M.Sc. PROGRAMME
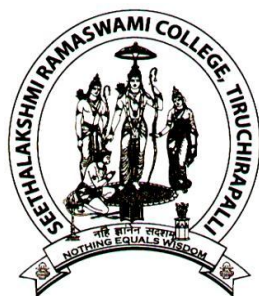
PHYSICAL CHEMISTRY PRACTICALS

Laboratory Manual

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Accredited with "A" Grade (3rd cycle) by NAAC

Tiruchirappalli – 620 002

M.Sc. PHYSICAL CHEMISTRY PRACTICALS

NAME   : _____

REG. No.   : _____

CLASS   : _____

RESEARCH AND POST GRADUATE DEPARTMENT OF CHEMISTRY

SEETHALAKSHMI RAMASWAMI COLLEGE (AUTONOMOUS)

(ACCREDITED BY NAAC)
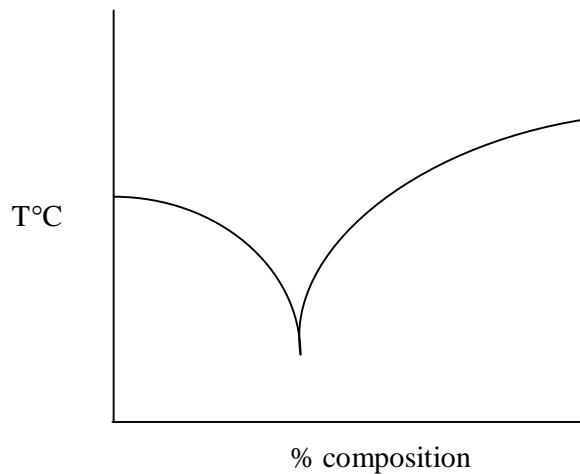
TIRUCHIRAPPALLI – 620 002

Ex. No. 1

SIMPLE EVTECDIC SYSTEM

BINARY SYSTEM OF NAPHTHALENE AND BIPHENYL

Table - 1

S. No.	Weight of naphthalene	Weight of biphenyl	Composition % of naphthalene	Composition % of β-biphenyl	Freezing point °C	Melting point °C	Average

Table - 2

S. No.	Weight of biphenyl	Weight of naphthalene	Composition % of biphenyl	Composition % of naphthalene	Freezing point °C	Melting point °C	Average

% composition

2

	PHASE RULE I
Ex.No.: 1	# BINARY SYSTEM OF NAPHTHALENE AND BIPHENHYL

Aim:

To determine the eutectic temperature and eutectic composition of Naphthalene and biphenyl.

Principle:

The pure substance has a definite melting point, but when another substance is added o it, the melting point is lowered gradually in proportion to the amount of the substance added. The lowest melting point gives the eutectic temperature.

Procedure:

Pure Naphthalene and Biphenyl of known weight (~ 5g) are taken in two different specimen tubes provided with an outer jacket. It is closed with a cork fitted with a sensitive thermometer and stirrer. It is clamped and suspended in a beaker containing distilled water. It is heated and the melting point is noted. When the substance becomes homogeneous throughout, it is allowed to cool and the temperature at which the first crystal appears is taken as the freezing point. To the specimen tube containing naphthalene, ~ 0.5g of biphenyl is added and heated. When the mixture becomes homogeneous throughout, it is allowed to cool and the freezing point is first noted. After it is completely frozen, it is heated and the melting point is noted. Similar additions of biphenyl are made for 7 times. The freezing and melting points are noted after each addition.

Simultaneously ~0.5g of naphthalene is added to biphenyl and the same procedure described above is repeated. The freezing point and melting point are noted after each addition. A graph is drawn by taking temperature along y- axis and percentage composition along x- axis. Two straight lines are obtained which meet at eutectic point. From the graph the eutectic temperature and eutectic composition are noted. It has been found that the freezing point of naphthalene decreases with the addition of biphenyl and the freezing point of biphenyl decreases with the addition of naphthalene.

Result:

1.   The eutectic temperature of naphthalene and biphenyl   =   °C

2. At eutectic point   i) composition of naphthalene   =   %
                              ii) Composition of biphenyl   =   %

3. On adding naphthalene, the freezing point of the mixture decreases / increases

4. The composition of naphthalene in the given
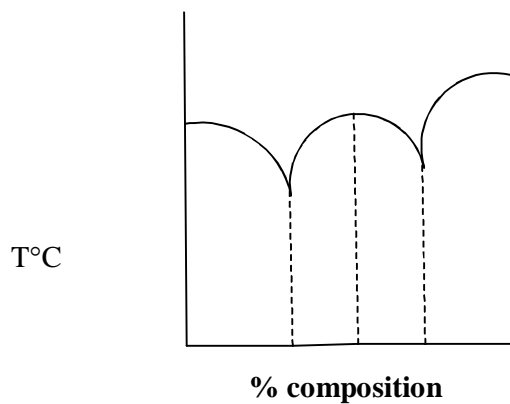   un-known mixture   =   %

Ex. No. 2

COMPOUND FORMATION

Table – 1

Weight of m-dinitrobenzene	Weight of α-naphthalamine	Composition % of m-dinitrobenzene	% of α-naphthyl amine	Freezing point °C	Melting point °C	Average

Table – 2

Weight of α-naphthalamine	Weight of m-dinitrobenzene	Composition % of α-naphthyl amine	Composition % of m-dinitrobenzene	Freezing point °C	Melting point °C	Average

T°C

% composition

	PHASE RULE I
Ex.No.: 2	# BINARY SYSTEM OF NAPHTHYLAMINE AND m-DINITROBENZENE

Aim:

To study the phase diagram of binary system of α – naphthylamine and m – dinitrobenzene.

Principle:

The pure substance has a definite melting point, but when another substance is added to it, the melting point is lowered gradually in proportion to the amount of the substance added. In these systems the two components form a compound with congruent melting point. The lowest melting point gives the eutectic temperature. Thus there will be 2 eutectic temperatures.

Procedure:

Pure α – naphthylamine and m – dinitrobenzene are taken in two different specimen tubes provided with an outer jacket. It is closed with a cork fitted with a sensitive thermometer and a stirrer. It is clamped and suspended in a beaker containing distilled water. It is heated and the melting point is noted. When the substance becomes homogeneous throughout, it is allowed to cool and freezing point is noted. About ~ 0.5g of m – dinitrobenzene is added to α – naphthylamine and heated. When the mixture becomes homogeneous throughout, it is allowed to cool and the temperature is noted, when the first crystal appears and it is taken as the freezing point. After it is completely frozen, it is heated and the melting point is noted. The whole of the substance melts and is taken as the melting point. The average of these two temperatures is noted. Similar additions of m – dinitrobenzene are made 7 times. The melting point and freezing points are noted for each addition.

Simultaneously ~0.5g of α – naphthylamine is added to m – dinitrobenzene and the same procedure described above is repeated. The freezing point and melting point are noted after each addition.

A graph is drawn by taking temperature along y- axis and percentage composition along x- axis. Two straight lines are obtained which meets at eutectic point. From the graph the eutectic temperature and eutectic composition are noted.

It has been found that the freezing point of m – dinitrobenzene decreases with the addition of α – naphthylamine and the freezing point of α – naphthylamine decreases with the addition of m – dinitrobenzene. The maximum point on the graph corresponds to the melting point of compound AB. The other two minima on the graph correspond to the two eutectic temperatures.

Ex.No.: 2 Contd.

Result:

1. α – naphthylamine and m – dinitrobenzene forms a compound having a congruent melting point = °C

2. The percentage composition of the compound at congruent melting point =

3. I Eutectic temperature =

   Percentage composition at the eutectic point

   (i) α – naphthylamine =

   (ii) m – dinitrobenzene =

   II Eutectic temperature =

   Percentage composition at the eutectic point

   (i) α – naphthylamine =

   (ii) m – dinitrobenzene =

Ex. No. 3

BINARY SYSTEM OF BENZOIC ACID AND CINNAMIC ACID

Graph -1

Table – 1

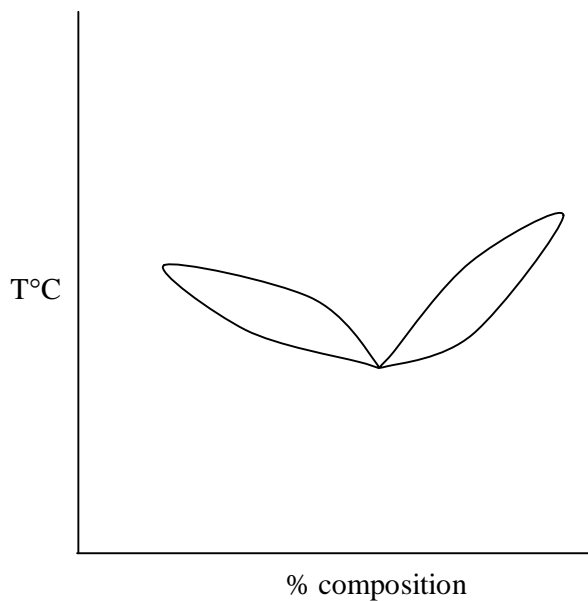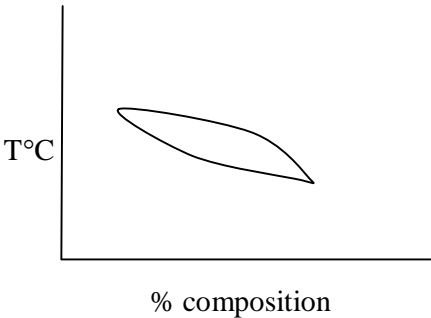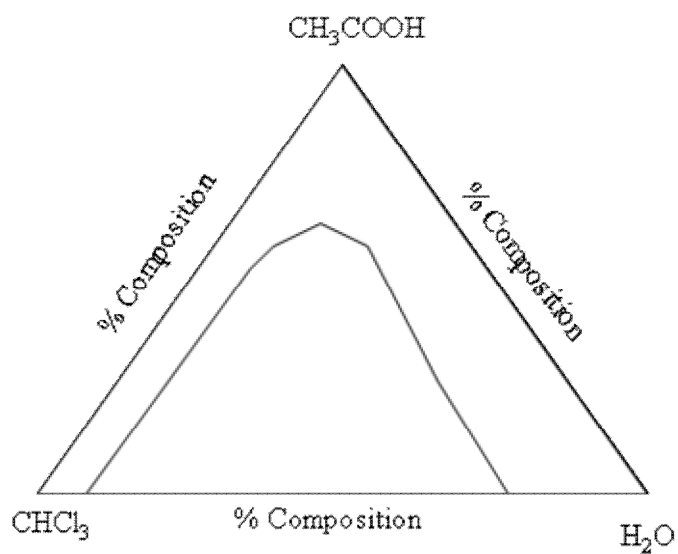| Weight of Benzoic acid	Weight of Cinnamic acid	Composition % of Benzoic acid	Composition % of Cinnamic acid e	Freezing point °C	Melting point °C	Average

Table – 2

Weight of Benzoic acid	Weight of Cinnamic acid	Composition % of Benzoic acid	Composition % of Cinnamic acid e	Freezing point °C	Melting point °C	Average

10

	PHASE RULE – II
Ex.No.: 3	**BINARY SYSTEM OF BENZOIC ACID AND CINNAMIC ACID.**

Aim:

   To study the phase diagram of a binary system of Benzoic acid and cinnamic acid.

Procedure:

   Pure Benzoic acid and cinnamic acid are taken in two different specimen tubes provided with a stirrer and outer jacket. It is clamped and suspended in a beaker containing glycerol. It is heated and the melting point is noted. When the substance become homogeneous throughout it is allowed to cool & the freezing point is noted. About 0.5g of benzoic acid is added to cinnamic acid and heated. When it becomes homogeneous it is allowed to cool and the temperature at which the crystal appears is noted as the freezing point. After it is completely frozen, it is heated. The temperature is noted, when whole of the substance melts and is taken as the melting point. The average of these two temperatures is noted. Similarly benzoic acid is added to cinnamic acid in portions for 10 times and the experiment is repeated. The melting & the freezing points are noted after each addition.

   Simultaneously 0.5g of cinnamic acid is added to benzoic acid and the procedure as described above is repeated. The melting and freezing points are noted. A graph is drawn by taking temperature along y axis & the percentage composition along x axis.

Result:

   Benzoic acid and cinnamic acid form a solid solution. Addition of Benzoic acid to cinnamic acid decreases the melting point of the latter. These two are miscible with each other to form a solid solution which has a lower melting point than either of the pure components.

Note : Binary system of naphthalene and β–Napthol

Result : naphthalene and β–napthol form a continuous series of solid solution.

Ex. No. 4

THREE COMPONENT SYSTEM

S. No.	Volume of Chloro-form (ml)	Volume of H₂O (ml)	Volume of Acetic acid (ml)	Weight of Chloro-form (g)	Weight of H₂O (g)	Weight of Acetic acid (g)	% of Chloro-form	% of H₂O	% of ethanol

Ex.No.:4	# THREE COMPONENT SYSTEM

Aim:

To study the phase diagram of a three component system.

Procedure:

Mixtures of $CHCl_3$ and CH_3COOH of varying composition are taken in a set of iodine flasks. The bottles containing the solutions are placed in a thermostat at room temperature for 15 minutes. Then water is run from a burette in small quantities and after each addition the flask is shaken well. Addition is continued till turbidity appears on shaking.

