

UNIVERSITY SOLVED QUESTION WITH ANSWER

Year : 2022-2023

Subject : Pharmaceutical analysis

Subject Code : BP-102T

Subject In-Charge : Kiranmayee Bhatra



Registration No :

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Total Number of Pages : 02

Course: B.Pharm
Sub_Code: BP102T

1st Semester Regular/Back Examination: 2022-23

SUBJECT: Pharmaceutical Analysis - I

BRANCH(S): Pharmacy

Time : 3 Hour

Max Marks : 75

Q. Code : L706

Answer Question No.1 (Part-1) which is compulsory, any seven from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions : (2 x 10)

- Define & differentiate accuracy and precision.
- Differentiate complexes and chelates with suitable examples.
- Mention the advantages of non-aqueous methods of titration.
- Mention two indicators used in Fajan's method of titration.
- Differentiate post-precipitation and co-precipitation.
- What is Nernst equation? Mention its significance.
- What is Ilkovic equation?
- Write two applications of potentiometry.
- Define specific resistance and specific conductance.
- Calculate the pH of 0.01N HCl.

Part-II

Q2 Focused-Short Answer Type Questions- (Answer Any Seven) (5 x 7)

- Classify errors with suitable examples.
- Write the preparation and standardization of 0.1N Oxalic acid.
- What are the steps involved in gravimetric analysis of drugs?
- With the help of a neat diagram, explain the construction and working of Rotating Platinum Electrode.
- What are the various applications of Polarography?
- Define potentiometry. Discuss the construction and working of any one Indicator Electrode.
- Explain various types of currents in Polarographic method.
- What are primary and secondary standards? Give suitable examples. Write down the criteria of a primary standard.
- Classify the solvents used in non-aqueous method of titration with suitable examples.

Part-III

Long Answer Type Questions (Answer Any Two)

- Q3** Describe various methods of minimization of errors. (10)
- Q4** Describe Mohr's method and Volhard's methods of titration in detail. (10)
- Q5** What are reference electrodes? Describe the construction, working, advantages and disadvantages of standard hydrogen electrode and calomel electrode. (10)
- Q6** Explain the construction of conductivity cell. Add a note on applications of conductometry. (10)

Pharmaceutical Analysis

2022-2023

part - 1

2 marks

1) a - Define & differentiate accuracy and Precision?

Ans

Accuracy

→ Accuracy refers to how close a measured value is to the true value or expected value.

→ Measurement can be accurate but not necessarily precise.

→ Accuracy may be affected with systematic errors.

→ Degree of conformity

precision

→ precision refers to the degree of closeness between the several measurement of some quantity of sample.

→ measurement can be precise but not necessarily accurate.

→ precision may be affected with random error.

→ Degree of Reproducibility

b) Differentiate complexes and chelates with suitable example?

Ans

complexing agent

→ complexing agent refers to substances that can form complexes with metal ions, which may or may not involve ring formation.

Chelating agent

→ chelating agent are specific type of complexing agent that forms a stable ring like structure with a metal ion. enhancing its stability.

→ May have one or multiple binding sites for metal ions.

→ can bind to a variety of metal ions often with lower specificity.

→ generally form less stable complexes.

→ Have multiple co-ordinating sites arranged in a way that allows the formation of a chelate ring with a metal ion.

→ They are designed to bind to specific metal ions through a defined co-ordinating patterns.

→ form high stable complexes.

c) mention the advantages of non-aqueous methods of titration.

Ans i) organic acids and bases that are insoluble in water are soluble in non-aqueous solvent.

ii) A very weak acid and bases can be analysed by non-aqueous titration.

iii) A non-aqueous solvent may help two or more acids in mixture. The individual acid can give separate end point in different solvent.

iv) By the proper choice of the solvents, the biological ingredients of a substance, whether acidic or bases can be selectively titrated.

d) mention two indicators used in Fajan's method of titration?

Ans ~~Fluo~~ Fluorescein, Eosin.

e) Differentiate post-precipitation and Co-precipitation.

Ans

Co-precipitation

→ It is a type of precipitation in which impurities get precipitated together with main precipitate.

→ High degree of contamination.

→ It occurs during the precipitation.

post-precipitation

→ In post precipitation impurities precipitate after the main precipitate completed.

→ low degree of contamination.

→ It occurs after the precipitation.

f) what is Nernst equation? mention its significance?

Ans The potential (E) of a metal electrode at 25°C immersed into a solution of its own ions is given by?

$$E = E^{\circ} + \frac{0.0542}{n} \log C$$

where E° = standard potential of metal
 n = valency of ions
 C = concentration of ions.

g) what is Ilkovic equation?

