King Saud University
Faculty of Science
Chemistry Department

General Practical Chemistry
EXPERIMENTS REOPRTS
101 Chem & 104 Chem

Text Book:
Practical General Chemistry
By
Dr. Ahmad Al-Owais & Dr. Abdulaziz Al-Wassil

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

LIST OF EXPERIMENTS

Week	Date	Experiment	Book Page
1		Determination of a Liquid Density	131 - 133
2		Preparation of a Standard Solution of Sodium Carbonate	63 - 86
3		Determination of Organic Indicators for Acid Base Titrations	95 - 98
4		Determination of Sodium Hydroxide Concentration By Titrations With A Standard Solution of Hydrochloric Acid +Quiz 1	99 - 109
5		Determination of Acetic Acid Concentration By Titrations With A Standard Solution of Sodium Hydroxide	99 - 109
6		Determination of Hydrochloric Acid Concentration By Titrations With A Standard Solution of Sodium Carbonate	87 - 93
7		First Exam	
8		Measurement of Gas Diffusion (Graham's Law of Diffusion)	137 - 140
9		Determination of Critical Solution Temperature+ Quiz 2	177 - 180
10		Hess's Law	197 - 203
11		Effect of Concentration on Reaction Rate	183 - 190
12		Determination of The Molar Mass of An Organic Compound by The Depression of Its Freezing Point	205 - 216
13		Determination of The Molar Mass of An Organic Compound by The Steam Distillation+ Quiz 3	191 - 196
14		Second Exam	

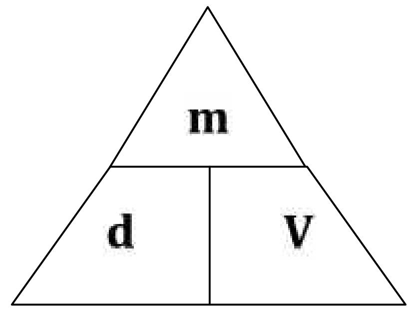
Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (1)
Determination of a Liquid Density

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Symbols

Mass of the empty beaker in g = m_1
Mass of the beaker and the liquid in g = m_2
Mass of the liquid $(m_2 - m_1)$ in g = m
Volume of the liquid in cm^3 = V
Density of liquid $(\frac{m}{V})$ in g / cm^3 = d



Notes:

The liquid used in this experiment is:

Results and Calculations:

1. Calculate the liquid's density in all cases and put in the following table:

V (cm^3)								
m_2 (g)								
m_1 (g)								
m (g)								
d (g / cm^3)								

2. Plot the relationship between the mass of the liquid (m) on the Y-axis versus its volume (V) on the X-axis, and find the liquid's density from the slope.

slope = d = $\frac{\Delta m}{\Delta V} = \frac{\_\_\_\_ - \_\_\_\_}{\_\_\_\_ - \_\_\_\_}$ = ________ =

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

Experiment (1)

Graphical relation between mass of liquid (m) and its volume (V)

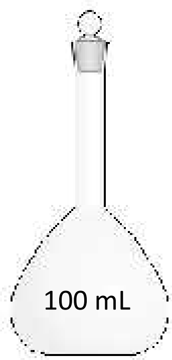
Created with nitro PDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (2)

<u>Preparation of a Standard Solution of Sodium Carbonate</u>

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Molar masses (g mol^{-1}): C = 12 ,	O = 16 ,	Na = 23



<u>Results & calculation:</u>

Molarity of sodium carbonate standard solution = $C_{Na_2CO_3}$ = mol L^{-1}

Molar mass of Na_2CO_3 = $M_{Na_2CO_3}$ = g mol^{-1}

Volume of solution in L = V = L

Number of mole of Na_2CO_3 = $n_{Na_2CO_3} = C_{Na_2CO_3} \times V$ = × = mol

Mass of Na_2CO_3 = $m_{Na_2CO_3} = n_{Na_2CO_3} \times M_{Na_2CO_3}$ = × = g

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (3)
Determination of Organic Indicators for Acid Base Titrations

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

A) Titration of a strong acid (HCl) with a strong base (NaOH) using the pH meter

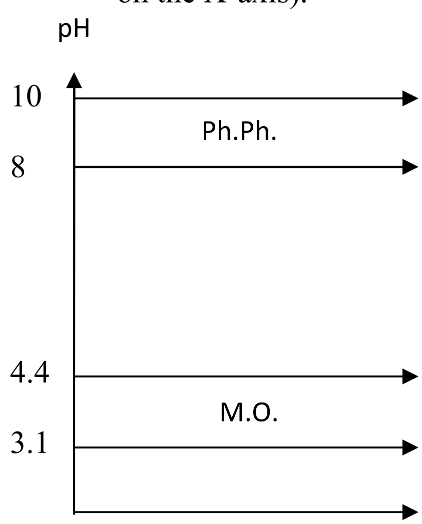
Molar masses (g mol^{-1}): H = 1 ,	O = 16 ,	Na = 23