From the amount of water added and the initial amount of $CHCl_3$ and CH_3COOH, the composition of mixture is calculated. The results are plotted in a triangular diagram. The points obtained are joined into a smooth curve.

The triangular diagram,

(i) The vertices A,B,C of the equilateral triangle represents the 3 pure components $CHCl_3$, CH_3COOH and H_2O.

(II) Side AB represents the composition of binary system CH_3COOH, $CHCl_3$. On the side AB, the concentration of water is zero. Similarly the component A is absent along BC and B is absent along AC.

(III) In plotting the composition of ternary mixture 2 points are marked on one side of the triangle representing the amount of two components and from these points, lines are drawn parallel to the other side of the triangle. The point of intersection gives the composition of ternary mixture.

(IV) A binodal curve is obtained by joining the experimentally determined points.

(V) Any point outside the curve represents a one phase system, all the three liquids (H_2O, $CHCl_3$, CH_3COOH) being completely miscible with each other.

(VI) Inside the binodal curve the system consists of two phases.

Result:

Chloroform and water are the partially miscible liquids. Only one bimodal curve corresponding to this pair of liquids appears in the phase diagram.

Ex. No. 5

COMPARISON OF STRENGTHS OF THREE ACIDS
Table – 1

Ester hydrolysis with 0.25N HCl at 33°C

Time in minutes	Burette Readings (ml)		Volume of NaOH (ml)	$(V_\infty - V_t)$ (ml)	Log $(V_\infty - V_t)$
	Initial	Final			

Infinite reading, V_∞=

Table – 2

Ester hydrolysis with 0.5N HCl at 33°C

Time in minutes	Burette Readings (ml)		Volume of NaOH (ml)	$(V_D - V_t)$ (ml)	Log $(V_D - V_t)$
	Initial	Final			

Infinite reading, V_∞=

Table – 3

Ester hydrolysis with 0.75N HCl at 33°C

Time in minutes	Burette Readings (ml)		Volume of NaOH (ml)	$(V_\infty - V_t)$ (ml)	Log $(V_\infty - V_t)$
	Initial	Final			

Infinite reading, V_∞=

14

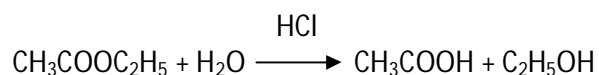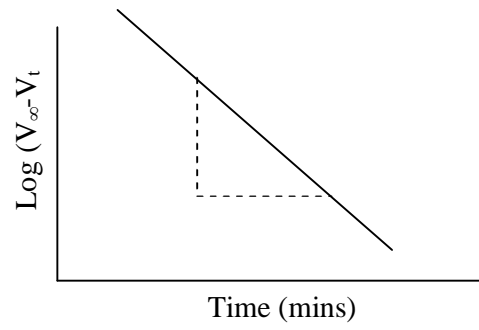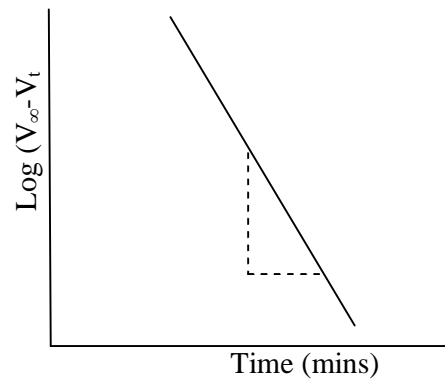|	

Ex. No.:5	# COMPARISON OF STRENGTHS OF THREE ACIDS
	
	Aim:
	
	    To compare the strengths of three acids.
	Principle:
	
	    The hydrolysis of all esters eg., Ethyl acetate is hydrolyzed according to the equation.
	
	$$CH_3COOC_2H_5 + H_2O \xrightarrow{\quad HCl \quad} CH_3COOH + C_2H_5OH$$
	
	    The reaction is an example of a pseudo unimolecular reaction. Although two molecules take part in the reaction, the active mass of water does not appreciably alter, because it is present in large excess. As the hydrolysis of an ester by pure water is very slow, mineral acids are added to the reaction mixture to catalyse the reaction. Since free acetic acid is produced in the reaction, the reaction can be followed by titrating known volume of reaction mixture with standardised alkali at regular time intervals. The amount of alkali consumed at any time corresponds to the quantities of the ester decomposed at that time.
	Procedure:
	
	    Buretted out 100ml of N/2 HCl is into a dry conical flask. The given ester is also taken in another conical flask. Both the conical flasks are suspended in a water bath to attain equilibrium. After equilibrium has been attained 10ml of the ester is pipetted out in to the conical flask containing acid. When half of the ester is added, the stop watch is started. The contents are shaken and after 10 minutes, 5ml of the reaction mixture is pipetted out into the ice cold water to arrest further reaction.
	
	    The liberated acid is titrated against 0.2N NaOH using phenolphthalein as an indicator. 5ml of the reaction mixture is withdrawn at regular intervals of 10 minutes up to one hour. The remaining solution is heated in a water bath at about 60-70°C to allow the reaction to proceed to completion. It is then cooled to room temperature and 5ml of the reaction mixture is run into ice cold water and titrated against 0.2N NaOH using phenolphthalein as indicator (v_∞)
	
	    The experiment is repeated with 0.25N and 0.75N HCl. Log (v_∞ - v_t) is plotted vs time in a graph, where v_t is the volume of NaOH, needed for neutralization at that time t. A straight line is obtained. From the slope, the rate constant is calculated using the formula
	
	$$k = \frac{2.303}{t} \times \log \frac{(V_\infty - V_0)}{(V_\infty - V_t)}$$

Graph – 1

Log $(V_\infty - V_t)$

Time (mins)

Graph – 2

Log $(V_\infty - V_t)$

Time (mins)

Graph – 3

Log $(V_\infty - V_t)$

Time (mins)
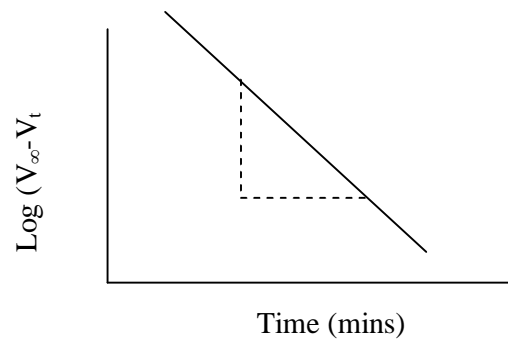
Result:

1. The rate constants of the reactions by the acid of three different concentrations are

$$k_{A\ [0.25N]} = min^{-1}$$

$$k_{B\ [0.50N]} = min^{-1}$$

$$k_{C\ [0.75N]} = min^{-1}$$

2. The ratio of the rate constants of the reactions by the acids of three different concentrations (A : B : C) are

DETERMINATION OF ACTIVATION PARAMETER
Table – 1
Ester hydrolysis with 0.25N HCl at 31°C

Time in minutes	Burette Readings (ml)		Volume of NaOH (ml)	$(V_\infty - V_t)$ (ml)	$\log (V_\infty - V_t)$
	Initial	Final			

Table – 2
Ester hydrolysis with 0.25N HCl at 37°C

Time in minutes	Burette Readings (ml)		Volume of NaOH (ml)	$(V_\infty - V_t)$ (ml)	$\log (V_\infty - V_t)$
	Initial	Final			

Table – 3
Ester hydrolysis with 0.25N HCl at 45°C

Time in minutes	Burette Readings (ml)		Volume of NaOH (ml)	$(V_D - V_t)$ (ml)	$\log (V_D - V_t)$
	Initial	Final			

Determination of activation parameter
Table – 4

T(K)	1/T x 10⁻³	kx10⁻³	log (kx10⁻³)	3+log k

Energy of activation, E_a =   slope x 2.303 x R
     =   kJ mol⁻¹

Enthalpy of activation, $\Delta H^{\#}$ = $E_a - RT$
     =   kJ mol⁻¹

Free Energy of activation, $\Delta G^{\#}$ = $RT \left[\ln \dfrac{k_B T}{h} - \ln k \right]$

     =   kJ mol⁻¹

Entropy of activation, $\Delta S^{\#}$ = $\dfrac{\Delta H^{\#} - \Delta G^{\#}}{T}$

     =   JK⁻¹ mol⁻¹

k = 1.38 x 10⁻²³
R = 8.314
h = 6.626 x 10⁻³⁴
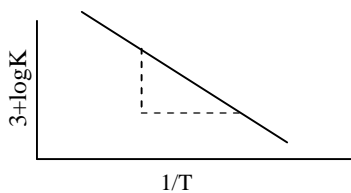
| Ex. No.:6 | # DETERMINATION OF ACTIVATION PARAMETERS |

Aim:

To determine the activation parameters for the acid catalyzed hydrolysis of ester

Principle:

Velocity constants for the hydrolysis of ester by HCl at different temperatures are determined and the energy of activation is calculated using the equation.

$$\log\frac{k_2}{k_1} = \frac{E_a \times (T_2 - T_1)}{2.303\ R(T_1 T_2)}$$

Procedure:

Buretted out 100ml of 0.25N HCl into a clean conical flask. Ethyl acetate (ester) is also taken in another conical flask. Both the flasks are kept in a thermostat at temperature T_1, when both the flasks have attained the same temperature, 10ml of the ester is pipetted out into the acid. A stop watch is started at the instant when half of the ester is added. The contents are shaken and after 10 minutes, 5ml of the reaction mixture is run into ice cold water to arrest the reaction. The excess acid is titrated against 0.2N NaOH using phenolphthalein as indicator. The above process is repeated at intervals of 10 minutes for an hour.

The remaining solution is heated in a water bath maintaining the temperature 60 - 70°C for 30 minutes. It is then cooled to room temperature, after which 5ml of the reaction mixture is run into ice cold water and titrated against 0.2N NaOH using phenolphthalein as indicator.

The same experiment is repeated with the same acid but at two higher temperatures such as 37°C and 45°C. The velocity constants are calculated for the three experiments and then the energy of activation is calculated from Arrhenius slope.

Result:

1. The energy of activation E_a = _____ kJ mol^{-1}
2. Enthalpy of activation $\Delta H^{\#}$ = _____ kJ mol^{-1}
3. Free energy of activation $\Delta G^{\#}$ = _____ kJ mol^{-1}
4. Entropy of activation $\Delta S^{\#}$ = _____ JK^{-1} mol^{-1}

Ex. No. 7

DETERMINATION OF CATALYTIC COEFFICIENT

Concentration of H$^+$ ions	Rate constant (min^{-1})

$$K \quad = \quad k\,[H^+]\,[H^+]$$

$$k[H^+] \quad = \quad \frac{K}{\left[H^+\right]}$$

Ex. No. :7	# DETERMINATION OF CATALYTIC COEFFICIENT

Aim:

To determine the catalytic coefficient.

Procedure:

Buretted out 100ml of N/2 of HCl into a clean conical flask and kept in a water bath at room temperature. The ester is also kept for equilibrium at the same temperature. When both have attained equilibrium, 10ml of the ester is pipetted out into a flask containing acid, starting the stopwatch when half of the quantity is added. Pipetted out 5ml of the reaction mixture and allowed to run into an ice cold water containing phenolphthalein. The unreacted acid is titrated against 0.2N NaOH. This is repeated at regular intervals of 10 minutes up to one hour.

The remaining solution is heated in a water bath at about 60-70°C to allow the reaction to proceed to completion. It is than cooled to room temperature and 5ml of the reaction mixture is run into ice cold water and titrated against 0.2N NaOH.

The above procedure is repeated for two different concentration of the same acid. Log $(V_o – V_t)$ is plotted Vs time in a graph. From the slope of the straight line obtained, corresponding rate constant K is calculated. By plotting rate constant Vs hydrogen ion concentration, a straight line is got. The slope obtained from the graph is a measure of catalytic coefficient.

Result:

The catalytic coefficient of ester hydrolysis is _____

Ex. No. 8

REACTION BETWEEN POTASSIUM IODIDE AND POTASSIUM PERSULPHATE

Table 1

Volume of K₂S₂O₈ (20ml)+ Thio (10ml)+ Starch (5ml)	Volume of KNO₃ (ml)	Volume of Water (ml)	Volume of KI (ml)	Time (sec)	4+ log k	$\sqrt{\mu}$

Calculation : $\qquad \mu = \dfrac{1}{2}\sum C_i Z_i^2$

μ　　　　＝

μ　　　　＝

μ　　　　＝

μ　　　　＝

μ　　　　＝

μ　　　　＝

Graph

$$k \;=\; \frac{\frac{1}{2}[\text{thio}]}{dt[S_2O_8^{2-}][I^-]} \;=\; \frac{0.00005}{2\times 0.001\times 0.01\times \text{time}}$$

k　　＝　　　　　　　4+logk＝

k　　＝　　　　　　　4+logk＝

k　　＝　　　　　　　4+logk＝

k　　＝　　　　　　　4+logk＝
unknown ;
k　　＝　　　　　　　4+logk＝

k　　＝　　　　　　　4+logk＝

22

Ex. No. : 8	**STUDY OF REACTION BETWEEN POTASSIUM IODIDE AND POTASSIUM PERSULPHATE**

Aim:

　　　　To study the effect of ionic strength on the kinetics of the reaction between potassium persulphate and potassium iodide.

Principle:

　　　　0.005M Potassium persulphate, 0.2 M KNO_3 , 0.05M KI, 0.0005N thio and 1% starch solution are prepared. The reaction rate is studied for the following set of reactants.