Ans Ilkovic equation is a relation used in polarography relating the diffusion current (i_d) and the concentration of the non-polarisable electrode. i.e. the substance reduced or oxidised at the dropping mercury electrode (polarisable electrode)

$$i_d = 607 n D^{1/2} m^{2/3} t^{1/6} C$$

Ilkovic equation (i_d)_{max} = $607 \times n \times D^{1/2} \times m^{2/3} \times t^{1/6} \times C$

where

i_d max = maximum current (μA)

D = Diffusion coefficient (cm^2/s)

m = rate of flow of mercury (mg/s)

t = drop time (s)

C = analyte concentration (mmoles/L)

n = number of electrons

h) write two applications of potentiometry?

Ans It is used in clinical chemistry for the analysis of electrolytes such as Na, K, Ca, H.

→ It is used in environmental chemistry for analysis of Cl^- , NH_3 , NO_3^- , F^- in water & waste water.

→ It is used in agricultural for analysis of NO_3^- , NH_4^+ , I^- , Ca, K in soils, plant materials, fertilizers.

Q) Define specific resistance and specific conductance?

Ans Specific resistance (f)

→ The resistance (R) of the conductor is directly proportional to the length (L) and inversely proportional to its area of cross section (a).

$$\therefore R \propto L \quad \& \quad R \propto \frac{1}{a}$$

$$\Rightarrow R \propto \frac{L}{a}$$

$$\Rightarrow R = f \frac{L}{a} \quad \text{or} \quad \boxed{f = \frac{R \cdot a}{L}}$$

where f = specific resistance.

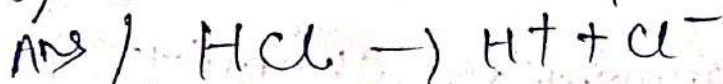
Specific conductance

→ It is the ~~inversely~~ proportional to specific resistance.

$$K = \frac{1}{f}$$

where K (κ) = specific conductance

i) Calculate the pH of 0.01 N HCl?



we know

$$\text{pH} = -\log[\text{H}^+]$$

$$= -\log[0.01]$$

$$= -\log[10^{-2}]$$

$$= 2 \cdot \log 10$$

$$\text{pH} = 2$$

\therefore pH of 0.01 N HCl is 2

5 marks

Q) Classify errors with suitable examples

Ans Errors

- Errors are simply defined as "mistake"
- In other words the difference between true / standard value and observed value is called error.

$$\text{Error} = \text{Standard value} - \text{measured value}$$

Types of Errors

- Errors are basically divided into 2 categories
- 1) systematic / Determinate error
- 2) Random / ~~Indeterminate~~ Indeterminate error

1) Systematic errors

→ Systemic errors are known as determinate errors generally occur by fault in the analytical procedure or in the instrumental errors are known to the analyst and can be overcome by preplanning and careful working.

Types

- 1) Personal errors
- 2) Instrumental errors
- 3) Reagent errors
- 4) Additive errors

Personal errors

→ These errors arise due to personal mistakes or carelessness of analyst or due to inability of an individual like colour blindness

Instrumental errors

→ These errors occur due to defects in the equipments or use of uncalibrated glasswares, apparatus and instrument.

Reagent errors

→ These errors depends on the quality of reagent. Many reagents and compounds are not present in pure form and contain impurities and due to presence of impurities error occurs.

Additive Errors

→ Sometimes errors are constant throughout the analysis and independent of amount of sample.

EX 10, 20, 30 (0.1 ml of error known amount)

Error in method

→ These type of errors caused due to selection of wrong / improper method.

2) Random errors

→ Random errors also known as indeterminate errors.

→ Generally cause of random error is not known, Analyst has no control over it.

→ These errors cannot be eliminated even after using high quality reagent and apparatus.

Q. Write the preparation and standardization of 0.1 N of oxalic acid?

Ans. Molecular weight of $(2H_2O_4 \cdot 2H_2O) \rightarrow 126$

$$M = \frac{\text{No. of moles of solute}}{\text{dissolve in volume of soln in lit}}$$

$$M = \frac{126}{1000}$$

\rightarrow 126 Oxalic acid - 1000 ml soln (1 molar soln)
1 N = $\frac{\text{gram of equivalent}}{1 \text{ lit of soln}}$

$$\text{Equivalent weight} = \frac{\text{molecular weight}}{2} = \frac{126}{2} = 63 \text{ gm}$$

the 0.1 N = 6.3 gm.

Standardization of oxalic acid

\rightarrow 0.1 N oxalic acid = 10 ml.

- \rightarrow Add 2-3 drops of phenolphthalein Indicator.
- \rightarrow Titrate against 0.1 N NaOH. until +0 proper appear pink colour.

Formula $N_1 V_1 = N_2 V_2$

where N_1 = Normality of oxalic acid
 N_2 = Normality of sodium hydroxide
 V_1 = volume of oxalic acid
 V_2 = volume of sodium hydroxide

$$N_1 \times 10 = 0.1 \times 10.1$$

$$N_1 = \frac{0.1 \times 10.1}{10} = 0.101 \text{ N}$$

Q) What are the steps involved in Gravimetric analysis of drug?