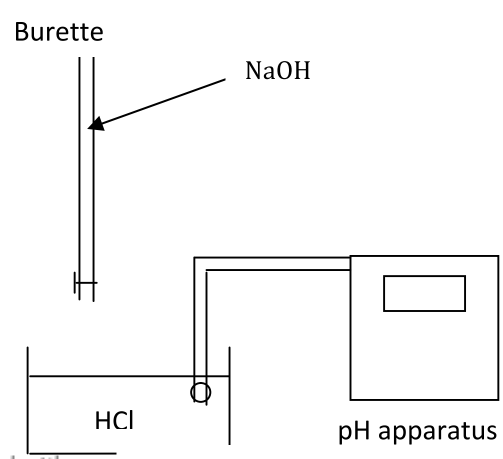
Results & calculation:

Volume of base added (V_{base})	0	5	10	15	20	22.5	24	24.5	24.8	25	26	28	30
Calculated pH	1.2	1.3	1.4	1.6	1.9	2.3	2.8	3.3	3.6	9.7	11	11.4	11.6
Measured pH													

HCl molarity = M = molar
HCl volume = V = mL
NaOH molarity = M' = molar
NaOH volume (from diagram) = V' = mL

1. Knowing that the pH range for methyl orange indicator (M.O.) is from 3.1 to 4.4, and for phenol phethaline indicator (Ph.Ph.) is from 8 to 10, plot pH (on the Y-axis) against V_{base} (on the X-axis).





From the graph:

- The pH range at the equivalent point is from (   ) to (   ).
- The suitable indicator for this titration is (   ).

2. Calculation of the base molarity :

3. Calculation of the base concentration in g L^{-1}:

4. Calculation of pH, pOH, $[H^+]$ and $[OH^-]$:

	HCl solution	NaOH solution
pH		
pOH		
$[H^+]$		
$[OH^-]$		

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

Experiment (3)

A) Graphical relation between the (pH) and the volume of base added (V)
(Titration of a strong acid with a strong base)

Created with nitro PDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (3)

Determination of Organic Indicators for Acid Base Titrations

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

B) Titration of a weak acid (CH_3COOH) with a strong base (NaOH) using the pH meter

Molar masses (g mol^{-1}): H = 1 ,	C = 12	O = 16

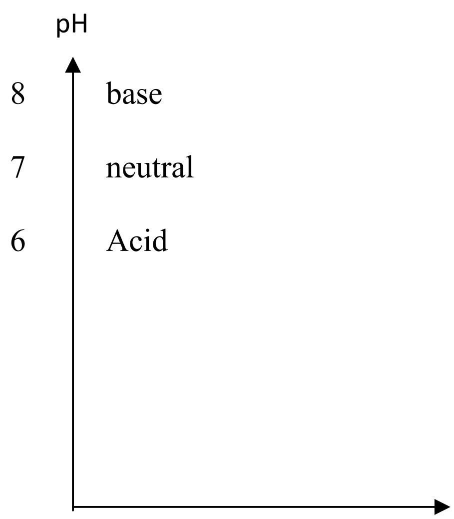
Results & calculation:

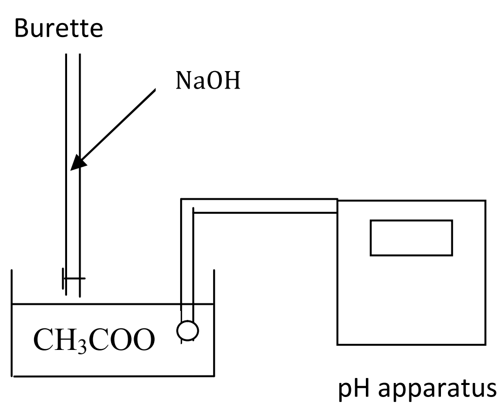
Volume of base added (V_{base})	0	2	4	6	8	10	12	14	16	17	17.5	18	18.5
Calculated pH	1.2	1.3	1.4	1.6	1.9	2.3	2.8	3.3	3.6	9.7	11	11.4	11.6
Measured pH													

CH_3COOH molarity = M = molar
CH_3COOH volume = V = mL
NaOH molarity = M' = molar
NaOH volume (from diagram) = V' = mL

Requirements:

1. Knowing that the pH range for methyl orange indicator (M.O.) is from 3.1 to 4.4, and for phenol phethaline indicator (Ph.Ph.) is from 8 to 10, plot pH (on the Y-axis) against V_{base} (on the X-axis).