(i) 20ml of $K_2S_2O_8$,10ml of thio, 5ml of starch,20ml of KI and 45ml of water.

(ii) 20ml of $K_2S_2O_8$, 10ml of thio, 5ml of starch, 20ml of KI, 35ml of water and 10ml of KNO_3.

(III) 20ml of $K_2S_2O_8$, 10ml of thio, 5ml of starch, 20ml of KI, 30ml of water and 15ml of KNO_3.

(IV) 20ml of $K_2S_2O_8$, 10ml of thio, 5ml of starch, 20ml of KI, 25ml of water and 20ml of KNO_3.

(v) 20ml of $K_2S_2O_8$, 10ml of thio, 5ml of starch, 20ml of KI, 20ml of water and 25ml of KNO_3.

(vi) 20ml of $K_2S_2O_8$, 10ml of thio, 5ml of starch, 20ml of KI, 15ml of water and 30ml of KNO_3.

(vii)20ml of $K_2S_2O_8$, 10ml of thio, 5ml of starch, 20ml of KI, 10ml of water and 35ml of KNO_3.

　　　　In a clean two stoppered conical flask, the solutions as in (i) except KI are mixed and it is kept in a constant temperature bath for 10minutes. The KI solution is also thermostated. Pipetted out 20ml of KI into the conical flask containing the mixed solution. The stopwatch is started, when half of it is added. As soon as the blue colour appears the stopwatch is stopped and time is noted. The experiment is repeated by taking the composition as given in (ii), (iii), (iv), (v), (vi) and (vii). Similar experiments are carried out with unknown KNO_3.

$$\frac{dx}{dt} = K [S_2O_8{}^{2}] [I^-]$$

$$K = \frac{dy}{dx} \cdot \frac{1}{[S_2O_8^{2-}][I^-]}$$

$$K = \frac{1/2 \ [thio]}{dt \ [S_2O_8^{2-}] [I^-]}$$

　　　　By substituting the noted time, the rate constant is calculated. A graph is drawn by plotting log $kv_s \sqrt{\mu}$. From the graph, the unknown concentration of KNO_3 is determined. This linear plot of log $kv_s \sqrt{\mu}$ indicates that the Bronsted – Bjerrum equation is obeyed.

Result:

　　　　The concentration of unknown KNO_3 are

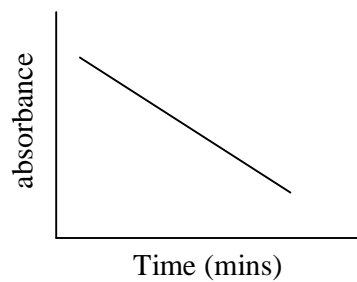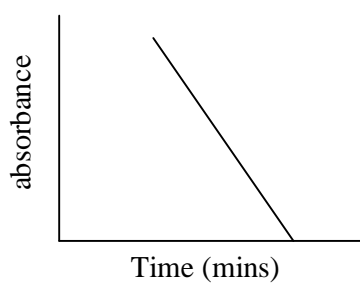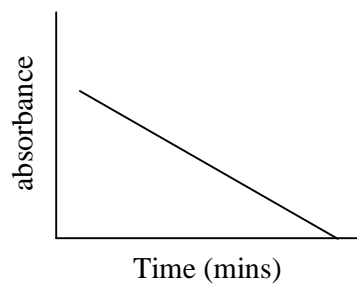　　　　　　　　a)　　　　　M

　　　　　　　　b)　　　　　M

IODINATION OF ACETONE

Graph 1

Graph 2

Graph 3

Graph 4
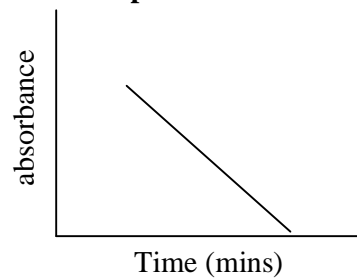
Table 1

Time (min)	Absorbance			
	I	II	III	IV

Ex. No. : 9	**IODINATION OF ACETONE**

Aim:

To study the reaction of iodination of acetone.

Principle:

The process of the reaction between acetone and iodine can conveniently be followed colorimetrically making use of the fact that the presence of iodine, mainly as trioxide ion [IO_3^-] imparts reddish brown colour to the reaction mixture. The colour fades to pale yellow as the reaction proceeds due to the consumption of iodine. Isolation method can be used conveniently taking both acetone and the acid in large excess. The order of the reaction is one each with respect to acetone & the acid and zero with respect to iodine.

Procedure:

Diluted 10ml of pure acetone to 100ml and mixed each of acetone solution, 0.5M H_2SO_4 and water. Added 10ml of iodine solution started the stop watch. The wavelength is set at 530nm in colorimeter. Transferred the reaction mixture into the Erma tube and recorded the absorbance using water as the blank at suitable intervals of time. Repeated the experiments with the composition of reaction mixture listed below.

	I	**II**	**III**	**IV**
Acetone (ml)	5	10	5	5
0.01M I_2 solution (ml)	10	10	5	10
0.5M H_2SO_4 (ml)	5	5	5	10
Water (ml)	5	0	10	0

Plotted the absorbance Vs time for different reaction mixtures. The plots are linear with a constant slope showing the reaction to be zero order with respect to iodine.

Result:

Rate constant (I)   =   _____ $min^{-1}dm^3mol^{-1}$
Rate constant (II)   =   _____ $min^{-1}dm^3mol^{-1}$
Rate constant (III) =   _____ $min^{-1}dm^3mol^{-1}$
Rate constant (IV) =   _____ $min^{-1}dm^3mol^{-1}$

The rate constant (II) is twice that of rate constant (I), when acetone concentration is doubled. The rate constant (III) is approximately equal to the rate constant (I), when iodine concentration is doubled. The rate constant (IV) is twice as that of rate constant (I) when sulphuric acid concentration is doubled. Hence the reaction is first order each respect to acetone and sulphuric acid and zeroth order with respect to iodine.

Ex. No. 10

Concentration	Angle of rotation	Specific rotation
5%		
10%		
15%		
20%		
25%		

Specific rotation $[\alpha] = \dfrac{a \, x \, 100}{c \, x \, 1}$

	POLARIMETRY
Ex.No.:10	**DETERMINATION SPECIFIC ROTATION**

Aim:

      To determine the specific rotation of glucose using polarimeter.

Principle:

      When a substance rotates the plane of polarized light to the right, it is called dextro rotatory and when it rotates the plane to the left, it is called laevorotatory. The angle of rotation depends upon the nature of the substance, the temperature and the wave length of the light used. The result is usually expressed as $[\alpha] = \dfrac{a \times 100}{c \times l}$ where 'α' is the specific rotation, 'a' is the observed angle of rotation, 'l' is the length of the column in decimeter and 'c' is the concentration in g /100 c.cs.

Procedure

      Distilled water is taken in the observation tube and the disc is rotated till the two halves are of equal intensity and the reading was noted. Then about 10% solution of glucose is prepared by weighing exactly. This solution is taken in the observation tube. Then the disc was adjusted for the same colour and the reading is noted. The difference between the two gives the angle of rotation. From this value specific rotation is calculated.

      The experiment is repeated with solutions of concentration 5%, 15%, 20% and 25%. A graph is drawn taking concentration in X-axis and angle of rotation in Y-axis.

Result

1. There is a linear relationship between concentration and angle of rotation.

2. The specific rotation of unknown glucose solution is

          A =   B =

Ex. No. 11

1N Hydrochloric acid

1	2	3	4	5	6	7
Time in minutes	Angle of rotation	$\alpha_0 - \alpha_\infty$	$\alpha_t - \alpha_\infty$	log $\alpha_0 - \alpha_\infty$	log $\alpha_t - \alpha_\infty$	$k = \dfrac{2.303}{t_n}\left[\log_{10}\left(\alpha_0 - \alpha_\infty\right) - \log_{10}\left(\alpha_t - \alpha_\infty\right)\right]$
0						
10						
20						
30						
40						
50						
60						
∞						
			Average =			

N/2 Hydrochloric acid

| Time in minutes	Angle of rotation	$\alpha_0 - \alpha_\infty$	$\alpha_t - \alpha_\infty$	$k = \dfrac{2.303}{t_n}\left[\log_{10}\left(\alpha_0 - \alpha_\infty\right) - \log_{10}\left(\alpha_t - \alpha_\infty\right)\right]$
0				
10				
20				
30				
40				
50				
60				
∞				
			Average =	

Analytical value = Ratio of Strengths = $\dfrac{\text{Rate constant for 1N HCl}}{\text{Rate constant for N/2 HCl}}$

$$= \underline{\hspace{3cm}} =$$

28

POLARIMETRY

Ex.No.: 11	DETERMINATION OF RELATIVE STRENGTHS OF TWO ACIDS
	Aim:

Aim:

To determine the relative strengths of 1N hydrochloric acid and N/2 hydrochloric acid.

Principle:

The inversion of cane sugar is a first order reaction, the velocity of which is accelerated by acids to a degree which is approximately proportional to the concentration of hydrogen atoms. This reaction is successfully employed to compare the strengths of acids. If α_0^- Is the angle of rotation at the commencement of the reaction, α_∞ is the final angle of rotation of the complete inversion of sugar present at time t_n. Hence in accordance with the law of unimolecular reaction, we have the velocity constant k by the equation,

$$k = \frac{2.303}{t_n}\left[\log_{10}(\alpha_0 - \alpha_\infty) - \log_{10}(\alpha_t - \alpha_\infty)\right]$$

Procedure

A 10% solution of cane sugar is prepared. The normal solution and N/2 solution of hydrochloric acid are prepared. Then 25ml of cane sugar solution is mixed with 25ml of 1N hydrochloric acid and a stop watch is started when half of the acid is added. After thorough mixing of the solutions, the polarimeter tube is filled with the mixture and immediately placed in the polarimeter and the readings are noted for every ten minutes. The final reading is taken after heating to 60° - 70°C over a water bath for an hour. The solution is cooled to the room temperature, the polarimeter tube is filled with the solution and then the reading is noted. The same experiment is repeated with N/2 hydrochloric acid. The velocity constant was calculated in the two cases. The ratio of the velocity constants gives the relative strengths of two acids.

N/2 Hydrochloric acid
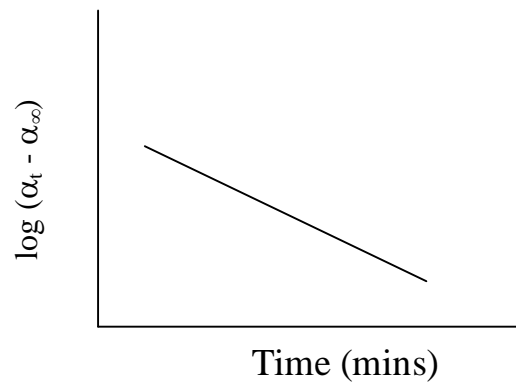
1N Hydrochloric acid
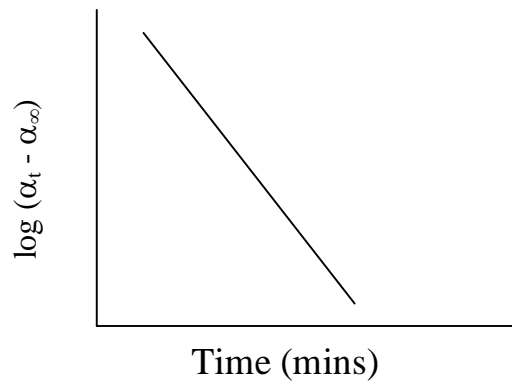
Result

The ratio of the strengths of the two acids

      1. Analytical value   =

      2. Graphical value   =

Ex. No. 12

ADSORPTION ISOTHERM

Standardization of $KMnO_4$

0.1N Oxalic acid Vs $KMnO_4$

Sl. No.	Volume of Oxalic acid (ml)	Burette Reading		Volume of $KMnO_4$ (ml)	Indicator
		Initial	Final		

Volume of Oxalic acid   =

Strength of Oxalic acid   =

Volume of $KMnO_4$ =

Strength of $KMnO_4$ =

Oxalic acid Vs $KMnO_4$

Bottle No.	Volume Taken (ml)	Burette Reading		Volume of NaOH (ml)	Indicator
		Initial	Final		

Calculation :

i. Concentration of oxalic acid after absorption C_e (1)   =

ii. Concentration of oxalic acid after adsorption C_e (2)   =

iii. Concentration of oxalic acid after adsorption C_e (3)   =

iv. Concentration of oxalic acid after adsorption C_e (4)   =

v. Concentration of oxalic acid after adsorption C_e (5)   =

vi. Concentration of oxalic acid after adsorption C_e (6)   =

Ex. No.: 12	# ADSORPTION ISOTHERM

Aim:

(i) To study the adsorption of oxalic acid on activated charcoal and to Verify (a) Freundlich adsorption isotherm and (b) Langmuir adsorption isotherm.

(ii) To determine the strength of unknown oxalic acid using Freundlich adsorption.

Principle:

The amount of the substance adsorbed decreases with rise of temperature. Since all adsorption processes are exothermic, the amount adsorbed at any temperature is proportional to the concentration owing to the general saturation on the surface. Freundlich isotherm is $x = kc^{1/n}$

Procedure:

Accurately known weights of charcoal are taken in six pyrex bottles and 100ml of oxalic acid is added to one of the bottles. Similarly 100ml each of 0.4N, 0.3N, 0.2N and 0.1N oxalic acid are added in to the other bottles. Oxalic acid unknown strength is taken in the sixth bottle. All of them are kept in an electrical shaker for half an hour.

