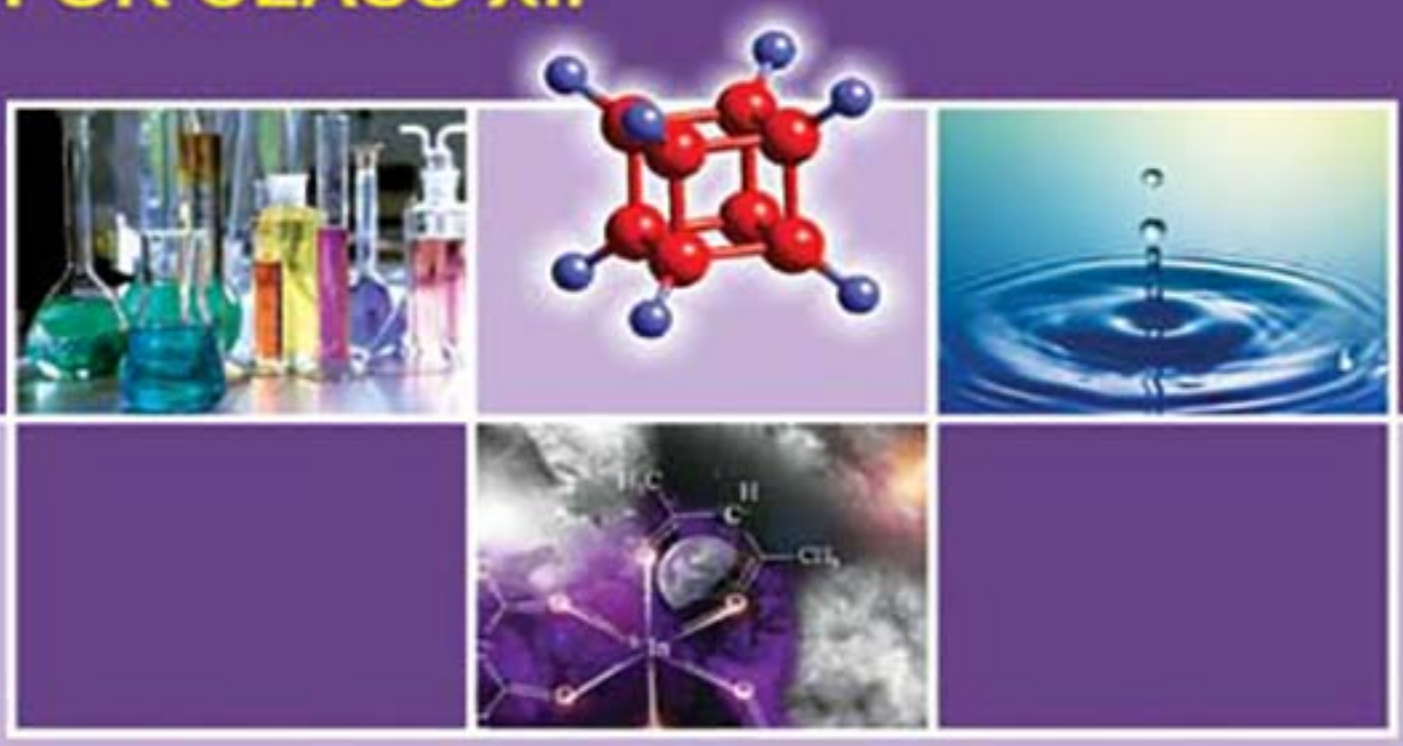
Revised Edition

ISC PRACTICAL CHEMISTRY

VOLUME II
FOR CLASS XII



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Dr. AJAYA BABOO

S. CHAND

(*Strictly according to the latest syllabus for ISC* (*XII Class*) *prescribed by the Council for Indian School Certificate Examination, New Delhi*

ISC
PRACTICAL CHEMISTRY

VOLUME II
(FOR CLASS XII)

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PREFACE TO THE REVISED EDITION

In an age where increasing specialization and professionalism count so much, chemistry cannot be done away from the practical life of the man; nor can it be kept in the backburner. Everything in life is basically founded on the Principles of Chemistry. This speaks volumes for the ever-growing significance of this subject. Once we are at home with this subject and the principles, the question of learning them by rot does not arise.