From the graph:

- The pH range at the equivalent point is from (   ) to (   ).
- The suitable indicator for this titration is (   ).

5. Calculation of the base molarity :

6. Calculation of the base concentration in g L^{-1}:

7. Calculation of pH, pOH, $[H^+]$ and $[OH^-]$:

	HCl solution	NaOH solution
pH		
pOH		
$[H^+]$		
$[OH^-]$		

Experiment (3)

B) Graphical relation between the (pH) and the volume of base added (V)
(Titration of a weak acid with a strong base)

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (4)

Determination of Sodium Hydroxide Concentration By Titrations With A Standard Solution of Hydrochloric Acid

DATE:

STUDENT'S NAME:

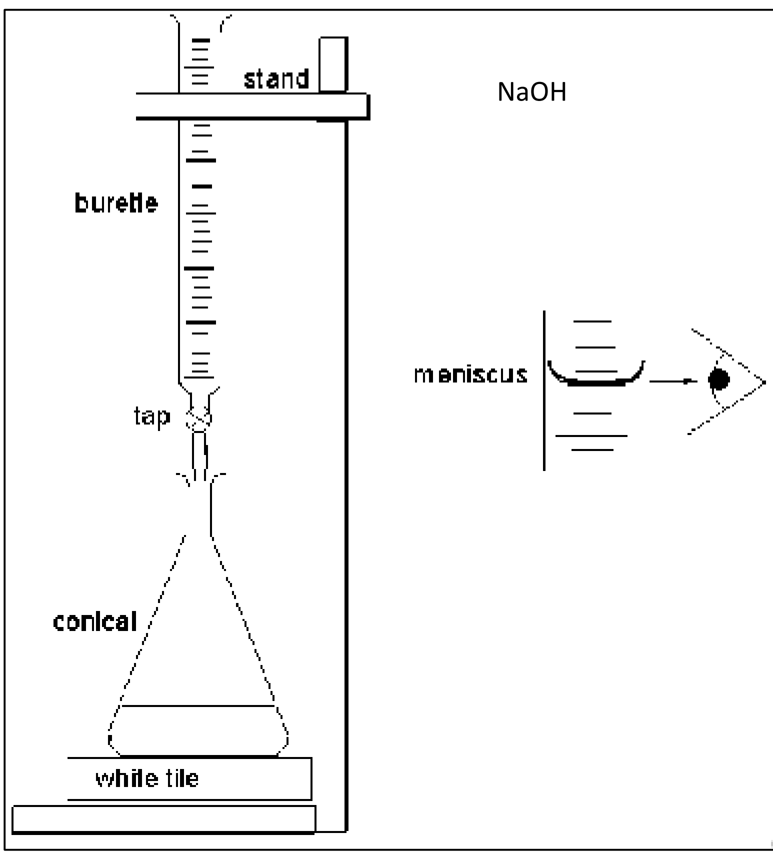
STUDENT'S NUMBER:

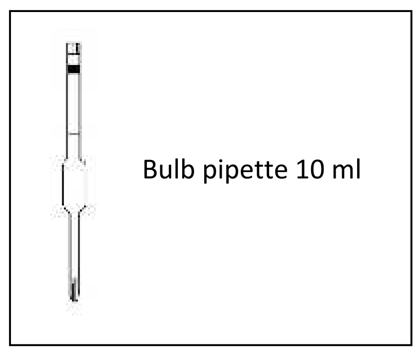
Molar masses (g mol^{-1}): H = 1 , O = 16 Na = 23

Results:

FIRST: Volume of NaOH using Ph.Ph. as indicator:

Exp.	Initial reading	Final reading	Volume (V) mL	Average
1				
2				
3				





Calculations:

1. Volume of NaOH = V = mL

2. Volume of HCl = V' = mL

3. Molarity of HCl = M' = mol L^{-1}

4. The reaction equation is:

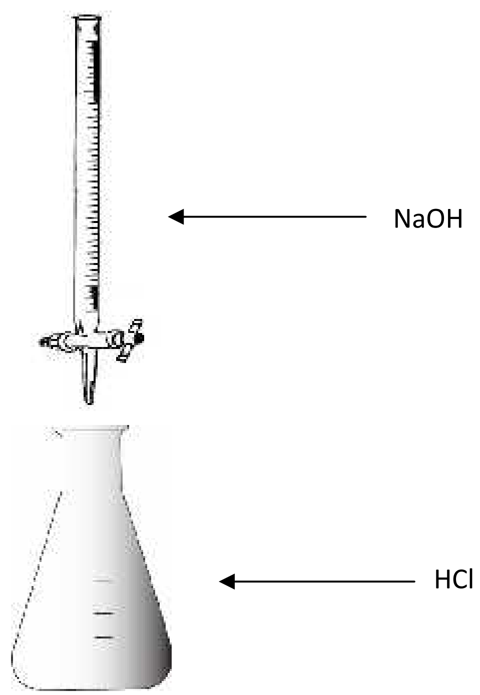
5. Calculation of the base molarity:
   - Ph.Ph. indicator used is ( ).
   - pH range of indicator is from ( ) to ( ).
   - At the end point the color of indicator changed from ( ) to ( ).
   - From the reaction equation using Ph .Ph. as indicator:
     n =
     n' =

6 Calculation of the base concentration in g L^{-1}:

Created with nitro PDF professional
download the free trial online at nitropdf.com/professional

SECOND: Volume of NaOH using M.O. as indicator:

Exp.	Initial reading	Final reading	Volume (V) mL	Average
1				
2				
3				



Created with nitro PDF professional
download the free trial online at nitropdf.com/professional

Calculations:

1. Volume of NaOH = V = mL
2. Volume of HCl = V' = mL
3. Molarity of HCl = M' = mol L^{-1}
4. The reaction equation is:
5. Calculation of the base molarity:
   - Indicator used is ( ).
   - pH range of indicator is from ( ) to ( ).
   - At the end point the color of indicator changed from ( ) to ( ).
   - From the reaction equation using M.O. as indicator:
     n =
     n' =
6. Calculation of the base concentration in g L^{-1}:

Created with nitro PDF professional
download the free trial online at nitropdf.com/professional

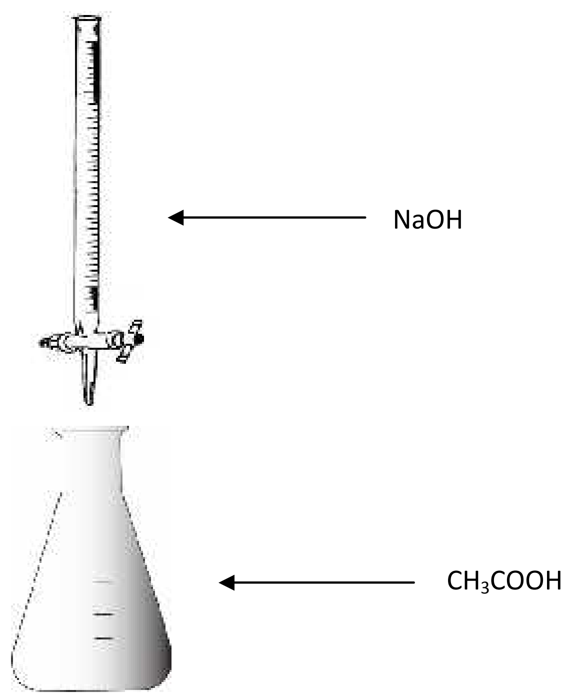
EXPERIMENT (5)
Determination of Acetic Acid Concentration By Titrations With A Standard Solution of Sodium Hydroxide

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Molar masses (g mol^{-1}): H = 1 , C = 12 O = 16

Results:
FIRST: Volume of NaOH using M.O. as indicator:

Exp.	Initial reading	Final reading	Volume (V) mL	Average
1				
2				
3				



Calculations:

1. Volume of NaOH = V = mL

2. Volume of CH_3COOH = V' = mL

3. Molarity of NaOH = M' = mol L^{-1}

4. The reaction equation is:

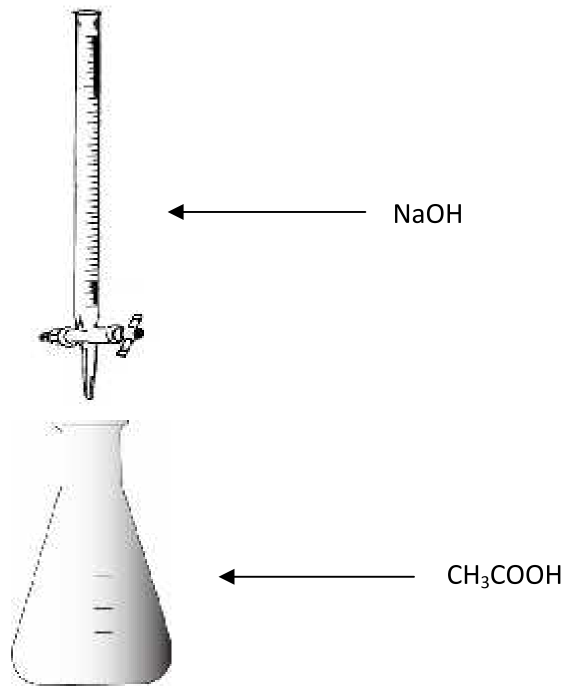
5. Calculation of the acid molarity:
   - Indicator used is ( ).
   - pH range of indicator is from ( ) to ( ).
   - At the end point the color of indicator changed from ( ) to ( ).
   - From the reaction equation using M.O. as indicator:
     n =
     n' =

6. Calculation of the acid concentration in g L^{-1}:

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

SECOND: Volume of NaOH using Ph.Ph. as indicator:

Exp.	Initial reading	Final reading	Volume (V) mL	Average
1				
2				
3				



Calculations:

1. Volume of NaOH = V = mL
2. Volume of CH_3COOH = V' = mL
3. Molarity of NaOH = M' = mol L^{-1}
4. The reaction equation is:
5. Calculation of the acid molarity:
   - Indicator used is ( ).
   - pH range of indicator is from ( ) to ( ).

- At the end point the color of indicator changed from (   ) to (   ).
- From the reaction equation using M.O. as indicator:
  n =
  n' =

6. Calculation of the acid concentration in g L^{-1}:

EXPERIMENT (6)

Determination of Hydrochloric Acid Concentration By Titrations With A Standard Solution of Sodium Carbonate

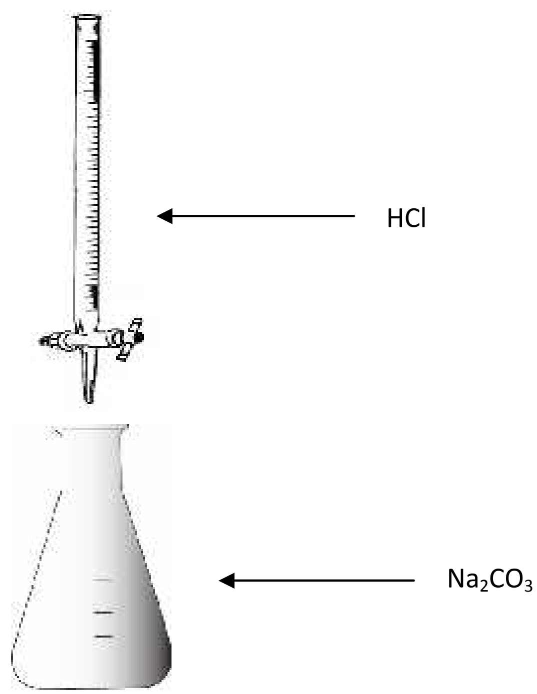
DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Molar masses (g mol^{-1}): H = 1 , Cl = 35.45

Results:

Volume of HCl using M.O. as indicator:

Exp.	Initial reading	Final reading	Volume (V) mL	Average
1				
2				
3				



Calculations:

1. Volume of HCl = V = mL
2. Volume of Na_2CO_3 = V' = mL
3. Molarity of Na_2CO_3 = M' = mol L^{-1}
4. The reaction equation is:
5. Calculation of the acid molarity:
   - Indicator used is ( ).
   - pH range of indicator is from ( ) to ( ).
   - At the end point the color of indicator changed from ( ) to ( ).
   - From the reaction equation using M.O. as indicator:
     n =
     n' =
6. Calculation of the acid concentration in g L^{-1}:

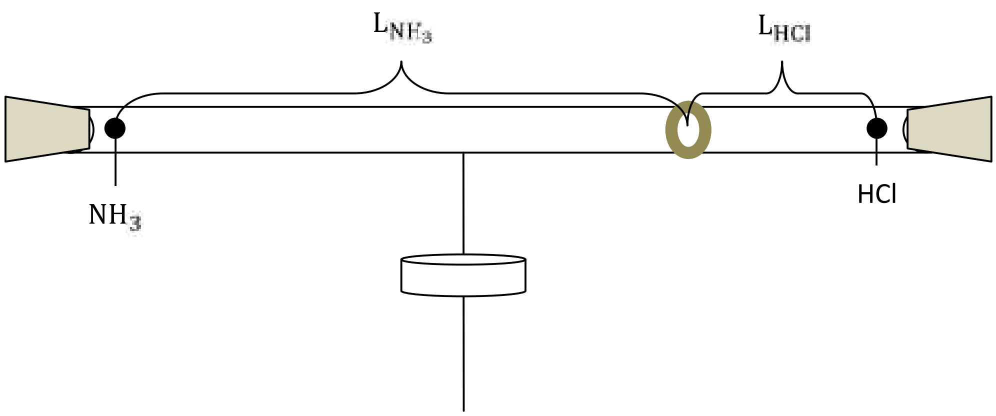
Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (7)
Measurement of Gas Diffusion
(Graham's Law of Diffusion)

STUDENT'S NAME:
STUDENT'S NUMBER:

Molar masses (g mol^{-1}): H = 1 ,N= 14 Cl = 35.45

$$\frac{r_{NH_3}}{r_{HCl}} = \frac{\sqrt{d_{HCl}}}{\sqrt{d_{NH_3}}} = \frac{\sqrt{M_{HCl}}}{\sqrt{M_{NH_3}}} \qquad \text{(Graham's law)}$$



$$\frac{r_{NH_3}}{r_{HCl}} = \frac{\frac{L_{NH_3}}{time}}{\frac{L_{HCl}}{time}}$$

$$\frac{L_{NH_3}}{L_{HCl}} = \frac{\sqrt{M_{HCl}}}{\sqrt{M_{NH_3}}}$$

Results:

1. Distance moved by HCl gas (L_{HCl}) = cm
2. Distance moved by NH_3 gas (L_{NH_3}) = cm
3. Reaction equation:

Calculations:

1. The theoretical ratio between the molar masses of the two gases (Y):

2. The measured ratio between the molar masses for the two gases (X):

3. The practical molar mass of one of the two gases (M_Y) knowing the theoretical molar mass of the other gas and the values of L_{HCl} and L_{NH_3} using Graham's law:

$$\frac{L_{NH_3}}{L_{HCl}} = \frac{\sqrt{M_{HCl}}}{\sqrt{M_{NH_3}}}$$

4 Calculation of the theoretical molar mass of the same gas using the molar masses of its atoms (M_X):

5 Error percentage:

- First method:

$$\text{Error percentage} = \pm \frac{\text{difference between theoretical and practical ratios}}{\text{theoretical ratio}} \times 100$$

$$\text{Error percentage} = \pm \frac{Y - X}{Y} \times 100$$

- Second method

$$\text{Error percentage} = \pm \frac{\text{difference between theoretical and practical molar masses}}{\text{theoretical molar mass}} \times 100$$

$$\text{Error percentage} = \pm \frac{M_Y - M_X}{M_X} \times 100$$

Created with nitro PDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (8)
Determination of Critical Solution Temperature

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Results:
Experimental results and calculations:

EXP. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mass of phenol (g)	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Mass of water (g)	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mass of solution (g)	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mass % of water														
Mass % of phenol														
Miscibility temperature (°C)														

Calculations:

1. A SAMPLE CALCULATINN OF A MASS PERCNTAGE

Mass % of water = $\frac{\text{mass of water}}{\text{mass of mixture}} \times 100$	Mass % of phenol = $\frac{\text{mass of phenol}}{\text{mass of mixture}} \times 100$

2. From the graphical relation between miscibility temperature (Y-axis) and the mass percentage of phenol (X-axis):
   - The critical solution temperature (C.S.T) = °C
   - Mass % of phenol =
   - Mass % of water =

Created with nitro PDF professional
download the free trial online at nitropdf.com/professional

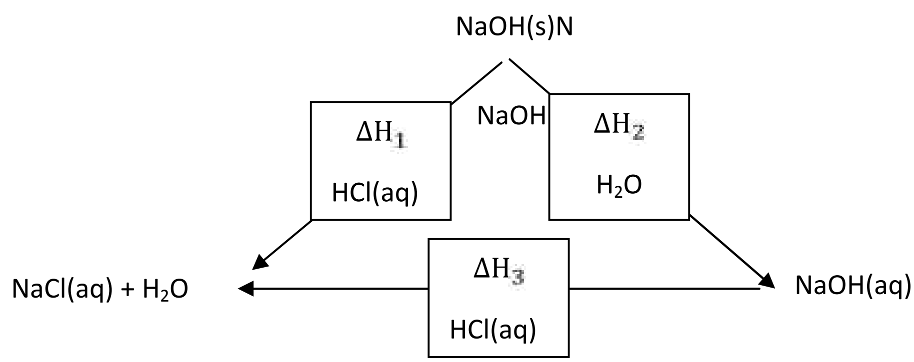
Experiment (8)