Approximately 0.2N potassium permanganate is prepared and standardized with oxalic acid of known strength. After half an hour, the bottles are removed and allowed to settle. Then it is filtered, 10ml of the solution is pipetted out, 15ml of dil. H_2SO_4 is added, heated to bearable warmth and titrated v_s standardized $KMnO_4$. This is repeated with other bottles. From the titration value C_e, the concentration at equilibrium is calculated. C_o is the initial concentration, $C_o - C_e$ is amount of acid that is adsorbed by m grams of charcoal which is added at the beginning. Here x/m is the amount of acid adsorbed by 1 gram of charcoal that was added at the beginning. A graph is drawn taking log x/m in the y axis and log C_e on the x axis. A linear plot obtained shows applicability of the Freundlich adsorption. The slopes and the intercept of the plot gives 1/n and logk respectively. For the unknown, log x/m value is calculated from the graph and hence x is determined.

Langmuir's adsorption equation is tested by plotting $\frac{C_e}{x/m}$ values (ordinate) Versus C_e (abscissa). A linear plot obtained shows the applicability of the isotherm.

Result:

(i) Adsorption of oxalic acid on charcoal obeys both Freundlich and Langmuir adsorption.

(ii) The unknown concentration of oxalic acid

(a)_____M (b)_____M

(iii) 1/n = _____

(iv) log k = _____

Adsorption of oxalic acid on activated charcoal

Bottle No.	Amount of Charcoal (ml)	C_o	C_e	$X=(C_o - C_e)$ x 6.005	x/m	$\dfrac{c_e}{x/m}$	2+log x/m	2+log C_e

Langmuir adsorption :

(i) $\quad \dfrac{C_e}{x/m} = \qquad\qquad =$

(ii) $\quad \dfrac{C_e}{x/m} = \qquad\qquad =$

(iii) $\quad \dfrac{C_e}{x/m} = \qquad\qquad =$

(iv) $\quad \dfrac{C_e}{x/m} = \qquad\qquad =$

(v) $\quad \dfrac{C_e}{x/m} = \qquad\qquad =$

Graph – 1
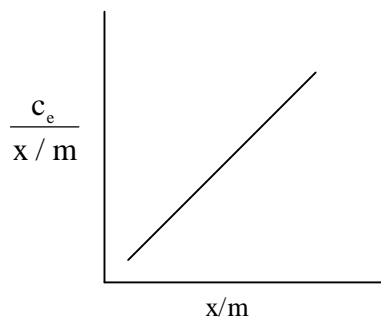
Graph – 2

Ex. No. 13

TITRATION OF HYDROCHLORIC ACID VS SODIUM HYDROXIDE

Volume of NaOH (ml)	Conductance (m.mho)	Volume of NaOH (ml)	Conductance (m.mho)

Volume of NaOH =

Strength of NaOH =

Volume of HCl =

Strength of HCl =

Volume of NaoH (ml)

CONDUCTOMETRY

Ex.No.:13	**TITRATION OF HYDROCHLORIC ACID V$_S$ SODIUM HYDROXIDE**

Aim:

      To determine the concentration of hydrochloric acid by conductometric titration.

Principle:

      According to Kohlrausch law, the electrical conductivity of a solution depends upon the number of ions present and their mobility. So conductivity measurements can be employed to find the end point of acid, alkali and other type of titrations. Let us consider the titration of strong acid like HCl v$_s$ strong base like NaOH.
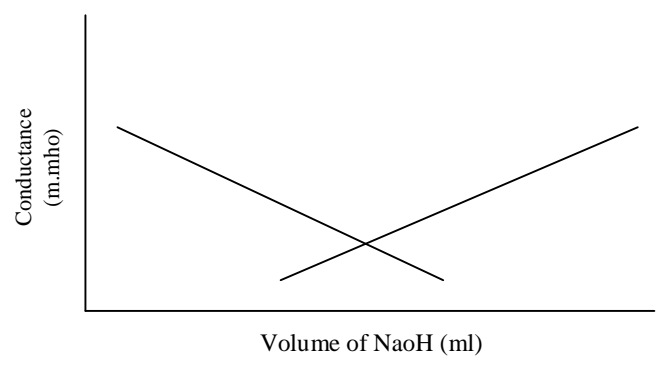
      A known volume of HCl is taken In the conductivity cell. A known volume of NaOH is added and after each addition the conductance is determined. The conductance of the solution is plotted v$_s$ the volume of alkali added. Two straight lines are obtained. The point of intersection is the end point and the volume of alkali corresponding to this point is the volume required to neutralize the known volume of the acid. Before the addition of alkali the conductivity is due to the presence of H$^+$ and Cl$^-$ ions.

      The conductance is mainly due to the H$^+$ ions which have very high mobility. As alkali is added the H$^+$ ions are removed as feebly ionized water molecules. The conductivity of the solution decreases due to replacement of H$^+$ ions by slow moving Na$^+$ ions. Once the end point is reached, after the neutralization, there will be an increase in conductance due to increase in concentration of OH$^-$ ions because the OH$^-$ ions have the high mobility. The point of minimum conductivity will therefore be the end point of the titration.

Procedure:

      Pipetted out 40ml of 0.02 N HCl into a 150 ml beaker so that the electrodes are completely immersed in the solution. Sodium hydroxide solution of strength 0.1 N is added in 0.5ml portions. The solution is stirred well and allowed to attain equilibrium. The conductance is noted and is plotted v$_s$ the volume of NaOH added. The point of intersection of two straight lines gives the end point.

Result:

      The strength of Hydrochloric acid is _____ N.

Ex. No. 14

TITRATION OF ACETIC ACID Vs SODIUM HYDROXIDE

Volume of NaOH (ml)	Conductance (m.mho)	Volume of NaOH (ml)	Conductance (m.mho)

Volume of Sodium hydroxide =

Strength of Sodium hydroxide =

Volume of acetic acid =

Strength of acetic acid =

Ex.No.:14	**TITRATION OF ACETIC ACID Vs SODIUM HYDROXIDE**

Aim:

To determine the strength of acetic acid by conductometric titration.

Procedure:

Pipetted out 40ml of given acetic acid into a 150ml beaker so that the electrodes are completely immersed in the solution. A saturated solution of NaOH (0.1N) is added in 0.5ml portions. The solution is stirred well and allowed to attain equilibrium. The conductance is noted and plotted v_s the volume of NaOH added. The point of intersection corresponds to the volume of NaOH required to neutralize the solution. From the point of intersection of two straight lines, the end point is noted and then the strength of acid is calculated.

Result:

The strength of acetic acid is _____ N.

Ex. No. 15
TITRATION OF MIXTURE OF ACIDS Vs SODIUM HYDROXIDE

Volume of NaOH (ml)	Conductance (m.mho)	Volume of NaOH (ml)	Conductance (m.mho)

Volume of Sodium hydroxide =

Strength of Sodium hydroxide =

Volume of HCl =

Strength of HCl =

Volume of sodium hydroxide =

Strength of sodium hydroxide =

Volume of acetic acid =

Strength of acetic acid =

Volume of NaOH (ml)
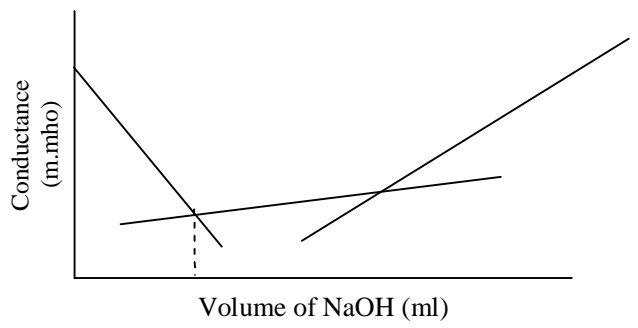
Ex.No.: 15	**TITRATION OF MIXTURE OF ACIDS VS SODIUM HYDROXIDE**
	Aim: To determine the strength of HCl and CH_3COOH using NaOH by conduction metric titration. **Procedure:** Pipetted out 40ml of given mixture of acetic acid and HCl into a conductivity cell containing electrodes which are fully immersed in the solution. A standardized solution of strength of 0.1N is taken in a burette and added in 0.5ml portions. The solution is stirred well and allowed to attain equilibrium. The conductance is measured and it is plotted Vs the volume of NaOH added. Three straight lines are obtained and the points of intersection give the end points. **Result:** (i) The strength of Hydrochloric acid in the given mixture = _____ N (ii) The strength of Acetic acid in the given mixture = _____ N

Ex. No. 16

TITRATION OF BARIUM CHLORIDE Vs MAGNESIUM SULPHATE

Conductance (m.mho)
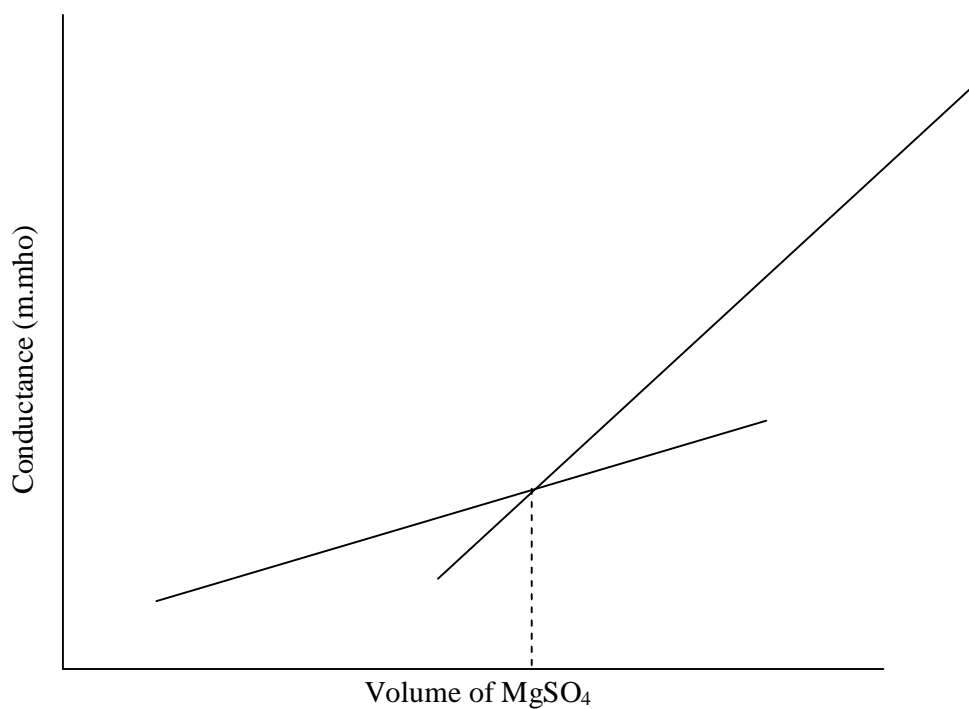
Volume of MgSO$_4$

Volume of NaOH (ml)	Conductance (m.mho)

Volume of barium chloride =

Strength of barium chloride =

Volume of MgSO$_4$ =

Strength of MgSO$_4$ =

Ex.No.:16	**TITRATION OF BARIUMCHLORIDE V$_S$ MAGNESIUM SULPHATE**

Aim:

To determine the strength of barium chloride conductometrically by titrating with magnesium sulphate.

Procedure:

Pipetted out 40ml of given $BaCl_2$ into a clean dry beaker and the conductivity cell should completely be immersed in the solution. 0.1N $MgSO_4$ is taken in the burette and added in 0.5ml portions. The solution is stirred well after each addition and allowed to attain equilibrium. The conductance is noted. Then the conductance is plotted Vs the volume of $MgSO_4$ added. Two straight lines with different slopes are obtained. The point of intersection gives the equivalence point from which the strength of barium chloride can be calculated.

Result:

The strength of barium chloride = _____ N

Ex. No. 17

STRONG ELECTROLYTE – VERIFICATION OF ONSAGER'S THEORY

S. No.	Concentration of NaCl (N)	Conductance (m.mho) x 10⁻³	$\lambda = \dfrac{k \times 1000}{C}$ (mho cm²) gequ⁻¹	$\sqrt{C}$

Calculation :

1) λ =
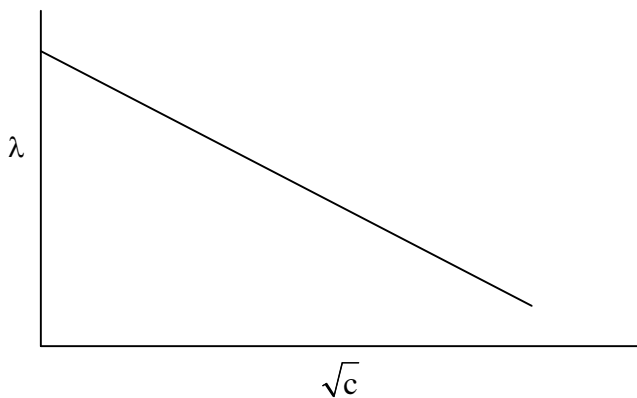
2) λ =

3) λ =

4) λ =

5) λ =

6) λ =

Ex.No.:17	# STRONG ELECTROLYTE – VERIFICATION OF ONSAGER'S THEORY

Aim:

To determine the equivalent conductance of strong electrolyte and to verify the validity of Onsager's equation as limiting law of infinite dilution.