This book fulfills the long-felt need and will prove a useful companion for the ISC students. Written strictly as per the ISC syllabus, where precision, keen observation, analytical thinking and application of knowledge in a given situation became an essential part of assessment. We hope that the students will find this volume a mine of knowledge about practical chemistry. The chief virtue of this book is to easily, quickly and clearly satisfy the immediate problems faced by a student. We are sure the students will be able to draw inspiration from this book and will explode the myth that chemistry is a different subject.

The success of any book depends largely on the able teachers, who must impart the inspiration that clinches the objectives of the book and course. We believe that this book will be a guide to reaching these objectives.

In acknowledging our debt we begin with our Principal for his instituted and sustained encouragement and cooperation. We also extend our sincere gratitude to the fellow teachers imparting knowledge of this branch of science. Last but not the least we express our thanks in a very special way to the very students of an esteemed institution St. Peter's College.

Authors

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PREFACE TO THE FIRST EDITION

"Those sciences are vain and full of errors which are not born from experimentation, the mother of all certainties."

Chemistry is the most delicate limb of our so-called mother "Science". The experimentation in chemistry is the only outcome and development of the unifying principles, produced through laboratory process. Once we become familiar with these widely applicable and recognised principles, there remains no longer any need for endless memorization of innumerable chemical facts.

The book is revised and enriched strictly according to the I.S.C. syllabus for 2000 + where precision, keen observations, critical thinking, application of knowledge in new situation etc. become inseparable part of evaluation. We are sure that the students will find this volume a veritable store-house of knowledge about practical chemistry. Their genius, unmanifested though rapidly developing, will enable them to enjoy and understand these pages. We hope for no greater reward than that young readers, with their lives before them, may find in this volume something to inspire them with an earnest and unflogging zeal for finding something new in the realm of chemistry.

We are whole-heartedly eager to express our sincere thanks and gratitude to our principal for his refined encouragement and pious blessings. Further, we are unable to spare ourselves from expressing our innermost feelings of thanks to our worthy fellow teachers imparting the knowledge of this subject allover. Last but not the least, we express our thanks in very special way to the students of our esteemed institution, St. Peter's College, Agra, which is the leading source of enriching the experimental knowledge in the field of chemistry.

Authors

ISC SYLLABUS

Paper II Practical work - 20 Marks

Candidates are required to complete the following experiments:

1. **Titrations:** Oxidation-reduction titrations: potassium manganate (VII)/ammonium iron (II) sulphate; potassium manganate (VII)/oxalic acid.

   The candidate may be required to determine the percentage purity of a compound and the number of molecules of water of crystallization in hydrated salts. In such experiments sufficient working details including recognition of the end point will be given.

   Candidates will be required to calculate:

   - *Molarity*
   - *Concentration in grams l^{-1}/molecular mass*
   - *Number of molecules of water of crystallisation/percentage purity.*

   NOTE: Molarity must be calculated upto 4 decimal places at least, in order to avoid error.

2. **Study of the rate of reaction:** The candidates will be required, having been given full instructions, to carry out an experiment on the rate of reaction, e.g. reaction between sodium thiosulphate (using different concentration) and hydrochloric acid, magnesium and dil. Sulphuric acid/dil. hydrochloric acid (using different concentrations).

3. **Identification of the following compounds and functional groups based on observations :**

   - Alcoholic group-glycerol
   - Aldehyde group-formaldehyde
   - Ketonic group-acetone
   - Carboxylic group-benzoic acid
   - Amino group-aniline

   ❖ Please Note: Carbylamine reaction should not be performed.

4. **Characteristic tests of carbohydrates and proteins :**

   - Carbohydrates-glucose
   - Proteins-powdered milk

5. **Experiments related to pH change using pH paper or universal indicator :**

   - Determination of pH of some solutions obtained from fruit juice, solutions of known and varied concentrations of acids, bases and salts.
   - Comparison of pH of the solutions of strong and weak acids of the same concentration.

6. **Electrochemistry:** Setting up a simple voltaic cell. Variation of cell potential in $Zn/Zn^{2+}//Cu^{2+}/Cu$ with change in concentration of electrolyte ($CuSO_4$, $ZnSO_4$) at room temperature.

7. **Qualitative analysis:** Qualitative analysis: identification of the following in a given mixture (containing two anions and two cations) :

Anions: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, SO_4^{2-}, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, $C_2O_4^{-2}$.

Cations: NH_4^+, Pb^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}.

More than one radical will not be given from the same group of anions and cations. (Insoluble salts excluded).

Anions: *Dilute acid group — CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}*

Concentrated Acid Group — NO_3^-, Cl^-, Br^-, I^-

Special Group — SO_4^{2-}, CH_3COO^-, $C_2O_4^{-2}$

Cations : *Group Zero: NH_4^+*

Group I : Pb^{2+}

Group II : Cu^{2+}, Pb^{2+}

Group III : Al^{3+}, Fe^{3+}

Group IV : Zn^{2+}, Mn^{2+}, Ni^{2+}

Group V : Ba^{2+}, Sr^{2+}, Ca^{2+}

Group VI : Mg^{2+}

NOTE:

- *Formal analytical procedure is required for Qualitative Analysis.*
- *Specific solvent for O.S to be used.*
- *Before adding Group III reagents to the filtrate of Group II, H_2S must be removed followed by boiling with conc. Nitric acid.*
- *The right order for buffer (NH_4Cl and NH_4OH) must be used.*
- *The flame test with the precipitate obtained in Group V for Ba^{2+}, Sr^{2+}, Ca^{2+} will also be accepted as a confirmatory test.*

For wet test of anions, sodium carbonate extract must be used (except for carbonate).

PATTERN OF CHEMISTRY PRACTICAL PAPER

Questions in the practical paper will be set as follows:

Question 1	**Volumetric Analysis**
Question 2	**Any one or a combination of the following experiments:**
	● Study of the rate of reaction.
	● Identification of the organic compounds and functional groups based on observations.
	● Characteristic tests of carbohydrates and proteins.
	● Experiments related to pH determination using pH paper or universal indicator.
	● Electrochemistry.
Question 3	**Qualitative Analysis (Salt mixture).**

PROJECT WORK AND PRACTICAL FILE

10 Marks

Project Work - 7 Marks

The project work is to be assessed by a Visiting Examiner appointed locally and approved by the Council.

The candidate is to creatively execute **one** project/assignment on an aspect of Chemistry. Teachers may assign or students may select a topic of their choice. Following is only a suggestive list of projects.

Suggested Evaluation criteria for Project Work :

- Introduction/purpose
- Contents
- Analysis/material aid (graph, data, structure, pie charts, histograms, diagrams, etc)
- Presentation
- Bibliography

Suggested Assignment

1. Amino acids: Peptides, structure and classification, proteins structure and their role in the growth of living beings.
2. Nucleic Acid: DNA and RNA — their structure. Unique nature. Importance in evolution and their characteristic features.
3. Lipids: Structure, membranes and their functions.
4. Carbohydrates and their metabolism, Blood-haemoglobin and respiration.
5. Immune systems.
6. Vitamins and hormones.
7. Simple idea of chemical evolution.
8. Natural polymers (any **five**) - structure, characteristics, uses.
9. Synthetic polymers (any **five**) - method of preparation, structure, characteristics and uses.
10. Thermoplastics and Thermosetting plastics methods of preparation, characteristics and uses.
11. Types of dyes - methods of preparation, characteristics and uses.
12. Chemicals in medicines: antiseptics, antibiotics, antacids, etc. and their uses.
13. Various rocket propellants and their characteristics.
14. Preparation of soap, nail polish, boot polish, varnish, nail polish remover, shampoo and scents.
15. Chemicals and chemical processes in forensic studies.
16. Air pollution, water pollution.
17. Insecticides, pesticides and chemical fertilisers.
18. Coal and coal tar as a source of many chemicals.
19. Ancient Indian medicines and medicinal plants.
20. Explosives - preparations and their uses.

Practical File - 3 Marks

The Visiting Examiner is required to assess students on the basis of the Chemistry Practical file maintained by them during the academic year.

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Chapter

1

Titration (Volumetric Estimations)

Out of the two methods of chemical analysis, the qualitative one has already been discussed in Chapter I. The other method *i.e.,* quantitative analysis is divided into volumetric and gravimetric analysis. This Chapter includes the details of volumetric analysis.

The principle of volumetric analysis is to take a measured volume of a solution of unknown strength and to this solution an equivalent amount of a solution of suitable reagent of known strength is added. The process of adding the solution till the reaction is complete is known as **titration**. The sharp change in colouration or the coloured precipitate formation indicates the completion of the titration. The change in colouration can be detected by the addition of a chemical known as **indicator**. In a titration like $KMnO_4$ solution against oxalic acid solution no indicator is required.

The terms used in this method of investigation are the following :

Titration :

It is a process of adding one solution through burette to the known volume of the other solution till the reaction is complete.

The two solutions are such that the strength of one is known to us and is being used or known as **titrant** or standard solution. The other solution whose concentration is to be determined by this process is known as **titrate**.

Indicator :

A chemical substance which helps in the visual detection of completion of titration is called indicator.

The completion of reaction is indicated by producing turbidity or a visible change in colour.

In a redox titration such as oxalic acid and potassium permanganate solution no indicator is required and the completion of reaction is indicated by the excess drop of potassium permanganate solution. Such a titration is known as self-indicator titration.

End Point :

A sharp point at which completion of reaction takes place is known as end point of the titration. It is also known as titre value.

Strength of the Solution :

It is the concentration of a solution expressed in grams per litre.

Normality :

It is the number of gram equivalent weight of solute dissolved in one litre of the solution. Normality is denoted by 'N'.

Gram equivalent weight :

The equivalent weight of a substance expressed in grams is known as its gram equivalent weight.

The stength of a solution, normality and gram equivalent weight can be related as–

Strength = Normality × Gram Equivalent Weight

Normal Solution :

It is a solution which contains gram equivalent weight of solute in a litre of solution.

It can be expressed as 1 N solution. When $\frac{1}{2}$ gram equivalent of solute is dissolved in 1 litre of solution, it is called semi-normal solution and is denoted as $\frac{N}{2}$.

Similarly deci-normal and centi-normal solutions are denoted as $\frac{N}{10}$ and $\frac{N}{100}$ respectively.

Gram Molecular Weight :

Molecular weight expressed in grams is known as gram molecular weight. It is also known as one mole.

Molarity :

It is the number of gram molecular weight or solute dissolved in one litre of solution. The molarity is denoted by 'M'.

Molar Solution :

It is a solution which contains gram molecular weight of solute dissolved in a litre of solution.

When $\frac{1}{2}$ gram molecular weight of solute is dissolved in one litre of solution, it is called semi-molar solution and is denoted as $\frac{M}{2}$.

Similarly, deci- and centi-molar solutions can be denoted as $\frac{M}{10}$ and $\frac{M}{100}$ respectively.

Molal Solution :

It is a solution which contains a gram molecular weight of solute in one thousand grams of solvent.

The molarity, gram molecular weight and strength are related as:

Strength = Molarity × Gram Molecular weight

Equipments used in Volumetric Analysis

BURETTE

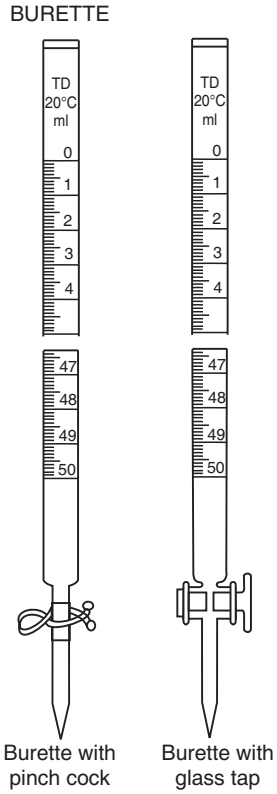
It is a long cylindrical glass-tube of uniform bore. It is graduated along most of its length from zero to fifty in millilitres such that one small division reads one-tenth of ml *i.e.* 0.1 ml. The lower end is provided with a glass stopper (or a pinch cock) for controlling the delivery of variable volumes of solutions.

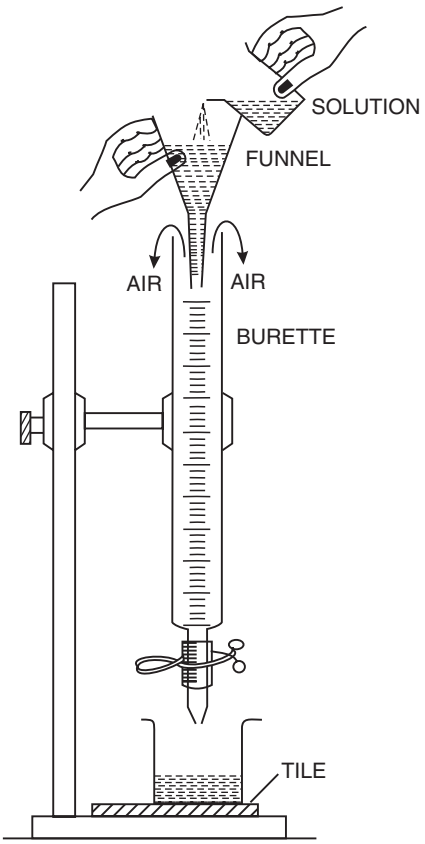
The surface of a solution touching the inner wall of the burette is often curved and is known as meniscus. while reading a burette the bottom of the meniscus or say concave meniscus opposite the graduation is considered.

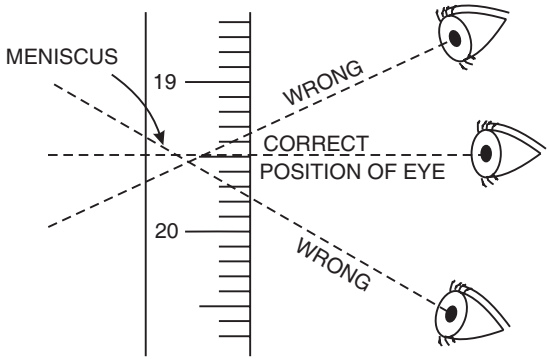
Use of Burette :

Clean the burette thoroughly with chromic acid. (To prepare chromic acid a mixture of solid potassium dichromate ($K_2Cr_2O_7$) and conc. sulphuric acid can be boiled in a beaker), and then with tap water. Make sure that it does not leak. If it does, apply a little grease or vaseline to the stopper. Insert it in its position and incite it to and fro to check its free movement.

Now, wash the burette with distilled water and then rinse (wash) with the solution to be filled and allow a part of the solution to run down through the jet.







Burette

Fix the burette vertically on a burette stand. Fill the solution in it, open the tap to remove air bubble if persists.

Adjust the concavity of meniscus to the zero mark or to a point convenient according to the level of your eye.

A piece of white paper can be fixed behind the level of the liquid to observe the reading accurately.

Precautions :

1. Make it a point to wash the burette with distilled water after use.
2. Allow some time for the sticking liquid to come down to the desired mark before adjusting the concavity of meniscus.
3. The oozed out drop sticking with the jet of burette should be wiped off with a filter paper.
4. Filling of hot liquid should be avoided as it is graduated at a much lower temperature.
5. Avoid the use of rubber tubing burette when solution like that of $KMnO_4$ or $K_2Cr_2O_7$ are to be filled. In this case read top level of the meniscus.

PIPETTE

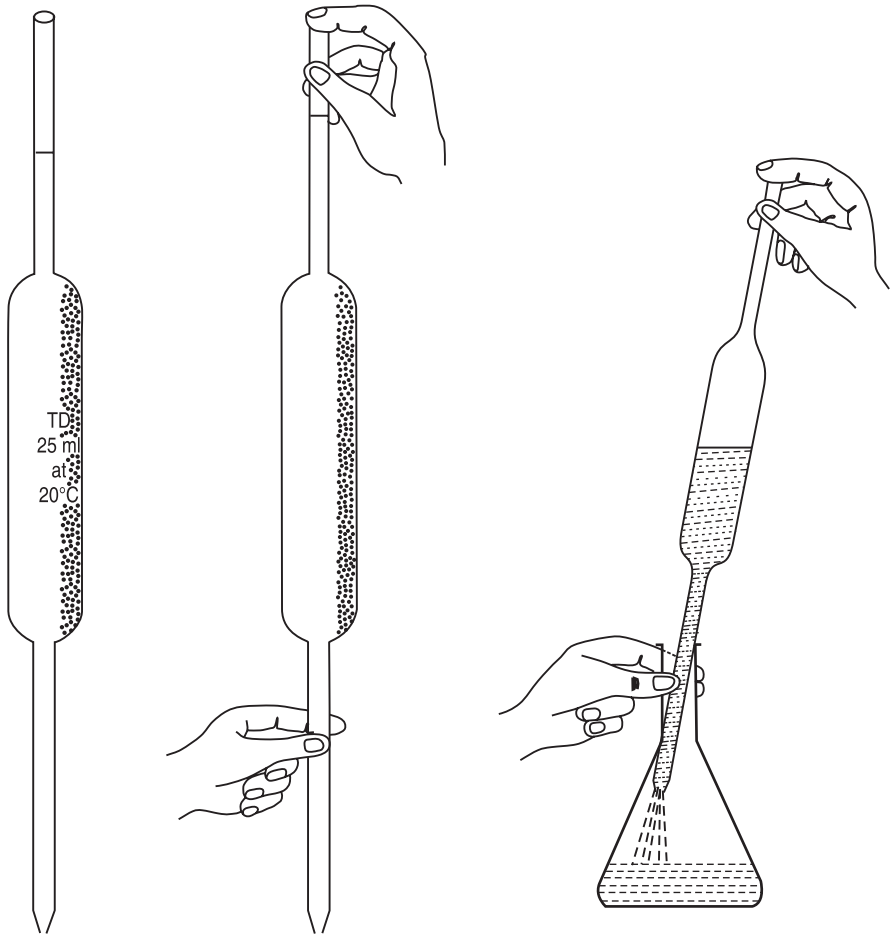
Pipette is an apparatus designed to deliver a fixed volume of liquid. It is specially designed glass-tube with a bulb in the middle, a jet at the bottom and etched circular mark at an appropriate height above the bulb.

Pipette is filled upto this circular mark for measuring a definite volume. The capacity of the pipette is stated on its bulb in ml at stated temperature. The pipettes in common use are of 25 ml, 20 ml and 10 ml.

Use of Pipette :

Wash the pipette in the same way as described for burette. Rinse (wash) the pipette with the solution to be measured.

Now dip the jet of the pipette in the solution and suck it from the other end gently, so that the liquid rises little above the etched mark. Stop sucking and quickly close the upper end with the forefinger. Rotate the pipette slowly to allow the liquid upto the etched mark.



Pipette | How to hold pipette | How to deliver liquid from a pipette to a conical flask.

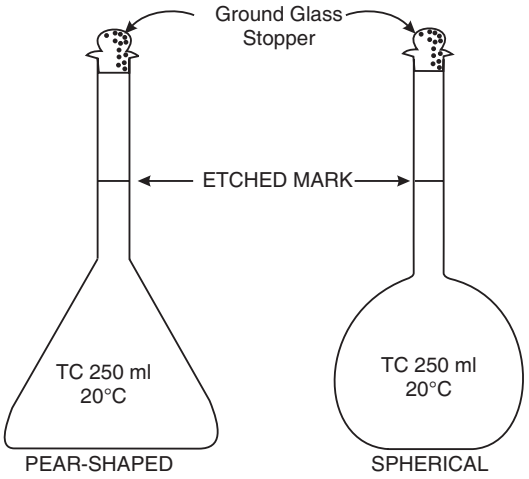
The measured liquid is transferred in a clean titration flask by releasing the pressure of the forefinger. When the solution has run out from the pipette, allow its tip to touch the flask held in a slanting position.

Precautions :

1. It should not be used for measuring poisonous liquids.
2. The solution retained in the tip should not be blown out.
3. Liquid should be sucked very carefully. During sucking the lower end of the pipette should be well dipped in the solution otherwise the sucked solution may go into the mouth.

MEASURING FLASK

It is a flat bottomed glass flask with a long narrow neck bearing a ground glass stopper. The neck has a circular line etched around it. The capacity upto the circular mark at the stated temperature is etched on each flask. It is also called a volumetric flask or graduated flask or standard flask. The measuring flask in common use are of 1000 ml, 500 ml, 250 ml, 200 ml and 100 ml.



Measuring Flask

Use of Measuring Flask :

Clean the flask with chromic acid followed by tap water and finally with distilled water. Now the flask is ready to prepare the solution.

Preparation of Standard Solution :

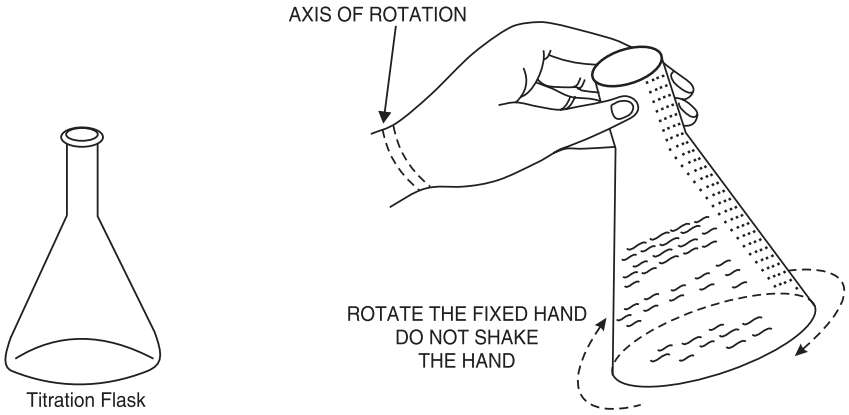
Collect the clean funnel and insert its stem in the washed measuring flask. Transfer the accurately weighed substance on to the funnel. Pour a little distilled water on it to allow the substance to run down into the flask. Place the stopper properly and shake the contents to dissolve the substance, dilute it with distilled water upto the mark. Carefully invert it 2-3 times and allow it to stand for some time. The solution so prepared is known as standard solution.

TITRATION FLASK

It is a conical flask made of glass. The titration flasks in common use are of 250 ml and 150 ml.

Use of a Titration Flask :

Wash the flask two to three times with tap water followed by distilled water. Now it is ready for use.



Titration Flak

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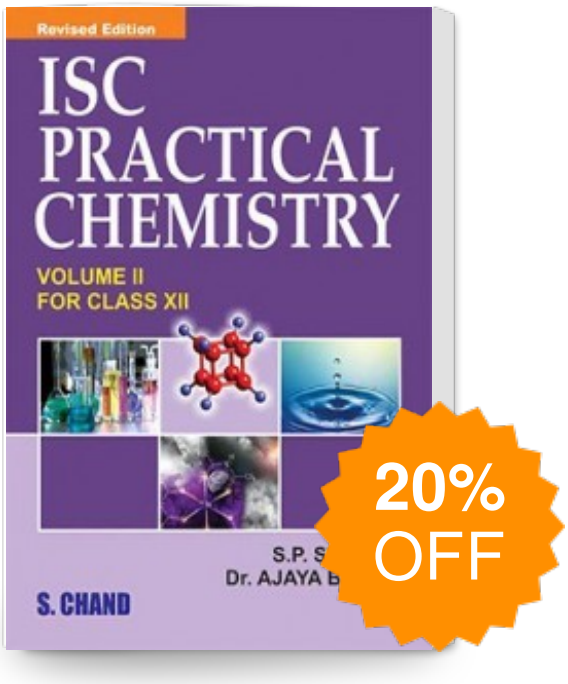

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