Graphical relation between miscibility temperature and the mass percentage of phenol

EXPERIMENT (9)
Hess's Law

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Diagrammatic illustration of Hess's law:



General Notes:

1. Density of NaOH solution = d = 1 g / cm^3
2. Specific heat of NaOH solution = $\rho_{solution}$= 4.18 J / g ºC
3. Specific heat for calorimeter (glass) = $\rho_{calorimeter}$ = 0.836 J / g ºC
4. Volume of NaOH solutions used in all experiment = V = 50 mL
5. Mass of NaOH solutions in g = $m_{solution} = V \times d = 50 \times 1 = 50$ g
6. Mass of calorimeter (glass tube) in g = $m_{calorimeter}$
7. Initial temperature in ºC = t_1
8. Final temperature in ºC = t_2
9. Temperature change in ºC = Δt
10. Heat gained by solution in J = $q_1 = \rho_{solution} \times m_{solution} \times \Delta t$
11. Heat gained by calorimeter in J = $q_2 = \rho_{calorimeter} \times m_{calorimeter} \times \Delta t$
12. Total heat gained in J = $Q = q_1 + q_2$
13. Number of moles of NaOH used in:
    - experiment 1 = $(n_{NaOH})_1 = \frac{(m_{NaOH})_1}{M_{NaOH}}$
    - experiment 2 = $(n_{NaOH})_2 = \frac{(m_{NaOH})_2}{M_{NaOH}}$
    - experiment 3 = $(n_{NaOH})_3 = (molarity)_{NaOH} \times V_{NaOH}$
14. $\Delta H = \frac{Q}{n_{NaOH}}$

Calculations and results:

	Experiment 1	Experiment 2	Experiment 3
t_1 (ºC)			
t_2 (ºC)			
Δt (ºC)			
q_1 (J)			
q_2 (J)			
Q (J)			
n_{NaOH} (mol)			
ΔH (kJ mol^{-1})			

Verification of Hess's law using thermochemical equations:

1)

2)

3)

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (10)

Effect of Concentration on Reaction Rate

(Determination of the order of the sodium thiosulphate and hydrochloric acid reaction)

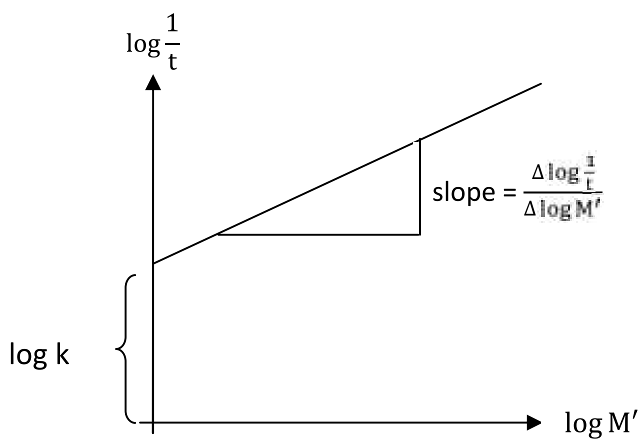
DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Reaction equation:

Rate law:

Arrhenius equation is:

The graphical plot:



Determination of the reaction order with respect to sodium thiosulphate:

- **Symbols**

1. Volume of $Na_2S_2O_3$ before dilution = $V_{Na_2S_2O_3}$
2. Volume of $Na_2S_2O_3$ After dilution = $V'_{Na_2S_2O_3}$ = 29 mL
3. Molarity of $Na_2S_2O_3$ before dilution = $M_{Na_2S_2O_3}$ = 0.15 mol L^{-1}
4. Molarity of $Na_2S_2O_3$ after dilution = $M'_{Na_2S_2O_3} = \frac{M_{Na_2S_2O_3} \times V_{Na_2S_2O_3}}{V'_{Na_2S_2O_3}}$
5. Reaction time in seconds = t
6. Reaction rate in seconds^{-1} = $\frac{1}{t}$