Ans:

- 1) Sampling
- 2) Preparation of solution
- 3) Precipitation
- 4) Digestion
- 5) Filtration / osward. Pipering
- 6) Washing
- 7) Drying or Ignition
- 8) weighing
- 9) calculation

Sampling

- > The sample which is weighed for gravimetric analysis should be very small.
- > The sample should be homogeneous.
- > The sample must be in powder form.
- > It should not be very expensive.

Preparation of solution

- > To dissolve the sample, take a clean beaker and transferred the weighed sample completely into beaker.
 - > Add sufficient water to get a clear sample.
 - > Temperature, pH, pressure should be maintained at normal.
 - > If necessary, then heat the solution.
- ### Precipitation
- > In this process, we generally add a precipitating agent to the ~~solution~~ sample solution.

- The ideal precipitating agent must react with analyte to form precipitate.
- The completeness of precipitation is checked by adding a few drops of precipitating agent on the side of beaker wall.
- It is very necessary to check the completeness of precipitation.

Digestion

- Digestion process is also known as Ostwald ripening.
- During digestion the precipitate is left for 30 min - 1 hour.
- Digestion involves dissolution of small particles.
- Digestion, sometimes increases the problem of post-precipitation.

Filtration

- In this step, precipitate is separate from the analyte solution.
- Various type of filter media used in this process.
- The choice of filter media is depend upon the nature of precipitate.
- The different filter media used in gravimetry analysis are
 - 1) Filter paper
 - 2) Filter pulp
 - 3) Filter mats

Washing

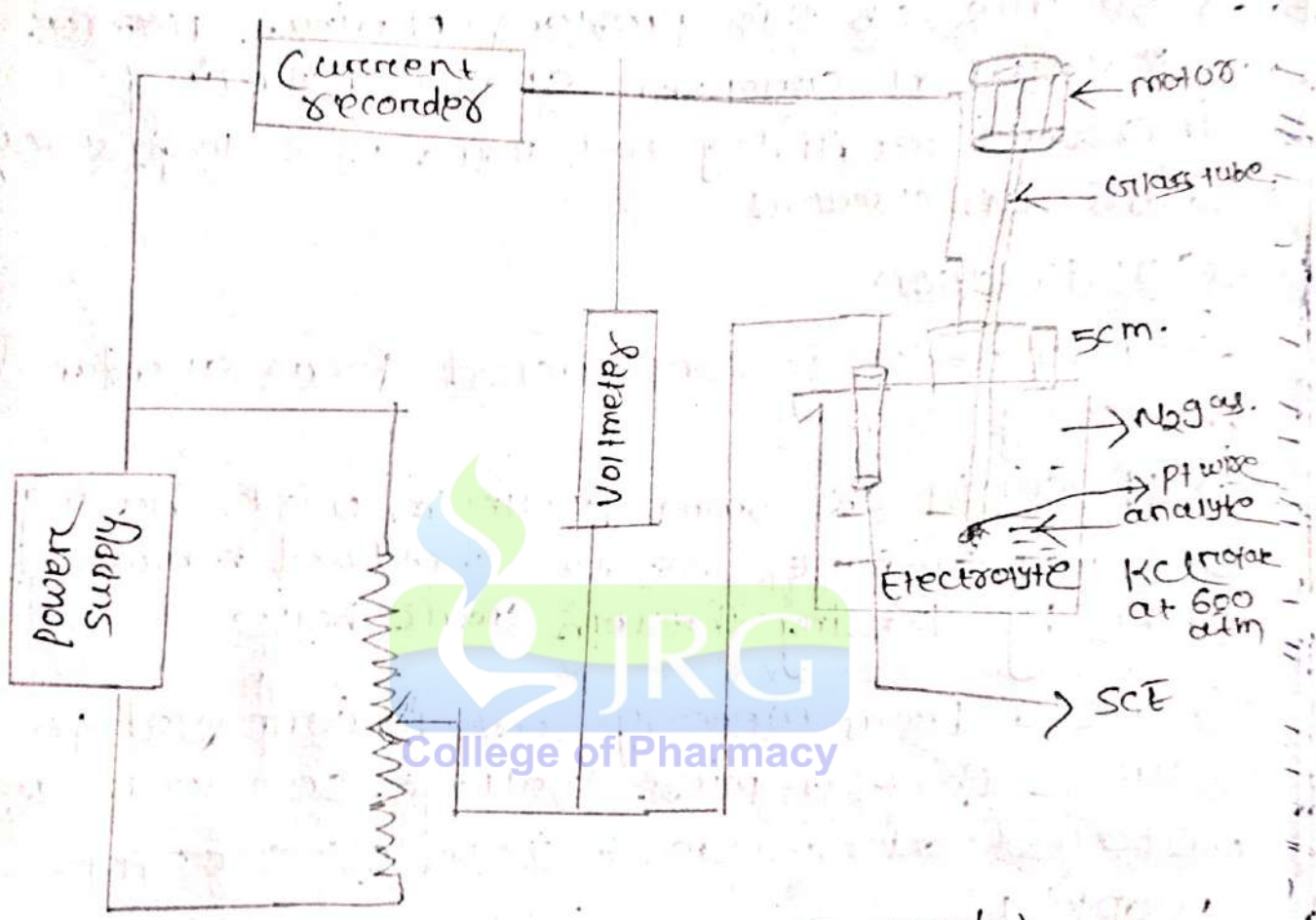
- After filtering the precipitate, the impurities at the surface of the precipitate can be removed by washing the precipitate.
- one should be very careful not to use too much water during washing because part of the precipitate may be lost.
- water is not suitable for many precipitates as washing solution.
- In such case dil. nitric acid, ammonium nitrate can be used as washing solution.

Drying or Ignition:

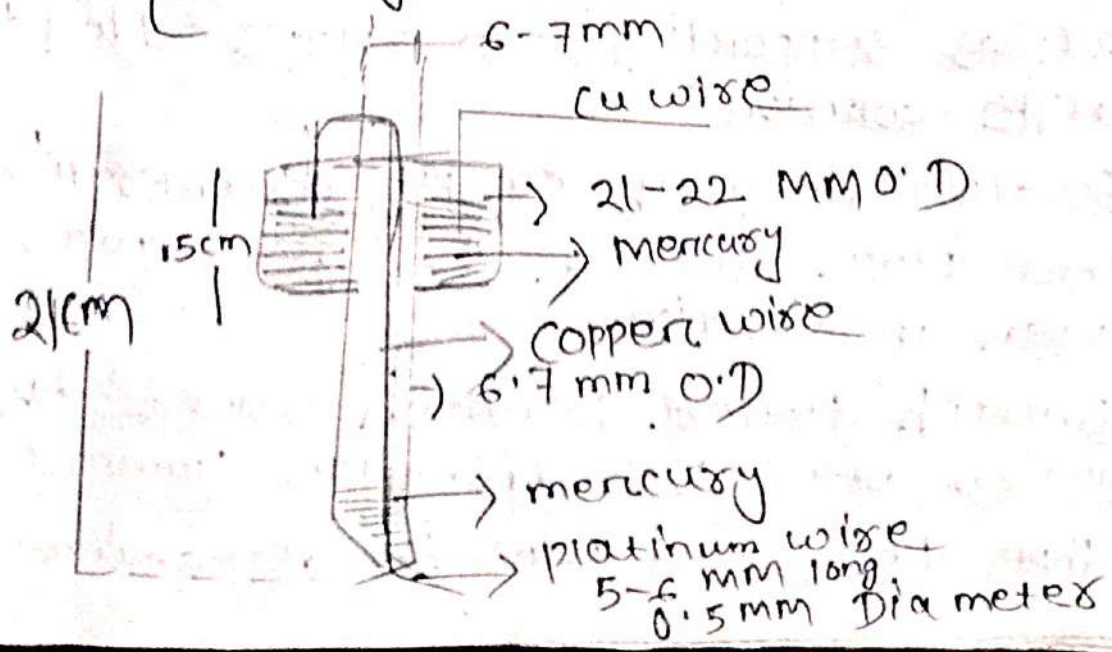
- The main purpose of drying or ignition is to convert the precipitate in a constant composition.
- It is heated to remove the water.
- Drying term is used when temp. is below 250°C .
- Ignition term is used when temp. is above 250°C & below 1200°C .
- Drying or Ignition is dependent upon the nature of precipitate.
- weighing & calculation
- After drying the precipitate is then cooled at room temp. and weighed accurately on the analytical balance.
- The calculations are generally made in terms of percentage.

1) With the help of a neat diagram, explain the construction and working of Rotating platinum electrode?

Ans:



[Rotating Platinum Electrode]



→ DME can not be used at high potential due to oxidation of mercury.

→ So platinum electrode used in such case.
Why platinum electrode is rotated?

→ If platinum electrode is stationary then diffusion current will be slowly obtained.

→ Because of this problem platinum ~~rotates~~ rotated at constant speed resulting increase sensitivity and rate of obtaining slowly diffusion current.

Construction

→ Electrode is constructed from standard mercury seal.

→ It consist of 5mm platinum wire having 0.5 mm diameter below standard mercury seal by passing through small hole.

→ wire from mercury seal is connected to source that applied voltage so electrode rotated at constant speed of 600 rpm.

Working

→ used as Indicator electrode.

→ KCl as supporting electrolyte added to the analyte solution.

→ 50-100 times of sample concentration.

→ Then pure nitrogen passing to remove oxygen in solution.

→ Graph plotted between volume of solution added vs diffusion current.

→ Then the end point is determined.

e) what are various application of polarography?

Ans

1) Qualitative analysis

→ It helps in characterization of organic matter and various metal interaction from half wave potential of the current vs voltage graph.

2) Quantitative Analysis

→ polarography is used in the determination of concentration of drugs, metal ions etc. in the given sample.

3) Determination of inorganic compound!

→ polarography is used in the determination of cations and anions in the presence of interfering analysis.

4) Determination of organic compound!

→ polarography is used in determination of structure quantitative analysis of mixture of organic compounds.

5) Estimation of dissolved oxygen

→ Amount of oxygen dissolved in aqueous solution or organic solvent can be calculated with the help of polarography.

6) Pharmaceutical application

→ Tetracyclin, antibiotics, sulphonamides can be analysed by polarography.

f) Define potentiometry, discuss the construction and working of any one Indicator electrode.

Ans → It is technique where potential of an electrode is used to measure the concentration of analyte.

Principle

→ It is based on the principle that in this we measure the electrode potential in which is depends on the concentration of analyte.

Indicator electrode

→ These are used in pair with reference electrode and connected with voltmeter.

→ It is used to determine the concentration of analyte in the sample solution.

1) Glass electrode

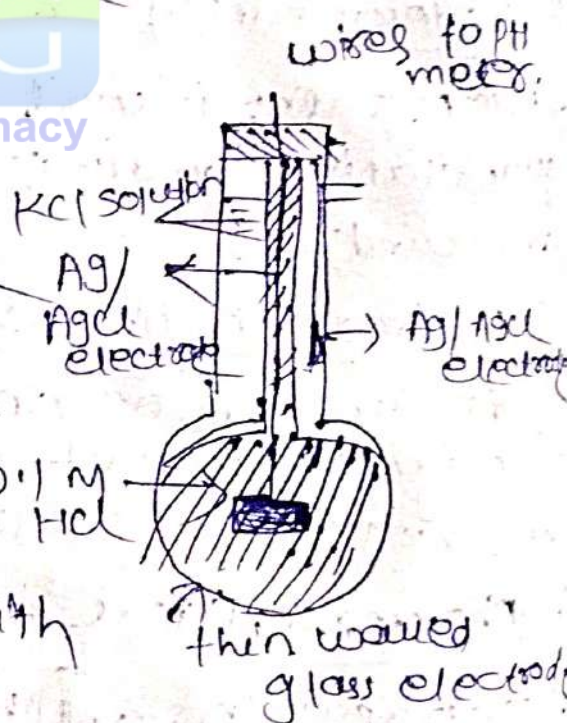
→ The measurement of pH for any given soln can be done easily using a glass electrode.

→ It includes a thin walled bulb at the bottom and 0.1 M HCl glass tube at the top.

→ The bulb is filled with 0.1 M HCl.

→ A silver wire covered with AgCl is present at the lower end of glass tube.

→ It is represented as $Ag-AgCl / 1M HCl / H^+$



Q) Explain various types of currents in polarography method?

Ans

1) Residual current (i_r)

→ The small current before the potential at which the analyte reacts caused by reactive species in the matrix and by the mercury drop ~~being~~ behaving like a capacitor.

2) Limiting current (i_L)

→ The maximum current reached.

3) Diffusion current (i_d)

→ The difference between the limiting and residual and proportional to the concentration of analyte.

~~4) hauwe~~

4) Migration current (i_m)

→ It is due to migration of cations from the bulk of the solution towards cathode due to diffusive force. irrespective of concentration gradient.

h) What are primary and secondary standards? Give suitable examples. Write down the criteria of a primary standard.

Ans

→ primary standards are reagent with accurate known concentration and high very high purity which after dissolving to a known amount of solvent gives primary standard solution.

Properties

- It should be 100% pure (0.01/0.02 tolerance)
- It should be stable at atmospheric condition
- It must have high molecular & equivalent weight.
- It must have high stability and low reactivity.
- It should be non hygroscopic & non toxic.
- It must be inexpensive & readily available.

Example

Acid-base Titration

Ex Benzoic acid, oxalic acid

Redox titration

Potassium bromate, sodium oxalate

Precipitation Titration

Silver nitrate, sodium chloride

Complexometric titration

metallic zinc, metallic magnesium

Secondary standards

- Secondary standards are those chemical compound that standardize against a primary standards for use in special analysis.

Properties

- Less pure than primary standards
- Less stable & more reactive compare to primary standards.
- It titrate against primary standards.

Acid-base Titration

Ex Hydrochloric acid, Sulphuric acid

Redox Titration

Ex Potassium permanganate, Sodium thiosulphate

Precipitation Titration

Ex Potassium thiocyanide, Ammonium thiocyanide

Complexometric Titration

Ex EDTA, Disodium, Lead nitrate

i) Classify the solvents used in non-aqueous method of titration with suitable example.

Ans Non aqueous titration

→ Non-aqueous titration is the most common titration procedure in which analyte is dissolved in a solvent which doesn't contain water.

→ It is used in determination of purity of hydrophobic compound such as Steroid.

→ In this titration solute is dissolved in solvent like Benzene, alcohol, ether form in non-aqueous solⁿ.

Solvent used in non-aqueous titration

→ The non-aqueous solvent can be classified based on its proton donor and acceptor properties

1) Protogenic solvent - acidic

2) Protophilic solvent - basic

3) Aprotic solvent - Neutral

4) Amphiprotic solvent - ~~may~~ both acidic & base

1) Protogenic solvent

→ This solvent have more acidic in nature.

Ex H_2SO_4 , HCl .

2) Protophilic solvent

→ This solvent have basic in nature & react with acid.

Ex Dimethyl formamide.

3) Aprotic solvent

→ This solvent are generally chemical in nature & inert in nature.

Ex Acetone, Chloroform.

4) Amphiprotic solvent

→ These solvent are both acidic & basic in nature.

Ex amino acid, water, many metal oxide & hydroxide.

10 mark

3) Describe various methods of minimization of errors?

Ans Error

→ Error are simply defined as (mistake)

→ In other words the difference between true / standard value and observed value is called error.

$$\text{Error} = \text{Standard value} - \text{observed value}$$

$$\% \text{ Error} = \frac{\text{Standard value} - \text{observed value}}{\text{Standard value}}$$

Minimization of errors

→ Error can be minimized by following methods given below.

- 1) Calibration of apparatus.
- 2) Independent method of analysis.
- 3) Running a blank determination.
- 4) Running a control determination.
- 5) Running a parallel determination.

Calibration of apparatus :-

→ By calibrating all instrument (weights, flask, burettes, pipettes) and applying appropriate corrections error can be minimized.

Independent method of Analysis

→ In this we perform the analysis for a particular substance by two or more different methods and compare the results.

Running A Blank determination

- By carrying out a separate determination without sample under exactly same condition as for actual analysis.
- we can find out error due to error ~~occurred~~ due to presence of impurities in the reagents.

Running A control determination

- In this we use standard substance and perform the analysis in the identical condition and compare it with the normal/actual analysis.

Running A parallel determination

- In this we basically ~~also~~ perform the analysis for the particular analyte more than two or three times so that we can get more accurate results.

4) Describe Mohr's method and Volhard's method of titration in detail.

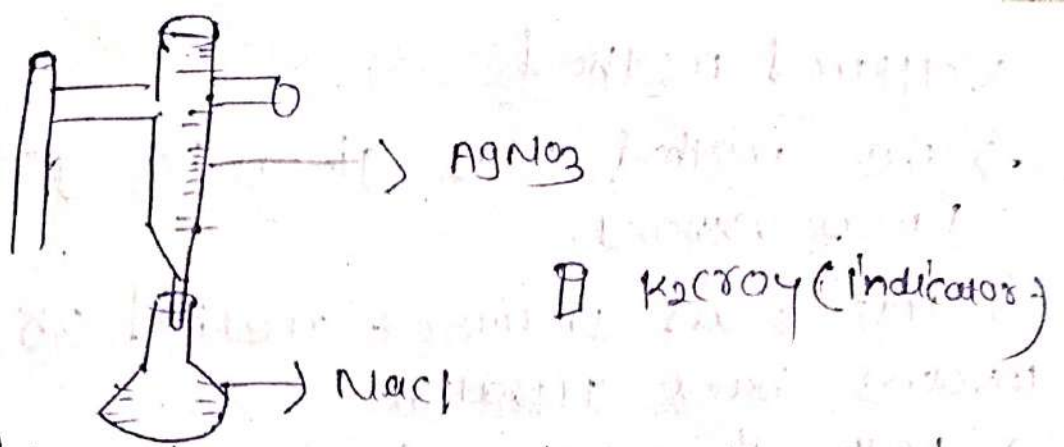
Ans Mohr's method

- The method was given by Sir Karl Friedrich Mohr.
- A precipitate titration in which silver nitrate is used as titrant & chromate ions as Indicator is called as Mohr's method.
- The method is mainly used for the determination of chlorides and bromides (Cl and Br)

Titrant - AgNO_3

Analyte - KCl , NaCl , KBr , NaBr

Indicator - K_2CrO_4 or Na_2CrO_4



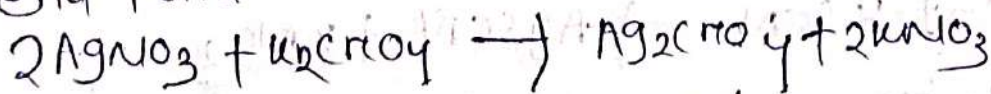
Methodology / procedure

→ Let's suppose we are titrating 0.1M NaCl using 0.1M AgNO_3 as Titrant and K_2CrO_4 as Indicator.

→ As the Titrant starts, silver nitrate solution is slowly added to sodium chloride and a precipitate of silver chloride forms.



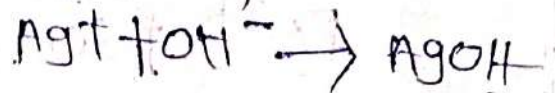
→ Now when all the chloride ions gets precipitated then additional silver ion react with chromate ions (Indicator) and form a reddish brown precipitate of silver chromate and this gives our end point.



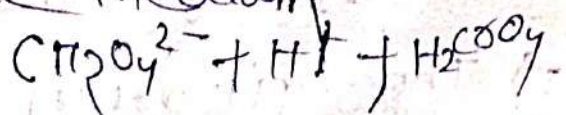
Condition for Mohr's method

→ In Mohr's method titration must be carried out in a neutral medium neither acidic nor basic.

Because ① In basic medium



② In acidic medium



Volhard method

→ The method was given by German scientist Jacob Volhard.

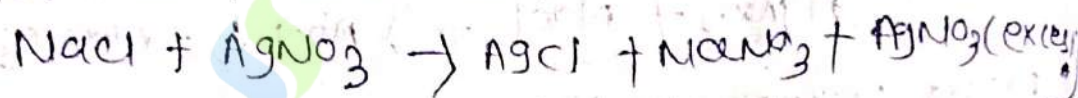
→ This is an indirect method of titration involves back titration.

→ Volhard's method is mainly used in the determination of Halides [Cl, Br, I]

→ Precipitation titration by Volhard's method completed into 2 steps.

Step-I

→ In first step excess amount of AgNO_3 is used for the titration with NaCl soln.



Step-II

→ Now the excess amount of AgNO_3 which gets remained in step-I is titrated using KSCN as titrant and Fe^{3+} as indicator.



→ Now when all AgNO_3 is consumed by KSCN then extra thiocyanate ions react with Fe^{3+} and form ferrous thiocyanate ($\text{Fe}(\text{SCN})_2$) which is a red complex and this gives our end point.



Condition for Volhard's method

→ The titration must be performed in an acidic medium so that complex formed

$[\text{Fe}(\text{SCN})_2]$ will be stable.

Modified volhard's method

→ In modified volhard's method we add some wetting agents like chromobrom, nitrobenzene etc.

→ since AgCl is also present in the analyte and it may solubilise which affect our end point, and addition of these wetting agents prevents the solubilization of AgCl.

5/ What are reference electrodes? Describe the construction, working, advantages and disadvantages of standard hydrogen electrode and calomel electrode?

Ans construction

→ It contains a glass tube with a platinum wire sealed within it.

→ platinum foil coated with Pt black to increase surface area.

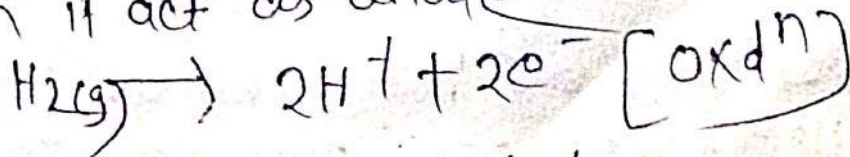
→ This act as platinum electrode with immersed in 1M HCl to maintain the concentration of H⁺ ion.

→ The hydrogen gas in pure form is continuously bubbled in the acidic solution at T = 298K and pressure 1 atm.

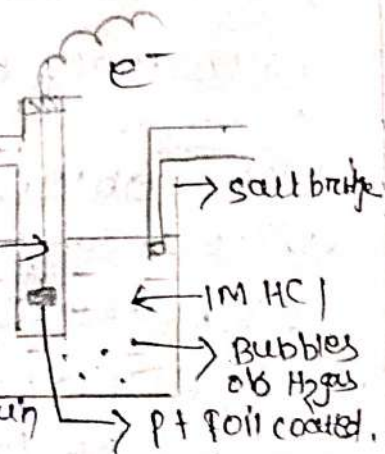
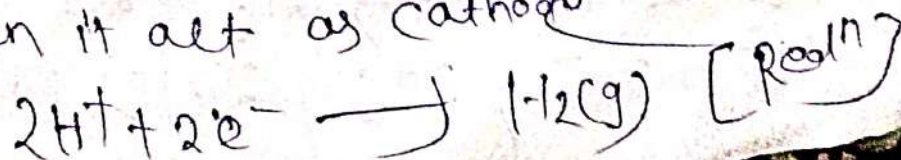
→ It is attached with another half cell with analyte solution.

working

when it act as anode



when it act as cathode



Advantages of Standard Hydrogen electrode

- It can be used over the entire pH change
- The electrode can be used as reference electrode for measuring the potential of other electrodes.
- It is highly accurate

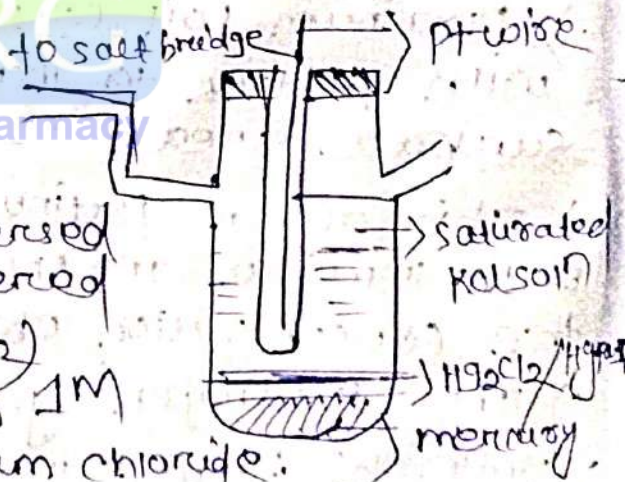
Disadvantages of Standard hydrogen electrode

- It can't be used in presence of oxidizing and reducing agents.
- Platinum can be easily poisoned by the adsorbed impurities from the solution.
- Adsorbed impurities reduces the life of SHE.

Calomel electrode

construction

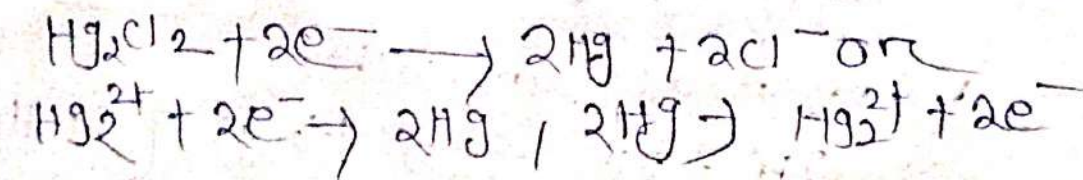
- It is often employed as a secondary standard reference electrode.
- A platinum wire, immersed in liquid mercury is covered with calomel i.e. Hg_2Cl_2
- The tube is filled with 1M saturated solution of potassium chloride.
- The narrow glass tube in which KCl solution is filled has a salt bridge which can connect this electrode to different electrode.



- It can be represented as $\text{Cl}^- (1\text{M}) / \text{Hg}_2\text{Cl}_2 / \text{Hg}$

working

reactions for half cell of calomel electrode



Advantages of calomel electrode

- It is very simple to construct.
- It can be used for a long time without much attention.
- Electrode potential is stable over a long period.

Disadvantages of calomel electrode

- Calomel electrodes should not be used above 50°C .
- Calomel electrode should be used with proper precaution as mercury compounds are toxic.

b) Explain the construction of conductivity cell. Add a note on application of conductometry.

Construction of conductivity cells

- It is made up with glass vessels in which two electrodes are present at a definite distance, i.e. 1cm and these electrodes are used to measure conductance.
- Electrodes are made up of platinum (Pt) and are coated with platinum black to avoid polarisation and increase surface area.

→ surface area of electrode is 1cm^2 and distance between two electrodes is 1cm .

→ It is three types.

1) low concentration

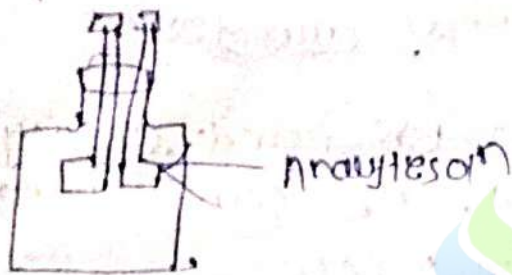
→ It contains a jar in which two electrodes are dipped in solution and electrodes made up of platinum.

Precipitate type

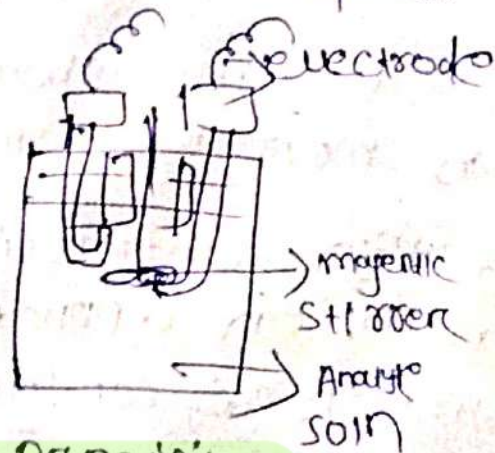
- It is used for those which contain precipitate in soil.
- It contains magnetic stirrer due to this precipitate does not stick on surface of electrode.

3) Dipped type

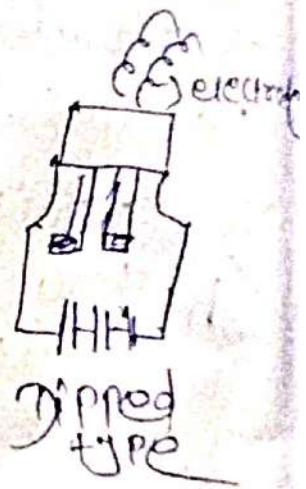
- Completely dipped in soil due to its compressed size.



low conductivity type



precipitate type



dipped type

Applications of conductometry

- It is used to check water pollution in pure river and.
- Also used to check solubility of sparingly soluble in salts.
- used to trace antibodies.
- used to check alkalinity of freshwater.
- purity of distilled and deionized water can be determined.