Principle:

A solution of strong electrolyte of known strength is prepared and the conductivity is measured for the solutions of concentrations ranging from 0.1N. Onsager's equation is $\lambda_c = \lambda_\infty - (A + B\lambda_\infty)\sqrt{c}$. λ_c and λ_∞ are the equivalent conductances at concentration 'c' and at infinite dilution respectively. A = 0.2273 and B = 59.79 for uni-univalent electrolyte. From the plot of λ_c vs $\sqrt{c}$, λ_∞ is obtained by extrapolating the line to $\sqrt{c}$ = 0. The slope is determined and compared with the value got from Onsager's equation.

Procedure:

Potassium chloride solutions of the following concentrations 0.01N, 0.02N, 0.04N, 0.06N, 0.08N and 0.1N are prepared. The solutions are taken in a conductivity cell one by one and the respective specific conductances are measured. From this, the equivalent conductance $\lambda_c = \dfrac{k \times 1000}{c}$ can be calculated. λ_c is plotted against $\sqrt{c}$. The value of λ_∞ is obtained by extrapolating to $\sqrt{c}$ = 0. The slope is compared with that obtained from Onsager's equation.

Result:

The equivalent conductance of Potassium chloride at infinite dilution is found to be λ_∞ = _____ ohm^{-1} cm^2 g equ^{-1}.

Onsager's slope = _____ ohm^{-1} g equ^{-1}.

Ex. No. 18

WEAK ELECTROLYTE – DISSOCIATION CONSTANT OF WEAK

ELECTROLYTE – VERIFICATION OF OSTWALD'S DILUTION LAW

S. No.	Concentration of CH$_2$COOH (N)	Conductance (m.mho)	λc(mho.m^2)	$\sqrt{C}$	$k_a = \dfrac{\alpha^2 C}{1-\alpha} x10^3$

Average =

T°C

$\sqrt{C}$

Ex.No.:18	# DISSOCIATION CONSTANT OF A WEAK ACID

Aim:

To verify Ostwald's dilution law and to determine the equivalent conductance of acetic acid and its dissociation constant.

Principle:

The equivalent conductance of any electrolytes is defined as the conducting power of all the ions produced by 1 gm equivalent of the electrolyte. The equivalent conductance of the solution depends upon the number and rate of migration of anions and cations. The experiment indicates that equivalent conductance increases with dilution. This would arise either from an increase in the number of individual ions (or) from the speed of ions. The ionic mobilities are independent of concentration so that λ is proportional to the number of ions present at different concentrations. The equivalent conductance at a particular concentration is a measure of degree of dissociation $\alpha = \frac{\lambda_c}{\lambda_\infty}$. Arrhenius theory is applicable only for weak electrolytes. For such solutions conductivity measurements are used to obtain the degree of dissociation and hence the dissociation constant.

Thus for acid of different normality the specific conductance and hence the value of dissociation constant at different concentrations are calculated λ_c is plotted v_s $\sqrt{c}$. According to Ostwald's dilution law $\alpha^2 c/(1- \alpha) = k_a$, where k_a is dissociation constant, α is the degree of dissociation and c is the concentration. The Thermodynamic dissociation constant is give by

$$k_a = \frac{a_{H^+} a_{CH_3COO^-}}{a_{CH_3COOH}} = \frac{c_{H^+} c_{CH_3COO^-}}{c_{CH_3COOH}} \ X \ \frac{f_{H^+} f_{CH_3COO^-}}{f_{CH_3COOH}}$$

$$= k_a \ \text{classical} \ x \ \frac{f_{H^+} f_{CH_3COO^-}}{f_{CH_3COOH}}$$

According to Debye – Huckel limiting law,

$- \log f_{\pm} = - A \mid Z^+ Z^- \mid \sqrt{\mu}$

where $\sqrt{\mu}$ is ionic strength

A = 0.509

Procedure:

Acetic acid of the following normalities 0.1N, 0.08N, 0.06N, 0.04N, 0.02N and 0.01N are pipetted out in a dry conductivity cell one by one and the conductivity cell is immersed in the solution. The respective value for the conductance is obtained. The specific conductance and equivalent conductance of each of these solution are calculated from these values of λ_c and λ_∞ can be calculated.

A = λ_c / λ_∞ and a plot of λ_c v_s $\sqrt{c}$ are noted.

Result:

Dissociation constant of Acetic acid is ------------ mol dm^{-3}

Ex. No. 19

ALKALINE HYDROLYSIS OF ESTER

$$\frac{C_o - C_t}{C_t - C_\infty}$$ (y-axis)

$$k_2 = \frac{\text{slope}}{0.01}$$
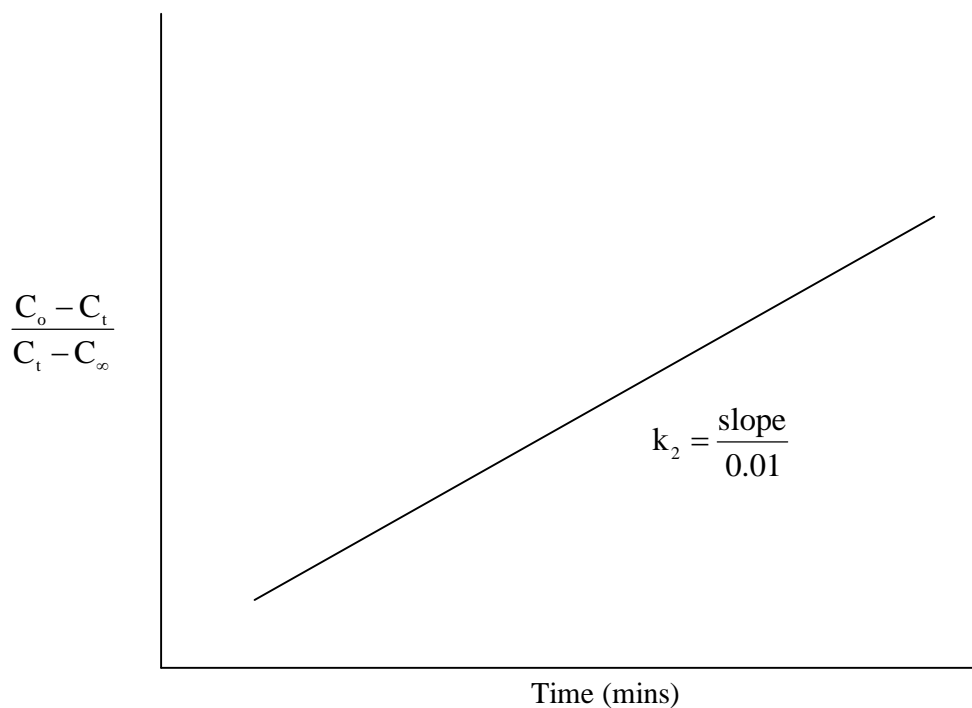
Time (mins)

Time (min)	Conductance (m.mho)	$k_a = \dfrac{C_o - C_t}{C_t - C_\infty}$	$k_a = \dfrac{1}{0.01t}\dfrac{C_o - C_t}{C_t - C_\infty}$

C_∞ =

C_o =

$\dfrac{C_o - C_t}{C_t - C_\infty}$ = $k_2 (0.01)t$

slope = $0.01\ k_2$

k_2 = $\dfrac{\text{slope}}{0.01}$

| Ex.No.:19 | **ALKALINE HYDROLYSIS OF ETHYL ACETATE** |

Aim:

To study the alkaline hydrolysis of ethyl acetate.

Procedure:

Exactly N/100 solution of sodium acetate and N/100 solution of NaOH are prepared. The conductance of each solution is determined. This corresponds to the final and initial conductances of the reaction respectively 20ml of N/20 NaOH and 5ml of 0.02N ethyl acetate are pipetted out into a clean 100ml standard flask and diluted up to the mark, so that the solution becomes 0.01N. The conductance of the solution is determined at the intervals of 4 minutes.

$$k = \frac{1}{t} \cdot \frac{x}{a(a-x)}$$ where, x is the amount of reactant that has reacted at time t, (a-x) is the amount of reactant that remains unreacted at time 't' and a is the initial concentration of the reactant. If c_o is the initial concentration and c_t is the concentration given at time t, then the concentration at time t is x equal to $(c_t - c_\infty)$. c_∞ is the conductivity of sodium acetate (N/10) and c_o being the conductivity of the N/100 NaOH at time 't'.

$$k = \frac{1}{t} \cdot \frac{x}{a(a-x)}$$

$$= \frac{1}{0.01} \cdot \left(\frac{C_o - C_t}{C_t - C_\infty} \right)$$

A graph is drawn by plotting $\frac{c_0 + c_t}{c_t - c_\infty}$ on y- axis and 't' on x- axis. The slope being equal to $0.1k_2$. From this k_2 can be calculated.

Result:

    (i) The reaction was found to be second order.

    (ii) The second order rate constant of the reaction.

        (a) Graphical value   = _____ $dm^3 mol^{-1} min^{-1}$
        (b) Analytical value   =_____ $dm^3 mol^{-1} min^{-1}$

Ex. No. 20

SOLUBILITY OF SPARINGLY SOLUBLE SALT

Specific conductance of conductivity water   =

Specific conductance of I filtrate   =

Specific conductance of II filtrate   =

Specific conductance of III filtrate   =

Specific conductance of saturated solution of a salt   =

Solubility product   =

Equivalent conductance at infinite dilution   =

Solubility of the given sparingly soluble salt   = $\dfrac{k \times 1000}{\lambda_{\infty}}$

Ex.No.:20	**SOLUBILITY OF A SPARINGLY SOLUBLE SALT BY CONDUCTOMETRIC METHOD**

Aim:

To determine the solubility of a given sparingly soluble salt - _____ .

Principle:

The conductivity method is applicable for determining the concentration of a saturated solution of a sparingly soluble salt, provided the salt is not hydrolyzed and solubility is not too high. Using Kohlrausch's law, λ_∞ is calculated from ionic conductances of individual ions.

Procedure:

The conductivity of water is first determined. The given salt is precipitated by slow addition of suitable reagent. The precipitate is digested on a steam bath for 30 minutes and washed with conductivity water. It is centrifuged several times and centrifugate is discarded. The precipitate is taken in a bottle and added conductivity water and shaken mechanically for half an hour. Then filtered in to the beaker containing the conductivity cell. The conductivity of the solution is noted. The experiment is repeated until constant values are obtained. From the conductivity of water and conductivity of saturated solution, the solubility was calculated using the formulae

$S = \dfrac{k \times 1000}{\lambda_\infty}$ where S is the solubility of a given salt in g. and k is the

specific conductance at infinite dilution.

Result:

The solubility of the given sparingly soluble salt = ...g.eq/lit

Ex. No. 21

TITRATION OF MIXTURE OF SODIUM ACETATE AND ACETIC ACID VS SODIUM HYDROXIDE

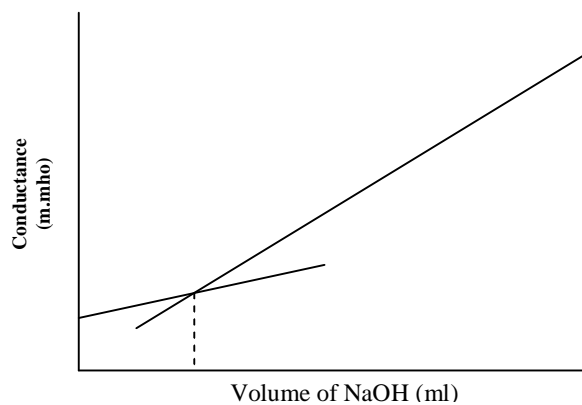| Volume of NaOH (ml)	Conductance (m.mho)	Volume of NaOH (ml)	Conductance (m.mho)

Calculation :

Volume of NaOH   =

Strength of NaOH   =

Volume of mixture   =

Strength of CH$_3$OOH   =

Volume of NaOH (ml)

52

Ex.No.:21	# TITRATION OF CH$_3$COONa and CH$_3$COOH V$_S$ NaOH

Aim:

    To determine the strength of CH$_3$COOH conductometrically by titrating the mixture of CH$_3$COOH and CH$_3$COONa v$_s$ NaOH.

Procedure:

    40ml of the mixture of CH$_3$COOH and CH$_3$COONA is taken in a conductivity cell, so that the electrode is completely immersed in the solution. A standard solution of NaOH is taken in the burette and added in 0.5ml portions. The solution is stirred well after each addition and allowed to attain equilibrium. The conductance is measured using digital conductivity bridge. The conductance is plotted against volume of NaOH. The equivalence point is the point of intersection. The equivalence point corresponding to the volume of NaOH required to neutralize CH$_3$COONA. Hence from this value it is possible to calculate the strength of CH$_3$COOH.

Result:

    The strength of CH$_3$COOH = _____ N

Ex. No. 22

TITRATION OF MIXTURE OF HCl AND AMMONIUM CHLORIDE VS

SODIUM HYDROXIDE

Volume of NaOH (ml)	Conductance (m.mho)

Calculation:

Volume of NaOH =

Strength of NaOH =

Volume of mixture =

Strength of HCl =

=

Volume of NaOH =

Strength of NaOH =

Volume of mixture =

Strength of NH$_4$Cl =

=

Volume of NaOH (ml)

Ex.No.:22	**TITRATION OF MIXTURE OF HCl and NH$_4$Cl V$_S$ NaOH**

Aim:

To determine the strength of NH$_4$Cl and HCl conductometrically by titrating with NaOH.

Procedure:

40ml of given mixture of NH$_4$Cl and HCl is taken in a conductivity cell, so that the electrode is completely immersed in the solution. A standard solution of NaOH is taken in the burette and added in 0.5ml portions. The solution is stirred well after each addition and allowed to attain equilibrium. The conductance is measured using digital conductivity bridge. The conductance is plotted against volume of NaOH. The equivalence point is the point of intersection. The equivalence point corresponding to the volume of NaOH required to neutralize HCl. Hence from this value it is possible to calculate the strength of HCl.

Result:

    (i) The strength of NH$_4$Cl in the mixture = _____ N

    (ii) The strength of HCl in the mixture   = _____ N

Ex. No. 23

TITRATION OF SODIUM ACETATE VS HYDROCHLORIC ACID

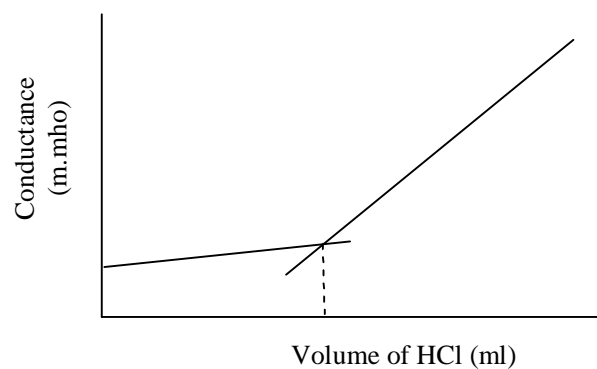| Volume of HCl (ml)	Conductance (m.mho)	Volume of HCl (ml)	Conductance (m.mho)

Calculation :

Volume of HCl =

Strength of HCl =

Volume of CH$_3$COONa =

Strength of CH$_3$COONa =

=

Ex.No.:23	# TITRATION OF CH$_3$COONa V$_S$ HCl

Aim:

To determine the strength of CH$_3$COONa by titrating with HCl.

Procedure:

Pipetted out 40ml of 0.1N in to clean beaker so that the electrode is completely immersed in the solution. An appropriate solution of 0.5N HCl is taken in the burette and added in 0.5ml portions. The solution is stirred well after each addition and allowed to attain equilibrium. The conductance is measured using digital conductivity bridge and the conductance was plotted against volume of HCl added. Two straight lines with different slopes are obtained. The point of intersection gives the equivalence point from which the strength can be calculated.

Result:

The strength of CH$_3$COONa = ------------ N

Ex. No. 24

TITRATION OF MIXTURE OF SODIUM ACETATE
AND ACETIC ACID VS HYDROCHLORIC ACID
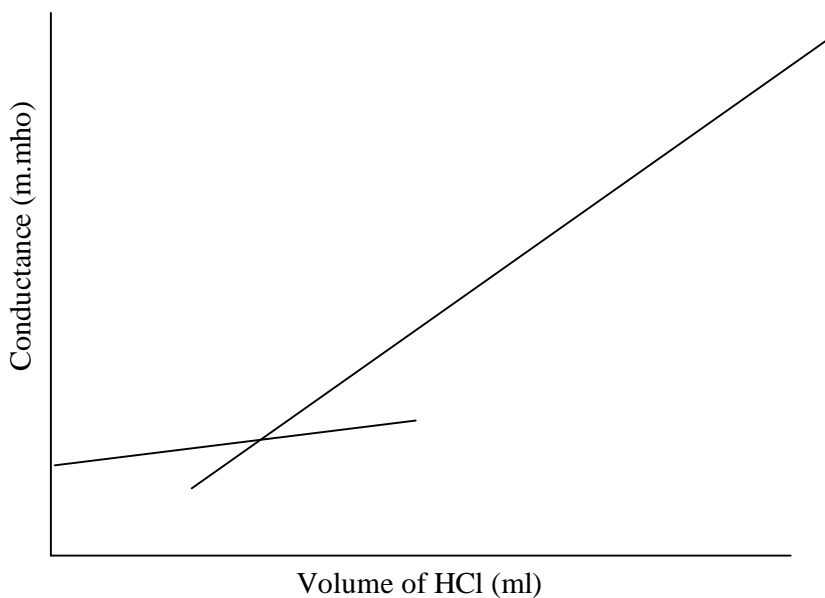
Volume of HCl (ml)

Volume of HCl (ml)	Conductance (m.mkho)

Calculation :

Volume of HCl   =

Strength of HCl   =

Volume of mixture   =

Strength of CH₃COONa   =

                                =

Ex.No.:24	**TITRATION OF CH₃COONa and CH₃COOH V$_S$ HCl**

Aim:

To determine the strength of CH_3COONa conductometrically by titrating the mixture of the CH_3COOH and CH_3COONa with HCl.

Procedure:

40ml of the mixture of CH_3COOH and CH_3COONa is taken in a conductivity cell, so that the electrode is completely immersed in the solution. A standard solution of 0.5N HCl is taken in the burette and added in 0.5ml portions. The solution is stirred well after each addition and allowed to attain equilibrium. The conductance is measured using digital conductivity bridge. The conductance is plotted against volume of HCl. The equivalence point is the point of intersection. The equivalence point corresponding to the volume of HCl required to neutralise CH_3COONa. Hence from this value it is possible to calculate the strength of CH_3COONa.

Result:

The strength of CH_3COONa = _____ N

Ex. No. 25

TITRATION OF MIXTURE OF AMMONIUM HYDROXIDE
AND SODIUM HYDROXIDE VS HYDROCHLORIC ACID

Volume of HCl (ml)	Conductance (m.mho)	Volume of HCl (ml)	Conductance (m.mho)

Calculation :

Volume of HCl	=	**Volume of HCl**	=
Strength of HCl	=	**Strength of HCl**	=
Volume of mixture	=	**Volume of mixture**	=
Strength of NaOH	=	**Strength of NH_4OH**	=
	=		=

Conductance (m.mho) vs Volume of HCl (ml)

Ex.No.:25	**TITRATION OF MIXTURE OF NaOH and NH$_4$OH V$_S$ HCl**

Aim:

To determine the strength of NaOH and NH$_4$OH conductometrically by titrating the mixture with HCl.

Procedure:

40ml of given mixture of NH$_4$OH and NaOH were taken in a conductivity cell, so that the electrode is completely immersed in the solution. A standard solution of HCl is taken in the burette and added in 0.5ml portions. The solution is stirred well after each addition and allowed to attain equilibrium. The conductance is measured using digital conductivity bridge. The conductance is plotted against volume of HCl. The equivalence point is the point of intersection. The equivalence point corresponding to the volume of HCl required to neutralize NaOH. Hence from this value it is possible to calculate the strength of NH$_4$OH and NaOH.

Result:

  (i) The strength of NaOH = _____ N

  (ii) The strength of NH$_4$OH in the mixture   = _____ N

Ex. No. 26

TITRATION OF HYDROCHLORIC ACID VS SODIUM HYDROXIDE

Rough Titration

Volume of NaOH (ml)	EMF (V)	ΔE		Volume of NaOH (ml)	EMF (V)	ΔE		Volume of NaOH (ml)	EMF (V)	ΔE

Fair Titration

Volume of NaOH (ml)	EMF (V)	ΔE	ΔE/ΔV	Mean volume		Volume of NaOH (ml)	EMF (V)	ΔE	ΔE/ΔV	Mean volume

Calculation :

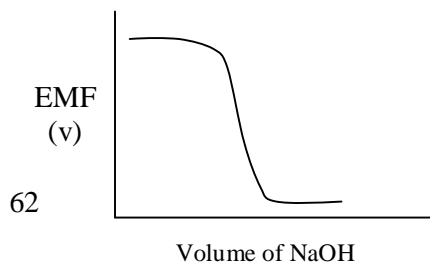Volume of Sodium hydroxide   =   Strength of sodium hydroxide   =

Volume of Hydrochloric acid   =   Strength of Hydrochloric acid   =

Graph – 1   **Graph – 2**

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	POTENTIOMETRY
Ex.No.:26	**TITRATION OF HYDROCHLORIC ACID V$_S$ SODIUM HYDROXIDE**

Aim:

To determine the strength of hydrochloric acid potentiometrically by titration with sodium hydroxide.

Principle:

The end point of the neutralization titration may be found by direct measurement of the emf of the solution after each addition of alkali to acid. The change of emf for the addition of a given amount of titrant is maximum at the equivalence point and so the later can be identified.

The potential of any hydrogen electrode is given by

$E = E° - 0.059 \log a_{H^+}$. The change in electrode potential or the emf of a cell made up of the hydrogen and a standard electrode is thus proportional to the change in pH during titration. At the end point $\frac{\Delta E}{\Delta v}$ is maximum, where ΔE is the change in potential (or) emf resulting from the addition of a definite volume (eg. 0.1ml) of titrant. The accuracy with which this point can be deducted depends on the magnitude of the inflexion in the pH neutralization curve.

Procedure:

An approximately 0.05N HCl is prepared, 10ml of which is pipetted out in to a beaker. A pinch of quinhydrone is added. A platinum electrode is dipped into the solution and it is connected to reference electrode (Saturated calomel electrode). A standard solution of (0.05N) sodium hydroxide is taken in aburette and added in 1 cc portions. Emf is measured and the range of equivalence point is noted. The exact end point is found out by noting the emf value for each addition of 1 cc portion of the titrant and nearing the equivalence point 0.5cc, 0.2cc and 0.1cc portions. The following graphs are drawn.

     1. The value of emt Vs Volume of NaOH

     2. The value of $\dfrac{\Delta E}{\Delta V}$ Vs mean volume of NaOH

Result:

The strength of hydrochloric acid is _____ N

TITRATION OF ACETIC ACID VS SODIUM HYDROXIDE

Rough Titration

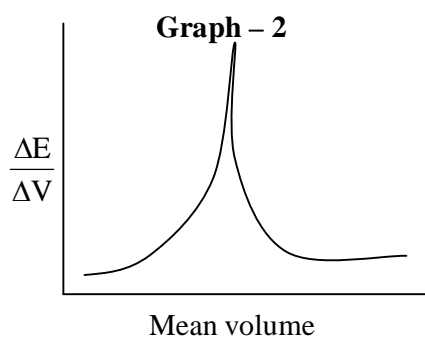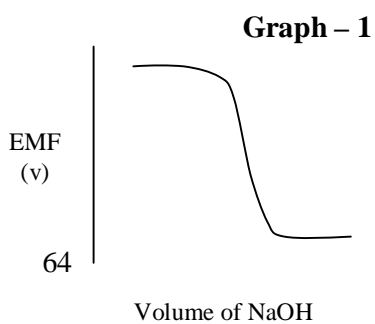| Volume of NaOH (ml)	EMF (V)	ΔE		Volume of NaOH (ml)	EMF (V)	ΔE		Volume of NaOH (ml)	EMF (V)	ΔE

Fair Titration

Volume of NaOH (ml)	EMF (V)	ΔE	ΔE/ΔV	Mean volume		Volume of NaOH (ml)	EMF (V)	ΔE	ΔE/ΔV	Mean volume

Calculation :

Volume of Sodium hydroxide	=	Strength of sodium hydroxide	=
Volume of acetic acid	=	Strength of acetic acid	=

Graph – 1

EMF (v)

Volume of NaOH

Graph – 2

$\dfrac{\Delta E}{\Delta V}$

Mean volume

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Ex.No.:27	**TITRATION OF ACETIC ACID V$_S$ SODIUM HYDROXIDE**

Aim:

To determine the strength of acetic acid potentiometrically by titration with sodium hydroxide.

Procedure:

An approximately 0.05N CH$_3$COOH is prepared, 10ml of which is pipetted out in to a beaker. A pinch of quinhydrone is added. A platinum electrode is dipped into the solution and it is connected to reference electrode (Saturated calomel electrode). A standardized solution of (0.05N) sodium hydroxide is taken in burette and added in 1 cc portions. From the emf value the range of equivalence point is noted. The exact end point is found out by noting the emf value for each addition of 1 cc portion of the titrant and nearing the equivalence point 0.5cc, 0.2cc and 0.1cc portions. The solution is stirred well after each addition and the corresponding emf is noted.

The following graphs are drawn.

(i) The value of emf v$_s$ volume of NaOH.

(ii) The value of $\frac{\Delta E}{\Delta V}$ v$_s$ mean value of NaOH.

Result:

The strength of given acetic acid = _____ N

Ex. No. 28

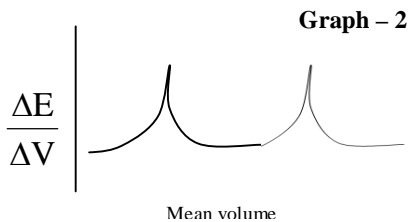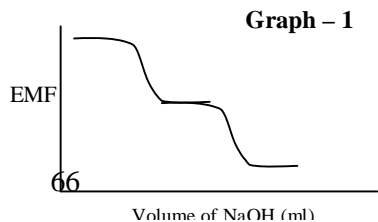# TITRATION OF MIXTURE OF ACIDS VS STRONG BASE (NaOH)
Rough Titration

Volume of NaOH (ml)	EMF (V)	ΔE		Volume of NaOH (ml)	EMF (V)	ΔE		Volume of NaOH (ml)	EMF (V)	ΔE

Fair Titration

Volume of NaOH (ml)	EMF (V)	ΔE	ΔE/ΔV	Mean volume		Volume of NaOH (ml)	EMF (V)	ΔE	ΔE/ΔV	Mean volume

Calculation :

Volume of Sodium hydroxide =   Strength of sodium hydroxide =

Volume of hydrochloric acid =   Strength of hydrochloric acid =

Volume of Sodium hydroxide =   Strength of sodium hydroxide =

Volume of acetic acid + HCl =   Strength of acetic acid =

Graph – 1

EMF

Graph – 2

$\dfrac{\Delta E}{\Delta V}$

Volume of NaOH (ml)

Mean volume

Ex.No.:28	# TITRATION OF MIXTURE OF ACIDS V$_S$ SODIUM HYDROXIDE

Aim:

To determine the strength of hydrochloric acid and CH_3COOH in a mixture potentiometrically by titration with sodium hydroxide.

Procedure:

An approximately 10ml of the given mixture is pipetted out in to a beaker. A platinum electrode is dipped into the solution. A pinch of quinhydrone is added. A reference electrode is also placed in a beaker. Both are connected to potentiometer. A saturated solution of (0.1N) sodium hydroxide is taken in the burette and added to the solution in 1cc portions. The corresponding emf values are noted from the emf values. The exact end point is noted from the emf value for each addition of 1 cc portion of the titrant and nearing the equivalence point corresponding to the 2 acids of the emf values, was noted for the addition of 0.5cc, 0.2cc and 0.1cc portions of the titrant.

The following two graphs are drawn.

 (i) The value of emf v$_s$ volume of NaOH added.

(ii) The value of $\frac{\Delta E}{\Delta V}$ v$_s$ mean volume of NaOH.

The first equivalence point corresponds to the neutralization of hydrochloric acid. The second equivalence point corresponds to that of mixture of hydrochloric acid and acetic acid.

Result:

(i) The strength of given acetic acid in the given mixture = _____ N

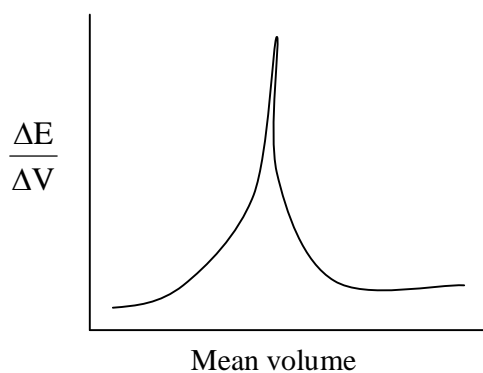(ii) The strength of HCl in the given mixture = _____ N

Ex. No. 29

TITRATION OF FAS VS POTASSIUM DICHROMATE

Graph – 1

EMF
(v)

Volume of NaOH (ml)

Graph – 2

$\frac{\Delta E}{\Delta V}$
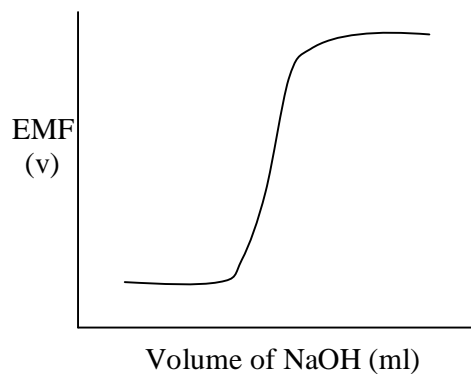
Mean volume

Volume of K$_2$Cr$_2$O$_7$ (ml)	EMF (v)	ΔE/ΔV (mv/mL)	Mean volume (ml)

Calculation :

Volume of potassium permanganate   =

Strength of potassium permanganate   =

Volume of FAS   =

Strength of FAS   =

Ex.No.:29	**TITRATION OF FERROUS AMMONIUM SULPHATE V$_S$ K$_2$ Cr$_2$ O$_7$**

Aim:

To determine the strength of Ferrous ammonium sulphate potentiometrically by titrating with potassium dichromate.

Procedure:

A standard solution of 0.05N $K_2Cr_2O_7$ is taken in the burette. 10 ml of approximately 0.05N Ferrous ammonium sulphate is taken in the beaker and about 10ml of dilute H_2SO_4 is added. A platinum electrode is dipped in the solution and reference electrode is also placed in the beaker. Both are connected to potentiometer.

The $K_2Cr_2O_7$ solution is added from the burette in 1ml portions to fix the range of equivalence point. It is followed by fair titration by adding 0.5ml, 0.2ml and 0.1ml, so that the equivalence point can be determined.

The following two graphs are drawn.

(i) The value of emf v$_s$ volume of $K_2Cr_2O_7$.

(ii) The value of $\frac{\Delta E}{\Delta V}$ v$_s$ mean volume of $K_2Cr_2O_7$.

Result:

The strength of Ferrous ammonium sulphate = ------------- N

Ex. No. 30

TITRATION OF POTASSIUM CHLORIDE VS SILVER NITRATE

Volume of AgNO₃ (ml)	EMF (v)	ΔE/ΔV (mv/mL)	Mean volume (ml)

Calculation :
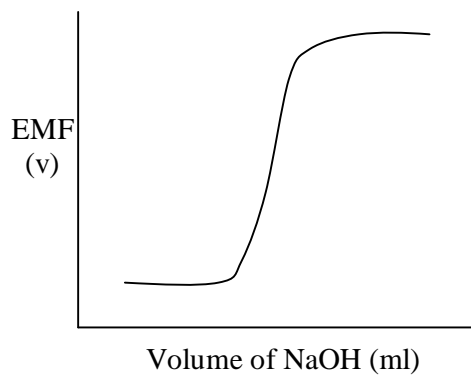
Volume of silver nitrate   =

Strength of silver nitrate   =

Volume of Potassium chloride   =

Strength of Potassium chloride   =

Graph – 1

EMF (v)

Volume of NaOH (ml)

Graph – 2

$\dfrac{\Delta E}{\Delta V}$

Mean volume
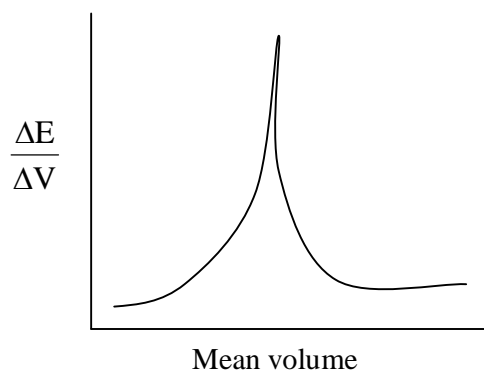
Ex.No.:30	**TITRATION OF KCl Vs AgNO₃**

Aim:

To determine the strength of KCl potentiometrically by titration with AgNO$_3$.

Cell construction: Pt / Hg, Hg$_2$Cl$_2$, kCl (salt)// Ag$^+$, Ag

Procedure:

Approximately 0.05N KCl is prepared, 10 ml of which is pipetted out into beaker and is covered with brown paper. A silver electrode is dipped into the solution and also a reference electrode is placed in the beaker. Both are connected to potentiometer.

0.05N AgNO$_3$ solution is taken in the burette. Added this in 1ml portions and 0.5ml, 0.2ml and 0.1ml towards the end point. The solution is stirred well after each addition and the emf is noted. An approximate titration is carried out to fix the equivalence point followed by fair titration.

The following two graphs are drawn.

(i) The value of emf v$_s$ volume of AgNO$_3$.

(ii) The value of $\frac{\Delta E}{\Delta V}$ v$_s$ mean volume of AgNO$_3$.
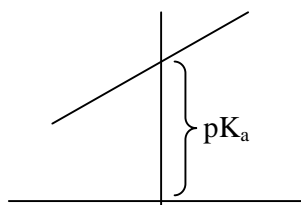
Result:

The strength of given KCl is = _____ N

Ex. No. 31
DETERMINATION OF DISSOCIATION CONTANT OF WEAK ELECTROLYTE

$$pH = \frac{\left(E_Q^0 - E_{cal} - E_{obs}\right)96500}{2.303\,RT}$$

pH	$\log \dfrac{[salt]}{[acid]}$	pH	$\log \dfrac{[salt]}{[acid]}$

Graph

$\log \dfrac{[salt]}{[acid]}$

$E_Q^0 = 0.6900 - 0.0017\,(t\text{-}25)$

$E_{cal} = 0.2420 - 0.0007\,(t\text{-}25)$

E_{obs} = emf values corresponding to the volume of NaOH from Rough titration.

$$\log \frac{[salt]}{[acid]} = \log \frac{V}{(V_n - V)} \quad \text{where}$$

V = volume of alkali added

V_n = Volume of alkali at the equivalence point from faire titration.

$$pH = pKa + \log \frac{[salt]}{[acid]}$$

$$\log \frac{[salt]}{[acid]} = \log \frac{V}{(V_n - V)}$$

$$pKa = pH - \log \frac{[salt]}{[acid]}$$

V – Vol. of alkali added

V_n – Equilance pt from fair titration

Calculation

1. Half neutralisation

   $$pH = pKa + \log \frac{(1/2)}{(1/2)}$$

   pH = pKa
   pKa = – log Ka
   Ka =

2. $\dfrac{1}{3}$ neutralisation

   $$\log \frac{(1/3)}{(2/3)} = \log (1/2)$$

   pKa = pH – log (1/2)– log Ka =
   Ka =

3. 2/3 neutralisation

   $$\log \frac{(2/3)}{(1/3)} = \log 2$$

   pKa = pH – log 2
   – log Ka = pH – log 2
   Ka =

4. 1/4 neutralisation

   $$\log \left(\frac{3/4}{1/4}\right) = \log 3$$

   pKa = pH – log (1/3)
   – log Ka = pH – log (1/3)
   Ka =

5. 3/4 neutralisation

   $$\log \left(\frac{3/4}{1/4}\right) = \log 3$$

   pKa = pH – log 3
   – log Ka = pH – log 3   Ka =

Ex.No.:31	# DISSOCIATION CONSTANT OF A WEAK ACID

Aim:

To determine the dissociation constant of a weak acid using quinhydrone electrode.

Principle:

According to Henderson equation, the pH corresponding to half neutralization point equals Pk_a, from which k_a can be calculated. Thus it becomes essential to measure the pH of solution. This can be done using quinhydrone electrode where potential depends upon hydrogen ion concentration.

$$E = E°_Q - \frac{RT}{nF} \ln a_{H_+} = E°_Q + \frac{RT}{nF} 2.303 \text{ pH}$$

from which pH can be calculated, hence k_a is calculated from Pk_a.

Procedure:

Pipetted out 10ml of 0.1N CH_3COOH in to a 100ml beaker. A pinch of quinhydrone is added. A platinum electrode is dipped into it and the calomel electrode is used as reference electrode. Both are connected to potentiometer. To this, standardized solution of (0.1N) sodium hydroxide is added in portions from the burette and the corresponding emf is measured. The solution is stirred after each addition.

The following two graphs are drawn.

(i) The value of emf v_s volume of NaOH added.

(ii) The value of $\frac{\Delta E}{\Delta V}$ v_s mean volume of NaOH.

The emf of the cell at half neutralization is determined from the graph. As the emf was known the ph can be calculated from the equation.

Ex. No. 31 Contd.

pH = [E_{cal} - $E°_Q$ - E_{obs}] F / 2.303RT

A graph is drawn taking pH on the y-axis and log $\dfrac{[\text{salt}]}{[\text{acid}]}$ on the x-axis.

(i) At half neutralization pH = pk_a – log k_a.

Therefore the dissociation constant k_a can be calculated.

(ii) The dissociation constant at ¾, 1/3, ¼, and 2/3 neutralisation is calculated.

Result:

The dissociation constant of CH_3COOH IS

(i)   At 1/2 neutralization = ---------- mol/dm^3

(ii) At 1/3 neutralization = ---------- mol/dm^3

(iii) At 2/3 neutralization = ---------- mol/dm^3

(iv) At 1/4 neutralization = ---------- mol/dm^3

(v) At 3/4 neutralization = ---------- mol/dm^3

The dissociation constant of acetic acid = ---------- mol/dm^3

Ex. No. 32

SOLUBILITY OF SPARINGLY SOLUBLE SALT (CHEMICAL CELL)

a) **0.1M KCl**

$$E_{obs} \quad = \quad E_{Ag^+/Ag} - E_{cal}$$

$$E_{Ag^+/Ag} \quad = \quad E_{obs} + E_{cal}$$

$$E_{Ag^+/Ag} \quad = \quad E^{\infty}_{Ag+/Ag} - \frac{RT}{nF} \ln a_{Ag^+} = E_{cal} + E_{obs}$$

$$E_{cal} \quad = \quad 0.2422 - 0.00076 \, (t - 25)$$

$$t \quad = \quad \text{Room Temp.}$$

$$\frac{2.30 \, 3RT}{nF} \log a_{Ag+} = E_{cal} + E_{obs} - E^{\circ}_{Ag^+/Ag}$$

$$\log a_{Ag+} = \frac{F\left[E_{cal} + E_{obs} - E^{\circ}_{Ag+/Ag}\right]}{2.303 \, RT}$$

$$a_{Ag+} = x = \underline{\qquad}$$

$$E^{\circ}_{Ag+/Ag} = \quad 0.7990v$$

$$R \quad = \quad 8.314 \text{ J/K}$$

$$F \quad = \quad 96500$$

$$T \quad = \quad \text{Room temp in K}$$

$$K_{S(AgCl)} = \quad a_{Ag^+} \, a_{Cl^-}$$

$$= \quad x.C_{Cl^-} . \gamma_{Cl^-}$$
$$= \quad x \,.\, 0.1 \times 0.8$$

$$Ks \quad =$$

$$S \quad = \quad \sqrt{K_s}$$

b. 0.01 M KCl

Same calculation

Ex.No.:32	**DETERMINATION OF SOLUBILITY OF SPARINGLY SOLUBLE SALT BY POTENTIOMETIC METHOD – CHEMICAL CELL**

Aim:

To determine the solubility of a sparingly soluble salt ($AgNO_3$) using chemical cell.

calomel 0.1M KCl, $AgNO_3$ /Ag

Procedure:

The electrode Ag / $AgNO_3$ (s) KCl (0.1N) is constructed. It is coupled with saturated calomel electrode using a salt bridge (KNO_3). The emf of cell is measured using potentiometer. The value of the solubility product (k_s) is calculated using the equation,

$$E_{obs} = E_{calomel} = E_{Ag+/AgNO3} = E°_{Ag+/AgNO3} = -\frac{RT}{F} \ln a_{Ag}$$

Solubility of silver chloride can be calculated from k_s using

$$K_s = a_{Ag^+} \, a_{Cl^-}$$

$$\sqrt{k_s} = S \text{ moles / litre}$$

Result:

Solubility of AgCl at room temperature using 0.1N KCl and 0.1N $AgNO_3$ is _____ mol/ dm^3

Ex. No. 33

SOLUBILITY OF SPARINGLY SOLUBLE SALT

(CONCENTRATION CELL)

Concentration Cell :

a) 0.1 M $AgNO_3$ & 0.1 M KCl $E_{obs} = $ _____

$$E_{obs} = \frac{2.303RT}{F} \log \frac{(a_{Ag^+})_2}{(a_{Ag^+})_1}$$

$$= 0.0591 \log \frac{(a_{Ag^+})_2}{(a_{Ag^+})_1}$$

$a_{Ag^+(1)}$ – activity of Ag^+ in 0.1 M KCl saturated with $AgNO_3$

$a_{Ag^+(2)}$ – activity Ag^+ in 0.1 M $AgNO_3$ solution

$a_{Ag^+(2)} = 0.1 \times 0.8$

$a_{Ag^+(1)} = $ _____

$a_{Cl^-}(1M) = 0.1 \times 0.755$

$Ks = a_{Ag^+(1)} \, a_{Cl^-(1)}$

$S = \sqrt{k_s} = $ m/dm^3.

Ex.No.: 33	**DETERMINATION OF SOLUBILITY OF SPARINGLY SOLUBLE SALT – CONCENTRATION CELL**

Aim:

      To determine the solubility of a sparingly soluble salt ($AgNO_3$) using concentration cell.

Procedure:

      The electrode Ag / $AgNO_3$ (s) KCl (0.1N) is constructed. It is coupled with $AgNO_3$/Ag, (0.1N) through salt bridge (KNO_3). The emf of cell is measured using potentiometer. The value of the solubility product (k_s) is calculated using the equation,

$$E_{obs} = \frac{2.303RT}{F} \log \frac{(a_{Ag^+})_2}{(a_{Ag^+})_1}$$

Solubility of silver chloride can be calculated from k_s using

$$Ks = a_{Ag^+} a_{Cl^-}$$

$\sqrt{ks}$ = s moles / litre

Result:

      Solubility of AgCl at room temperature using 0.1N KCl and 0.1N $AgNO_3$ is _____ mol/ dm^3

Ex. No. 1

```
/*conversion of celsius to fahrenheit*/
#include<iostream.h>
#include<conio.h>
void main()
{
 float fahrenheit,celsius;
 clrscr();
 cout<<"12PCH001:"<<endl;
 cout<<"give the value of the celsius"<<endl;
 cin>>celsius;
 cout<<"celsius="<<celsius<<endl;
 fahrenheit=1.8*celsius+32;
 cout<<"fahrenheit="<<fahrenheit;
 cout<<"\n give the value of fahrenheit\n"<<endl;
 cin>>fahrenheit;
 cout<<"fahrenheit="<<fahrenheit<<endl;
 celsius=(fahrenheit-32)/1.8;
 cout<<"celsius="<<celsius;
 }
```

Ex. No. 2

```
/*computation of normality, molarity, molality*/
#include<iostream.h>
#include<conio.h>
void main()
{
 float n,m,M;
 float wt,mwt,eqwt,wtsol,wtlit;
 clrscr;
 cout<<"12PCH001:"<<endl;
 cout<<"Give the value of wt"<<endl;
 cin>>wt;
 cout<<"Give the value of mwt"<<endl;
 cin>>mwt;
 cout<<"Give the value of eqwt"<<endl;
 cin>>eqwt;
 cout<<"Give the value of wtsol"<<endl;
 cin>>wtsol;
 cout<<"Give the value of wtlit"<<endl;
 cin>>wtlit;
 n=wtlit/eqwt;
 M=wtlit/mwt;
 m=(wt/mwt)*(1000/wtsol);
 cout<<"normality="<<n<<endl;
 cout<<"molarity="<<M<<endl;
 cout<<"molality="<<m<<endl;
 }
```

Ex. No. 3

```
/*To calculate activation parmeters at a given temperature*/
#include<iostream.h>
#include<conio.h>
#include<math.h>
void main()
{
 float Ea,H,S,T,K,logK,Arrslope;
 clrscr();
 cout<<"12PCH001:"<<endl;
 cout<<"give the value of Arrslope"<<endl;
 cin>>Arrslope;
 cout<<"give the value of T"<<endl;
 cin>>T;
 cout<<"give the value of K"<<endl;
 cin>>K;
 Ea=Arrslope*2.303*8.314;
 H=Ea-(8.314*T);
 S=19.147*(logK-12.7856+(H/5610.11));
 cout<<"Activation energy="<<Ea<<endl;
 cout<<"enthalpy of activation ="<<H<<endl;
 cout<<"entropy of activation ="<<S<<endl;
 }
```

Ex. No. 4

```
/*To compute reduced mass and force constant*/
#include<iostream.h>
#include<conio.h>
#include<math.h>
void main()
{
float m1,m2,p,w,c,k;
double reducedmass;
clrscr();
cout<<"12PCH001:"<<endl;
cout<<"Give the value of m1"<<endl;
cin>>m1;
cout<<"Give the value of m2"<<endl;
cin>>m2;
cout<<"Give the value of w"<<endl;
cin>>w;
cout<<"Give the value of c"<<endl;
cin>>c;
p=(m1*m2)/(m1+m2);
reducedmass=p/6.02323;
k=4*3.14*3.14*w*w*c*c*reducedmass;
cout<<"force constant="<<k<<endl;
cout<<"raducedmass="<<reducedmass;
}
```

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Ex. No. 5

```
#include<iostream.h>
#include<conio.h>
#include<math.h>
void main()
{
float c,z1,z2,iostr,a1,a2,z1,z2,x1,x2;
char electro[10];
clrscr();
cout<<"12PCH001"<<endl;
cout<<"Enter the name of the electrolyte"<<endl;
cin>>electro;
cout<<"Give the value of concentration of the ions"<<endl;
cin>>c;
cout<<"Give the charges of the ions"<<endl;
cin>>z1;
cin>>z2;
Z1=z1*z1;
Z2=z2*z2;
iostr=(c*(Z1+Z2))/2;
cout<<"give the value of activation of ions"<<endl;
cin>>a1;
cin>>a2;
x1=a1/c;
x2=a2/c;
cout<<"ionic strength="<<iostr<<endl;
cout<<"activity coefficient of ion1="<<x1<<endl;
cout<<"activity coefficient of ion2="<<x2<<endl;
}
```

Ex. No. 6

```
/*A program to obtain d spacing in a cubic crystral*/
#include<iostream.h>
#include<conio.h>
#include<math.h>
void main()
{
 int h,k,l;
 float d1,d2,d3,x1;
 clrscr();
 cout<<"12PCH001"<<endl;
 cout<<"give the value ofh,k,l"<<endl;
 cin>>h>>k>>l;
 /*
 cout<<"h=1"<<endl;
 cout<<"k=0"<<endl;
 cout<<"l=0"<<endl;*/
 x1=(h*h+k*k+l*l);
 d1=(100/sqrt(x1))/100;
 cout<<"d100="<<d1<<endl;
 cout<<"give the value of h,k,l"<<endl;
 cin>>h>>k>>l;
 /*
 cout<<"h=1"<<endl;
 cout<<"k=1"<<endl;
 cout<<"l=0"<<endl;
 */
 d2=(100/sqrt(h*h+k*k+l*l))/100;
 cout<<"d110="<<d2<<endl;
 cout<<"given the value of h,k,l"<<endl;
 cin>>h>>k>>l;
 /*
 cout<<"h=1"<<endl;
 cout<<"k=1"<<endl;
 cout<<"l=1"<<endl;
 */
 d3=(100/sqrt(h*h+k*k+l*l))/100;
 cout<<"d11="<<d3<<endl;
 double a=1.0/sqrt(2);
 double b=1.0/sqrt(3);
 cout<<"a is:"<<a<<endl;
 cout<<"b is:"<<b<<endl;
 cout<<"d1 is:"<<d1<<endl;
 cout<<"d2 is:"<<d2<<endl;
 cout<<"d1 is:"<<d3<<endl;
 if((d1==1.0)&&(d2==a)&&(d3==b))
```

```cpp
{
 cout<<"crystal type=simple cubic"<<endl;
 }
 }/*else
 {
 if(d1==1&&d2==2/sqrt(2)&&d3==1/sqrt(3))
 {
 cout<<"crystal type=bcc"<<endl;
 }else
 {
 if(d1==1&&d2==1/sqrt(2)&&d3==2/sqrt(3))
 cout<<"crystal type=fcc"<<endl;
 }
 }*/
```

Ex. No. 7

AM1 CHARGE=0 GNORM=0.1 BONDS GEO-OK VECTORS DENSITY
Hydrogen 12PCH001

```
H
H 1.1 1 1
```

Ex. No. 8

```
AM1 CHARGE=0 GNORM=0.1 BONDS GEO-OK VECTORS DENSITY
Boron 12PCH001 triflouride
```

```
B
Cl 1.1 1       1                 1
Cl 1.1 1 120 1 1                 1 2 1
Cl 1.1 1 120 1 180 1             1 2 3
```

Ex. No. 9

```
AM1 CHARGE=0 GNORM=0.1 BONDS GEO-OK VECTORS DENSITY
Ammonia 12PCH001
```

```
N
H 1.1 1                          1
H 1.1 1 109 1                    1 2
H 1.1 1 109 1 120               1 2 3
```

Ex. No. 10

```
AM1 CHARGE=0 GNORM=0.1 BONDS GEO-OK VECTORS DENSITY
Methane 12PCH001
```

```
C
H 1 1 1
H 1 1 120 1   1 2
H 1 1 120 1   109               1 1 3 2
H 1 1 120 1   109               1 1 4 3
```

Ex. No. 11

```
AM1 CHARGE=0 GNORM=0.1 BONDS GEO-OK VECTORS DENSITY
Ethane 12PCH001

C
C 1.54 1                          1
H 1.09 1 110 0                    2 1
H 1.09 0 110 0 120 0             2 1 3
H 1.09 0 110 0 240 0             2 1 3
H 1.09 0 110 0  60 0             1 2 3
H 1.09 0 110 0 180 0             1 2 3
H 1.09 0 110 0 300 0             1 2 3
```

Ex. No. 12

```
AM1 CHARGE=0 GNORM=0.1 BONDS GEO-OK VECTORS DENSITY
ETHYLENE 12PCH001

C
C 1.34 1                          1
H 1.09 1 122 1                    1 2
H 1.09 0 122 0 180.0             1 2 1 3
H 1.09 0 122 0   0.0             1 1 2 3
H 1.09 0 122 0 180.0             1 1 2 3
```

Ex. No. 13

```
AM1 CHARGE=0 GNORM=0.1 BONDS GEO-OK VECTORS DENSITY
Acetylene 12PCH001

H
C 1.0 1                           1
C 1.2 1 180 1                     2 1
H 1.0 1 180 1 180 1              3 2 1
```

INSTRUCTIONS
(C++ Programming)

Desktop Turbo C++

File → New Type the program

Alt F9 compile

File → save as → save the programme. (Name Reg.No. Program No.cpp)

<div align="center">(eg. SASI10I.cpp)</div>

* Be in the program window

* Control F9

* Give the Input, Output will appear.

* Enter program window will appear.

Window (option at the top)

↓

Output

(output will appear)

* click print screen button in the keyboard (No change will be appear).

* click start button in the keyboard.

* select run option and then go to notepad.

* A new window will appear.

* Now type control+V (output will paste)

* Now go to file → save as → give name for your output

(like name Reg. No. prgm. No. output). (SASI10I.cpp)

WINMOPAC

Desktop → Shortcut to WINMOPAC

↓

Type the program

↓

File → Save As (give name register no. name of the molecule program no.)

Be in the program window

↓

Options

↓

Set parameter

↓

AM1

↓

Apply

↓

View

↓

Run MOPAC

↓

Brief result (output will appear)

↓

File (in the same window)

↓

Save as (give name reg. no. program no. output)