. Vol. of unknown solution	10.00 ± 0.05	10.00 ± 0.05		10.00 ± 0.05
5. Vol. of EDTA solution	5.90 ± 0.07	5.40 ± 0.07		5.65 ± 0.07
6. ppm Ca	—	—		190 mg/L

Instructor's Signature: .....

Instructor's Name: .....

09-12-21

Calculations

Part A: Standardization of 0.01M EDTA Solution with Standard Zinc Sulfate Solution

- weight of Zinc sulfate ($ZnSO_4.7H_2O$) = **0.3237 ± 0.0001 g**
- No. of moles of ($ZnSO_4.7H_2O$) = $\frac{m}{Mwt}$, Molar mass of $ZnSO_4.7H_2O$ = **287.55 g/mol**

$$= \frac{0.3237}{287.55}$$

$$n = 1.126 \times 10^{-3} \text{ mole of } ZnSO_4.7H_2O$$

- Molarity of $ZnSO_4.7H_2O$ = $\frac{n}{V(L)} = \frac{1.126 \times 10^{-3}}{100.00 \times 10^{-3}} =$ **0.01126 M**
- Average Volume of $ZnSO_4.7H_2O$ ($\bar{V}$) = **10.00 ± 0.05 ml** (in 2 trials) "using a pipette"
  - error = $\frac{1}{2} \times 0.1 = \pm 0.05$
- Average Volume of EDTA Solution ($\bar{V}$) = $\frac{13.80 + 13.10}{2}$ = **13.45 ± 0.07 ml**
  - error → $V_{EDTA} = V_f - V_i \rightarrow \pm 0.07$

? → $(M\bar{V})$ EDTA = $(M\bar{V})$ $ZnSO_4.7H_2O$

$$M \times 13.45 \times 10^{-3} = 0.01126 \times 10.00 \times 10^{-3}$$

$$M_{EDTA} = \frac{0.01126 \times 10.00 \times 10^{-3}}{13.45 \times 10^{-3}} = 8.372 \times 10^{-3} \text{ M of EDTA}$$

Part B: Determination of water hardness

- Chemical equations:

$$M^{n+} + H_2Y^{2-} \rightleftharpoons MY^{n-4} + 2H^+$$

$$Mg^{2+} + H_2Y^{2-} \rightleftharpoons MgY^{-2} + 2H^+$$

$$Ca^{2+} + H_2Y^{2-} \rightleftharpoons CaY^{2-} + 2H^+$$

- Molar mass (Mg^{2+}) = 24.31 g/mol
- Molar mass (Ca^{2+}) = 40.08 g/mol
- Molar mass ($CaCO_3$) = 100.09 g/mol

1. ppm of Ca^{2+} : # V_1 = volume of EDTA corresponding to Ca^{2+} and Mg^{2+} # V_2 = Volume of EDTA corresponding to Ca^{2+} only

- Average volume of EDTA Solution ($\bar{V}_2$) = $\frac{7.20 + 6.70}{2}$ = **6.95 ± 0.07 ml**

$$(M\bar{V}_2) \text{ EDTA} = (M\bar{V}) Ca^{2+}$$

$$8.372 \times 10^{-3} \times 6.95 \times 10^{-3} = M \times 50.00 \times 10^{-3}$$

$$M_{Ca^{2+}} = 1.164 \times 10^{-3} \frac{mol}{L}$$

$$\text{ppm } Ca^{2+} = 1.164 \times 10^{-3} \frac{mol}{L} \times 40.08 \frac{g}{mol} \times \frac{1000 mg}{1 g} = \mathbf{46.65 \frac{mg}{L}}$$

follow →

ppm of Mg^{2+} : $V_1 - V_2$ ⇒ corresponding to Mg^{2+}

$= 13.25 - 6.95 = 6.30 \pm 0.14$ mL

$(M\bar{V})_{EDTA} = (M\bar{V})_{Mg^{2+}}$

$8.372 \times 10^{-3} \times 6.30 \times 10^{-3} = M \times 50.00 \times 10^{-3}$

$M_{Mg^{2+}} = 1.05 \times 10^{-3}$ M

ppm $Mg^{2+} = 1.05 \times 10^{-3} \frac{mol}{L} \times 24.31 \frac{g}{mol} \times \frac{1000\,mg}{1\,g} =$ **25.5** ppm

[3] water hardness

$(M\bar{V}_1)_{EDTA} = (M\bar{V})_{CaCO_3}$

$8.372 \times 10^{-3} \times 13.25 \times 10^{-3} = M \times 50.00 \times 10^{-3}$

$M_{CaCO_3} = 2.219 \times 10^{-3}$ M

$2.219 \times 10^{-3} \frac{mol}{L} \times 100.09 \frac{g}{mol} \times \frac{1000\,mg}{1\,g} =$ **222.1** $\frac{mg}{L}$

Average volume of EDTA solution $(\bar{V}_1) = \frac{13.10 + 13.40}{2} = 13.25 \pm 0.07$ mL

Part C : Determination of the concentration of Calcium and Magnesium; in an Unknown Solution

[1] water hardness

$(M\bar{V})_{EDTA} = (M\bar{V})_{CaCO_3}$

$8.372 \times 10^{-3} \times 27.05 \times 10^{-3} = M \times 10.00 \times 10^{-3}$

Average volume of EDTA solution $= \frac{26.90 + 27.20}{2} = 27.05 \pm 0.07$ mL

$M_{CaCO_3} = 0.02265$ M

$ppm_{CaCO_3} = 0.02265 \frac{mol}{L} \times 100.09 \frac{g}{mol} \times \frac{1000\,mg}{1\,g} =$ **2267** $\frac{mg}{L}$

[2] ppm Ca^{2+}

$(M\bar{V}_2)_{EDTA} = (M\bar{V})_{Ca^{2+}}$

$3.372 \times 10^{-3} \times 5.65 \times 10^{-3} = M \times 10.00 \times 10^{-3}$

Average volume of EDTA solution $(\bar{V}_2) = \frac{5.90 + 5.40}{2} = 5.65 \pm 0.07$ mL

$M_{Ca^{2+}} = 4.73 \times 10^{-3}$ M

ppm $Ca^{2+} = 4.73 \times 10^{-3} \frac{mol}{L} \times 40.08 \frac{g}{mol} \times \frac{1000\,mg}{1\,g} = 189.5 \approx$ **190** $\frac{mg}{L}$

[3] ppm Mg^{2+}

(EDTA)$\bar{V}$ corresponding to $Mg^{2+} = 27.05 - 5.65 = 21.40 \pm 0.14$ mL

$(M\bar{V})_{EDTA} = (M\bar{V})_{Mg^{2+}}$

$8.372 \times 10^{-3} \times 21.40 \times 10^{-3} = M \times 10.00 \times 10^{-3}$

$M_{Mg^{2+}} = 0.01792$ M

ppm $Mg^{2+} = 0.01792 \frac{mol}{L} \times 24.31 \frac{g}{mol} \times \frac{1000\,mg}{1\,g} =$ **435.6** $\frac{mg}{L}$

[4] ppm Ca^{2+} and $Mg^{2+} = 435.6$ mg Mg^{2+}/L + 190 mg Ca^{2+}/L = **626** mg Ca^{2+} and Mg^{2+}

* Name : Aya Rae'd Ismail Hasan.

ايه رائد اسماعيل حسن

* Reg. No. : [redacted]

* Section : "15"

* Experiment No. : "8"

* Experiment Name : Determination of Calcium by Quantitative Precipitation and Titration.

* Instructor's Name : Prof. Mohammed Rasheed.

* Date : 2th / Dec / 2021.

Experiment 8

Data Sheet and Calculations

Name: Aya Rae'd Hasan. Section: 15

Reg. No: [redacted] Date: 2nd / Dec / 2021.

Unknown ID No.:

(A) Standardization of $KMnO_4$

Mass of Sodium oxalate 0.6030 ± 0.0001 g per 100 mL

Molarity of sodium oxalate = 0.0450 M

Vol. of $Na_2C_2O_4$ solution	Vol. of $KMnO_4$
1) 10.00 ± 0.05	9.05 ± 0.07
2) 10.00 ± 0.05	9.00 ± 0.07
3) 10.00 ± 0.05	8.90 ± 0.07

Molarity of $KMnO_4$ solution = 0.0200 M

Concentration of $KMnO_4$ in g/L: 3.16 g/L

(B) Precipitation and Titration of Ca^{2+}

Vol. of Ca^{2+} solution	Vol. of $KMnO_4$
1) 10.00 ± 0.05	29.90 ± 0.07
2)	
3)	

Concentration of Ca^{2+} solution in g/L = 6.01 g/L

Instructor's Signature: .....

Instructor's Name: .....

Calculations

Part (A): Standardization of 0.1 M $KMnO_4$

- Chimical equations : $Ca^{2+} + C_2O_4^{2-} \rightleftharpoons CaC_2O_{4(s)}$

$$CaC_2O_4 + H_2SO_4 \rightarrow CaSO_4 + H_2C_2O_4$$

$$5\,H_2C_2O_4 + 2\,MnO_4^- + 6H^+ \rightarrow 2\,Mn^{2+} + 10\,CO_2 + 8H_2O$$

- Calculations of part (A) :
  - Mass of Sodium oxalate = 0.6030 ± 0.0001 g
  - Mw of $Na_2C_2O_4$ = 134 g/mol
  - Mw of $KMnO_4$ = 158.03 g/mol
  - average volume of $KMnO_4$ ($\bar{V}$) = $\frac{9.05 + 9.00 + 8.90}{3}$ = 8.98 ml
  - Volume of $Na_2C_2O_4$ in 3 trials = 10.00 ± 0.05 ml
  - n of moles of $Na_2C_2O_4$ = $\frac{m}{Mr}$ = $\frac{0.6030}{134}$ = 4.50×10^{-3} mole.

$$\therefore M_{Na_2C_2O_4} = \frac{n}{V(L)} = \frac{4.50 \times 10^{-3}}{100.00 \times 10^{-2}} = 0.0450\ M$$

$$\frac{M_{KMnO_4} V_{KMnO_4}}{2} = \frac{M_{C_2O_4^{2-}} \cdot V_{C_2O_4^{2-}}}{5} \rightarrow \frac{M_{KMnO_4} \times 8.98}{2} = \frac{0.0450 \times 10.00}{5} \rightarrow M_{KMnO_4} = 0.0200$$

$$0.0200\ \frac{mol}{L} \times 158.03\ \frac{g}{mol} = 3.16\ g/L$$

Part (B): Precipitation of Calcium as Calcium oxalate and titration with Standard $KMnO_4$ Solution

- Chemical equations : Reduction equation: $(8H^+ + MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O) \times 2$

Oxidation equation: $(H_2C_2O_4 \rightarrow 2CO_2 + 2H^+ + 2e^-) \times 5$

Net equation : $6H^+ + 2MnO_4^- + 5H_2C_2O_4 \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$

- Mw of Ca^{2+} = 40.08 g/mol
- Volume of $KMnO_4$ = 29.90 ± 0.07 ml
- Volume of Ca^{2+} Solution = 10.00 ± 0.05 ml

$$\frac{n\,Ca^{2+}}{5} = \frac{n\,CaC_2O_4}{5} = \frac{n_{H_2C_2O_4}}{5} = \frac{n_{KMnO_4}}{2}$$

$$\therefore \frac{n\,Ca^{2+}}{5} = \frac{n\,KMnO_4}{2}$$

$$\frac{(MV)Ca^{2+}}{5} = \frac{(MV)KMnO_4}{2} \rightarrow \frac{M_{Ca^{2+}} \times 10.00}{5} = \frac{0.0200 \times 29.90}{2} \rightarrow M_{Ca^{2+}} = 0.150\ M$$

$$0.150\ \frac{mol}{L} \times 40.08\ \frac{g}{mol} = 6.01\ g/L$$

follow →

Questions

[1] Why methyl red is used ?

Because this indicator have pH between "4.5 - 6.2", the pH range of indicator is suitable for pH solution to precipitate Ca^{2+} as CaC_2O_4 in neutral or slightly basic media.

[2] Why the precipitate must be washed ?

[1] To get rid of Cl^-, because Cl^- will react with $KMnO_4$ to give Cl_2, and it will cause to have an (+ve) error.

[2] To get rid of $C_2O_4^{2-}$ (oxalate), because it react with H_2SO_4 to give $H_2C_2O_4$ which will consume more volume of the titrant ($KMnO_4$) and be the cause of having positive error [(+ve) error].

[3] What are the possible sources of error in carrying out this experiment ?

1. incomplete dissolving CaC_2O_4 with H_2SO_4.
2. incomplete washing.
3. incomplete filtration.
4. incomplete precipitation of the solution.
5. There was free Chloride (Cl^-) or free Oxalate ($C_2O_4^{2-}$).

شغلة

* Name: Aya Rae'd Ismail Hasan.

اية رائد اسماعيل حسن

يوم الخميس

* Reg.NO. : [redacted]

* Section: "15"

* Experiment No.: "9"

* Experiment Name: Gravimetric Determination of Sulfate.

* Instructor's Name: Prof. Mohammed Rasheed.

* Date: 23th / Dec / 2021.

Experiment 9
Data Sheet and Calculations

Name: Aya Rae'd Hasan Section: 15

Reg. No.: [redacted] Date: 23rd / Dec / 2021

Unknown ID No.:	
Vol. of unknown solution	10.00 ± 0.05 mL
Mass of empty crucible	16.7334 ± 0.0001 g
Mass of crucible + precipitate	17.3425 ± 0.0001 g
Mass of precipitate ($BaSO_4$)	0.6091 g ± 0.0001
Mass of sulfate	0.2507 g
Concentration of sulfate in mg/L	2.5070×10^4 mg/L

Instructor's Signature: .....

Instructor's Name: .....

Calculations

- Chemical equations : $Ba^{2+}_{(aq)} + SO_4^{2-}_{(aq)} \longrightarrow BaSO_{4(s)}$

- Volume of SO_4^{2-} in an unknown solution = 10.00 ± 0.05 ml
- Mass of empty crucible (m_1) = 16.7334 ± 0.0001 g
- Mass of crucible + precipitate (m_2) = 17.3425 ± 0.0001 g
- Mass of precipitate ($BaSO_4$) = $m_2 - m_1$

$= 17.3425 - 16.7334$

$m_{BaSO_4} = 0.6091$ g

- uncertainty = $\sqrt{(0.0001)^2 + (0.0001)^2} = \pm 0.0001$

- M_w of SO_4^{2-} = 96.06 g/mol
- M_w of $BaSO_4$ = 233.38 g/mol

$\therefore m_{SO_4^{2-}} = m_{BaSO_4} \times \frac{Mw\ SO_4^{2-}}{Mw\ BaSO_4}$

$= 0.6091_3 \times \frac{96.06\ g/mol}{233.38\ g/mol} = 0.2507$ g of SO_4^{2-}

$\therefore$ Concentration of $SO_4^{2-} = \frac{\text{mass } SO_4^{2-}}{10 \times 10^{-3}} \times 1000$ mg

$= \frac{0.2507}{10 \times 10^{-3}} \times 1000 = 2.5070 \times 10^4$ mg/L

- Questions :

1) Why should the sulfate precipitation be carried out in a slightly acidic solution ?

to : 1) prevent co-precipitate of Ba^{2+}. 2) Force precipitate to form larger crystals and so making filtration easier.

3) prevent any crystals passing with filtrate throw the filter paper.

2) Why the $BaCl_2$ solution is added quickly to the sulfate containing solution ?

to : 1) prevent inclusion and occlusion. 2) Ensure that only $BaSO_4$ will precipitate.

3) Why filtration is carried out while the solution is still hot ?

If the solution not filtered hot, the solution might crystallize quickly thus trapping the insoluble impurities (to prevent co-precipitation).

4) Why the filter paper should be charred without inflaming ?

To prevent reduction of $BaSO_4$ by carbon :

$BaSO_4 + 4C \rightarrow BaS + 4CO$

10

Experiment 11
Data Sheet and Calculations

Name: Aya Rae'd Hasan. Section: 15
Reg. No.: [redacted] Date: 30th / Dec. / 2021

Unknown ID No.: 85		
Trial	Volume of 0.02 M NaOH	Volume of unknown
1	16.10 ± 0.07 mL	10.00 ± 0.05 mL
2	mL	mL
3	mL	mL
	Average: ..... mL	

- Number of mmols of H^+: 0.322 mmole
- Number of mmols of displaced (exchanged) Ca^{2+} per liter of the unknown: 16.1 mmole / L
- Concentration of Ca^{2+}: ~~0.0161~~ 0.0161 mole / L ppm: ~~645.288~~ 645.288 ppm

Instructor's Signature: .....

Instructor's Name: Manar A.L.

30.12.2021

* Name : Aya Rae'd Ismail Hasan.

اية رائد اسماعيل حسن

* Reg. No. : [redacted]

* Section : "15"

* Experiment No. : "12"

* Experiment Name : paper Chromatography

* Instructor's Name : prof. Mohammed Rasheed.

* Date : 16th / Dec / 2021.

Experiment 12

Data Sheet and Calculations

Name: Aya Rae'd Hasan. Section: 15

Reg. No. [redacted] Date: 16th Dec 2021.

A. PURE COMPONENTS

Component	X_s	X_c	$X_c/X_s = R_f$
Cargo red	5	1.5	0.3
Phenyl red	5	4.2	0.84
Bromothymol blue	5	5	1
Methyl orange	5	4.8	0.96

X_s = Distance of the solvent front, X_c = Distance of the component

B. UNKNOWN SAMPLE

Distance of the solvent front 5 cm (X_s)

Spot Nr.	X_c	$R_f = X_c/X_s$	SpotIdentification
1	1.6	0.32	Cargo red
2	4.1	0.82	Phenyl red
3			
4			

Instructor's Signature: .....

Instructor's Name: .....