- **Calculatoins**

1. Calculation of $M'_{Na_2S_2O_3}$ in the reactions of $Na_2S_2O_3$ with HCl in 29 mL solution:

- $(M'_{Na_2S_2O_3})_1$ =

- $(M'_{Na_2S_2O_3})_2$ =

- $(M'_{Na_2S_2O_3})_3$ =

- $(M'_{Na_2S_2O_3})_4$ =

- $(M'_{Na_2S_2O_3})_5$ =

Exp.	$V_{Na_2S_2O_3}$	V_{H_2O}	V_{HCl}	$M'_{Na_2S_2O_3}$	t	$\frac{1}{t}$	$-\log M'_{Na_2S_2O_3}$	$-\log\frac{1}{t}$
1	25	0	4					
2	20	5	4					
3	15	10	4					
4	10	15	4					
5	5	20	4					

2. Obtaining the order, n, from the plot of $\log\frac{1}{t}$ versus $\log M'_{Na_2S_2O_3}$ according to:

$$\log\frac{1}{t} = \log k + n \log M'_{Na_2S_2O_3}$$

slope =

n =

Determination of the reaction order with respect to hydrogen chloride:

- **Symbols**

1. Volume of HCl before dilution = V_{HCl}
2. Volume of HCl after dilution = V'_{HCl} = 15 mL
3. Molarity of HCl before dilution = M_{HCl} = 1 mol L^{-1}
4. Molarity of HCl after dilution = $M'_{HCl} = \frac{M_{HCl} \times V_{HCl}}{V'_{HCl}}$
5. Reaction time in seconds = t
6. Reaction rate in seconds^{-1} = $\frac{1}{t}$

- **calculatins**

1. Calculation of M'_{HCl} in the reactions of HCl with $Na_2S_2O_3$ in 15 mL solution:

- $(M'_{HCl})_1$ =
- $(M'_{HCl})_2$ =
- $(M'_{HCl})_3$ =
- $(M'_{HCl})_4$ =
- $(M'_{HCl})_5$ =

Exp.	V_{HCl}	V_{H_2O}	$V_{Na_2S_2O_3}$	M'_{HCl}	t	$\frac{1}{t}$	$-\log M'_{HCl}$	$-\log\frac{1}{t}$
1	5	0	10					
2	4	1	10					
3	3	2	10					
4	2	3	10					
5	1	4	10					

2. Obtaining the order, n, from the plot of $\log\frac{1}{t}$ versus $\log M'_{HCl}$ according to the equation:

$$\log\frac{1}{t} = \log k + m \log \log M'_{HCl}$$

slope =

n =

Rate law:

Rate constant:

k =

Experiment (10)

Graphical relation between log $\frac{1}{t}$ and log $M'_{Na_2S_2O_3}$

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

Experiment (10)

Graphical relation between log $\frac{1}{t}$ and log M'_{HCl}

Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (11)
Determination of the Molar Mass of An Organic Compound By The Depression of Its Freezing Point

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Results:

	Unknown A	Unknown B
Mass of solvent m_1 (g)		
Mass of solute m_2 (g)		
$t_{solvent}$ (ºC)		
$t_{solution}$ (ºC)		
$\Delta t_f = t_{solvent} - t_{solution}$ (ºC)		

Calculations:

- Molal freezng point edpression constant of solvent = K_f = 1.86 ºC $molal^{-1}$
- Molar mass of solute in g mol^{-1} = $M_2 = K_f \frac{m_2 \times 1000}{\Delta t_f \times m_2}$

$(M_2)_A$ =

$(M_2)_B$ =

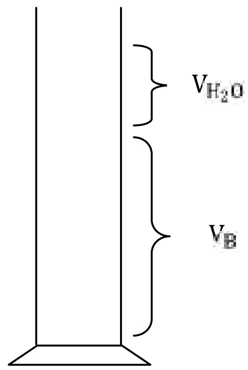
Created with nitroPDF professional
download the free trial online at nitropdf.com/professional

EXPERIMENT (12)

Determination of the Molar Mass of An Organic Compound By The Steam Distillation

DATE:
STUDENT'S NAME:
STUDENT'S NUMBER:

Results:



1. Volume of water after distillation = V_{H_2O} = cm^3
2. Density of water = d_{H_2O} = 1 g cm^{-3}
3. Volume of unknown liquid after distillation V_B = cm^3
4. Density of unknown liquid = d_B = 1.106 g cm^{-3}
5. Atmosphere pressure in Riyadh P° = 720 mmHg
6.

P°_{water} (mmHg)	489.8	504.7	526.0
$T_{b,\ water}$ (ºC)	88	89	90

7. P_{total} = P° = 720 mmHg

Calculationss:

1. Calculation of the unknown vapor pressure:

2. Calculation of the unknown molar mass: