

Laboratory Manual **Chemistry**

Class XI



राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

First Edition

August 2008 Shravana 1930

Reprinted

October 2012 Ashwin 1933

January 2017 Pausha 1938

April 2018 Chaitra 1940

June 2019 Jyeshtha 1941

July 2019 Shraavan 1941

October 2019 Kartika 1941

December 2020 Agrahayana 1942

October 2021 Ashwin 1943

PD 5T RPS

© **National Council of Educational
Research and Training, 2008**

₹ 150.00

*Printed on 80 GSM paper with NCERT
watermark*

Published at the Publication Division by the
Secretary, National Council of Educational
Research and Training, Sri Aurobindo Marg,
New Delhi 110 016 and Printed at Sagar
Offset Printer India (P.) Ltd., 518, Ecotech
III, Udyog Kendra II, G.B. Nagar, Greater
Noida (U.P.)

ALL RIGHTS RESERVED

- ❑ No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.
- ❑ This book is sold subject to the condition that it shall not, by way of trade, be lent, re-sold, hired out or otherwise disposed of without the publisher's consent, in any form of binding or cover other than that in which it is published.
- ❑ The correct price of this publication is the price printed on this page. Any revised price indicated by a rubber stamp or by a sticker or by any other means is incorrect and should be unacceptable.

**OFFICES OF THE PUBLICATION
DIVISION, NCERT**

NCERT Campus
Sri Aurobindo Marg
New Delhi 110 016 Phone : 011-26562708

108, 100 Feet Road
Hosdakere Halli Extension
Banashankari III Stage
Bangalore 560 085 Phone : 080-26725740

Navjivan Trust Building
P.O. Navjivan
Ahmedabad 380 014 Phone : 079-27541446

CWC Campus
Opp. Dhankal Bus Stop
Panihati
Kolkata 700 114 Phone : 033-25530454

CWC Complex
Maligaon
Guwahati 781 021 Phone : 0361-2674869

Publication Team

Head, Publication Division : *Anup Kumar Rajput*

Chief Editor : *Shveta Uppal*

Chief Production Officer : *Arun Chitkara*

Chief Business Manager : *Vipin Dewan*

Assistant Editor : *Ram Niwas Bhardwaj*

Production Assistant : *Om Prakash*

Cover

Shweta Rao

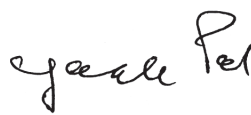
Layout

Digital Expressions

FOREWORD

The National Council of Educational Research and Training (NCERT) is the apex body concerning all aspects of refinement of School Education. It has recently developed textual material in Chemistry for Higher Secondary stage which is based on the National Curriculum Framework (NCF)–2005. NCF recommends that children's experience in school education must be linked to the life outside school so that learning experience is joyful and fills the gap between the experience at home and in community. It recommends to diffuse the sharp boundaries between different subjects and discourages rote learning. The recent development of syllabi and textual material is an attempt to implement this basic idea. The present laboratory manual will be complementary to the textbook of Chemistry for Class XI. It is in continuation to the NCERT's efforts to improve upon comprehension of concepts and practical skills among students. The purpose of this manual is not only to convey the approach and philosophy of the practical course to students and teachers but to provide them appropriate guidance for carrying out experiments in the laboratory. The manual is supposed to encourage children to reflect on their own learning and to pursue further activities and questions. Of course the success of this effort also depends on the initiatives to be taken by the principals and teachers to encourage children to carry out experiments in the laboratory and develop their thinking and nurture creativity.

The methods adopted for performing the practicals and their evaluation will determine how effective this practical book will prove to make the children's life at school a happy experience, rather than a source of stress and boredom. The practical book attempts to provide space to opportunities for contemplation and wondering, discussion in small groups, and activities requiring hands-on experience. It is hoped that the material provided in this manual will help students in carrying out laboratory work effectively and will encourage teachers to introduce some open-ended experiments at the school level.



21.5.08

PROFESSOR YASH PAL

Chairperson

National Steering Committee

National Council of Educational
Research and Training

New Delhi
21 May 2008

PREFACE

The development of the present laboratory manual is in continuation to the NCERT's efforts to improve upon comprehension of concepts and practical skills among the students. The present laboratory manual will be complementary to the textbook of Chemistry for Class XI.

The expansion of scientific knowledge and consequently the change in the system of education has led to the development of new methods of instructions. Today the stress is laid on the enquiry approach and discussion method instead of lecture method of teaching. Unfortunately, it is believed that study of chemistry means abstract thinking, writing long formulas and complex structures and handling complicated equipments. The reason behind such endeavour is that even well-endowed schools tend to give only the cosmetic importance to the laboratory work. Children's natural spirit of inquiry is often not nurtured.

The new syllabus of practical work in chemistry has been designed to cater to the needs of pupil who are desirous of pursuing science further. The fundamental objective of this course is to develop scientific attitude and desired laboratory skills required at this level. The practical syllabus includes content based experiments, which help in comprehension of the concepts.

The project work is expected to provide thrill in learning chemistry. It is expected to serve the real purpose of practical work, which means inculcating the ability to design an experiment, to make observations methodically and to draw conclusions out of experimental data. The real purpose of practical work should be to enable the students to represent the outcome of experiments logically to conclusion, with genuine appreciation of its limitation.

For each practical work, brief theory, material required, procedure, precautions and the questions for discussion are given in the book. The questions are aimed at testing learner's understanding of the related problems. However, teacher may provide help in case the problem is found to be beyond the capability of the learner. Precautions must be well understood by the learners before proceeding with the experiments and projects.

In order to provide some basic idea about the investigatory projects, a brief description of some investigatory projects is given in the book. However, this list is only suggested and not exhaustive. The students may select projects from subject area of chemistry, interdisciplinary areas or from the environment. While selecting a project, care should be taken to see that the facilities for carrying it out are available.

Appendices related to the chemical data and logarithmic tables are attached at the end of the book. International symbols for hazards and hazard warnings are given at several places in the book. It is expected that this will make the learners more careful about the environment and make them careful while dealing with the chemicals. Some non evaluative learning material has been given in the boxes to provide interesting information related to the practical work.

It is a pleasure to express my thanks to all those who have been associated at various stages of development of this laboratory manual. It is hoped that this practical book will improve teaching learning process in chemistry to a great extent. The learners will be able to understand the subject well and will be able to apply the acquired knowledge in new situations. I acknowledge with thanks the dedicated efforts and valuable contribution of Dr Alka Mehrotra, coordinator of this programme and other team members who contributed and finalised the manuscript. I especially thank Professor Krishna Kumar, *Director*, and Professor G. Ravindra, *Joint Director*, NCERT for their administrative support and keen interest in the development of this laboratory manual. I am also grateful to the participating teachers and subject experts who participated in the review workshop and provided their comments and suggestions which helped in the refinement of this manual and make it learner friendly. We warmly welcome comments and suggestions from our readers for further improvement of this manual.

HUKUM SINGH
Professor and Head
Department of Education in
Science and Mathematics

LABORATORY MANUAL DEVELOPMENT TEAM

MEMBERS

Anjni Koul, *Senior Lecturer*, DESM, NCERT, New Delhi

Brahm Parkash, *Professor*, DESM, NCERT, New Delhi

I. P. Aggarwal, *Professor*, Regional Institute of Education, NCERT, Bhopal

R. S. Sindhu, *Professor*, DESM, NCERT, New Delhi

Ruchi Verma, *Lecturer*, DESM, NCERT, New Delhi

MEMBER-COORDINATOR

Alka Mehrotra, *Reader*, DESM, NCERT, New Delhi

© NCERT
not to be republished

ACKNOWLEDGEMENTS

The National Council of Educational Research and Training (NCERT) acknowledges the valuable contributions of the individuals and the organisations involved in the development of Manual for Chemistry Practicals for Class XI. The following academics contributed very effectively for the review of the manuscript of this manual : D. S. Rawat, *Reader*, Department of Chemistry, University of Delhi; Haritima Chopra, *Reader*, Maitreyi College, New Delhi; K. G. Trikha, *Reader (Retired)*, A.R.S.D. College, New Delhi; M. S. Frank, *Vice Principal*, St. Stephen's College, Delhi; Samta Goel, *Reader*, Zakir Hussain College, New Delhi; S. G. Warkar, *Lecturer*, Delhi College of Engenering, Delhi; Sunita Bhagat, *Reader*, A.R.S.D. College, New Delhi; K. K. Singh, *PGT*, Kendriya Vidyalaya, Pushp Vihar, New Delhi; Mona Rastogi, *Senior Headmistress*, ITL Public School, Dwarka, New Delhi; Nivedita Bose, *PGT*, Bluebells School, New Delhi; Nishi Saraswat, *PGT*, Kendriya Vidyalaya No.1, Delhi Cantt. We are thankful to them. We also acknowledge the contribution of Sunita Kumari, *JPF*. Special thanks are due to Hukum Singh, *Professor and Head*, DESM, NCERT for his administrative support.

The Council also acknowledges the support provided by the administrative staff of DESM; Deepak Kapoor, *Incharge*, Computer Station; Ishwar Singh, *DTP Operator* for refining and drawing some of the illustrations; Ritu Jha and Hari Darshan Lodhi, *DTP Operator*; K. T. Chitralkha, *Copy Editor*. The efforts of the Publication Department are also highly appreciated.

CONTENTS

FOREWORD	iii
PREFACE	v
UNIT-1 : Introduction	1
1.1 Do's and don'ts in a chemistry laboratory	2
1.2 Analytical methods	5
1.3 Basic laboratory equipment and procedures	5
1.4 Handling reagent bottles	10
1.5 Heating devices	11
UNIT-2 : Basic Laboratory Techniques	16
2.1 Cutting of glass tube and glass rod	16
2.2 Bending of a glass tube	18
2.3 Drawing out a jet	19
2.4 Boring a cork	20
2.5 Heating solution in a test tube	22
2.6 Heating solution in a beaker or a flask	22
2.7 Filtration	22
2.8 Measuring volume of liquids	25
2.9 Weighing technique	30
• <i>Experiment 2.1 : Preparation of standard solution of oxalic acid</i>	34
UNIT-3 : Purification and Criteria of Purity	38
• <i>Experiment 3.1 : Purification of sample of a compound by crystallisation</i>	38
• <i>Experiment 3.2 : Determination of melting point of a solid organic compound</i>	40
• <i>Experiment 3.3 : Determination of boiling point of a liquid organic compound</i>	43
UNIT-4 : Chemical Equilibrium (Ionic Equilibrium in Solution)	46
• <i>Experiment 4.1 : Study of shift in equilibrium in the reaction of ferric ions and thiocyanate ions...</i>	47

• Experiment 4.2 : Study of shift in equilibrium in the reaction between $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and Cl^- ions...	50
UNIT-5 : pH and pH Change in Aqueous Solutions	53
• Experiment 5.1 : To determine the pH of some fruit juices	54
• Experiment 5.2 : To observe the variation in pH of acid/base with dilution	56
• Experiment 5.3 : To study the variation in pH by common ion effect in the case of weak acids and weak bases	58
• Experiment 5.4 : To study the change in pH during the titration of a strong acid with a strong base by using universal indicator	61
• Experiment 5.5 : To study the pH of solutions of sodium chloride, ferric chloride and sodium carbonate	63
UNIT-6 : Titrimetric Analysis	65
6.1 Detection of end point	65
6.2 Requirement for a reaction in the titrimetric analysis	66
6.3 Acidimetry and alkalimetry	66
6.4 Indicators in acid base titration	67
• Experiment 6.1 : Determination of the concentration (strength) of a given sodium hydroxide solution by titrating it against a standard solution of oxalic acid	69
• Experiment 6.2 : Preparation of standard solution of sodium carbonate	74
• Experiment 6.3 : Determination of the strength of a given solution of dilute hydrochloric acid by titrating it against a standard solution of sodium carbonate	75
UNIT-7 : Systematic Qualitative Analysis	79
• Experiment 7.1 : To detect one cation and one anion in the given salt...	80

7.1 Systematic analysis of anions	81
7.2 Systematic analysis of cations	93

Group Analysis

(I) Analysis of Group-zero cation	99
(II) Analysis of Group-I cations	101
(III) Analysis of Group-II cations	102
(IV) Analysis of Group-III cations	105
(V) Analysis of Group-IV cations	106
(VI) Analysis of Group-V cations	109
(VII) Analysis of Group-VI cations	111
• <i>Experiment 7.2 :Detection of nitrogen, sulphur and halogens in an organic compound</i>	116

PROJECTS

122

1. To test the contamination of water by bacteria by checking the sulphide ion concentration and find out the cause of contamination	125
2. To study the methods of purification of water	126
3. Testing the hardness, presence of iron, fluoride, chloride etc. in drinking water obtained from different regions and a study of the cause of presence of these ions above permissible limits	126
4. Investigation of the foaming capacity of different washing soaps and the effect of addition of sodium carbonate on their foaming capacity	127
5. Study of the acidity of different samples of tea leaves and reasons for the variation in colour of tea prepared from these leaves	128
6. Study the rates of evaporation of different liquids	129
7. Study the effect of acids and alkalies on the tensile strength of fibres	130
8. Study of the acids and mineral contents of vegetables and fruits	130

APPENDICES

135

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a ¹**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

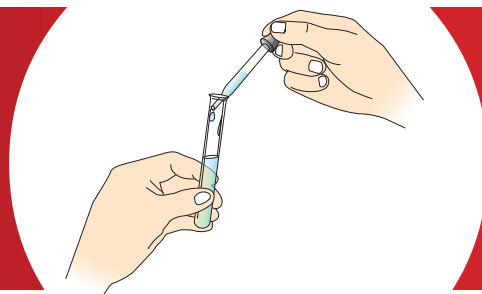
FRATERNITY assuring the dignity of the individual and the ²[unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)

UNIT-1

INTRODUCTION



LABORATORY work has special importance in the learning of science as scientific principles develop and grow on the basis of laboratory work. Chemistry is an experimental science; the concepts learned in the theory classes are better understood through experimentation. Laboratory work provides an opportunity to observe many of the chemical phenomena under controlled laboratory conditions and workout a problem through the method of inquiry. In other words, it provides you with ample opportunity to become a keen observer and to draw inferences and explain results.

The training in laboratory work helps to develop skills for handling apparatus and equipment and carry out experiments. In this way, the experimental work helps to promote scientific temper and adopt a cooperative attitude. Working in the laboratory provides a platform for trying novel and creative ideas and giving them concrete shape.

Before you become familiar with the scientific procedures and experimental skills and start working in the laboratory, you should be well acquainted with the chemistry laboratory. You should notice the facilities provided in the laboratory and on your working table.

You will notice that your table is provided with a water-tap, gas-tap, Bunsen burner spirit lamp/kerosene lamp, a reagent shelf and a bin for disposing waste material. You will find that some reagents are kept on the shelf fixed on the table while some reagents are kept on the shelf fixed on sidewalls. Reagents kept on the shelf of the table are frequently required while those on the shelf fixed on walls are less commonly used. Besides the facilities on the table, you will see that there are exhaust fans fitted on the upper portion of the wall opposite to the doors and windows and are placed close to the level of the ceiling. This facilitates the exhaustion of harmful fumes and circulation of fresh air in the laboratory. For this purpose, there are also enough number of windows in the laboratory. Keep these open while working. A fume cupboard is provided in the laboratory for performing those experiments in which fumes are produced.

It is strongly advised that you should become fully familiar with your chemistry laboratory, laboratory practices and procedures, and more importantly the precautions to be taken while working in the laboratory.

The environment in the chemistry laboratory is somewhat special in the sense that it can be a place of joy, discovery and learning. It can also become a place of frustration and danger. Frustration – if you come unprepared and neglect recording the important data properly, and danger – if you do not follow the precautions properly in conducting the experiments where potential danger exists.

In order to become proficient in basic principles underlying the laboratory work, you must learn to handle the equipment and familiarise yourself with the safety measures and good laboratory practices.

You should organise yourself before entering into the laboratory for work and be aware of the pre-laboratory preparation and experimental procedures so that your work is not haphazard. You should work individually unless the experiments require teamwork. Use your ingenuity and common sense while working. This attitude is the basic requirement to acquire scientific approach. Prepare reports of the experiments in the laboratory notebook. Do not use loose sheets or scraped papers for this purpose. Think and try to get answers of important questions that give you an understanding of the principles on which the experimental procedure is based.

Scientists learn much by discussion. In the same manner, you too may be benefitted by discussion with your teacher and classmates. Use books in case of any doubt because books are more reliable, complete and better source of information than classmates. Else consult your teacher.

Safety rules are designed to ensure that the work done in the laboratory is safe for you and your fellow students. Follow the safety rules and be aware of where the items like first-aid box, fire extinguisher etc., are kept.

Don't taste anything in the laboratory (Poisonous substances are not always so labelled in the laboratory) and never use laboratory as an eating-place. Never use glass apparatus of the laboratory for eating and drinking purposes. Never work in the laboratory alone. Seek the permission of your teacher for working for extra hours, in case it is needed.

1.1 DO'S AND DON'TS IN A CHEMISTRY LABORATORY

The practices outlined below are designated to guide you in developing efficient laboratory techniques and to make your laboratory a pleasant place to work. You should follow the practices listed below:

- Wear safety glasses, lab coat and shoes while working in the laboratory.
- Check and read the label of the reagent bottle carefully before using its content.
- Read procedures and precautions carefully and follow them.
- It is a bad practice to leave the reagent bottles on the working table. Put the stoppers properly on the bottles and keep them on the shelf immediately after use.

- If a reagent bottle on your seat is empty, ask the laboratory attendant to fill it.
- If you require a reagent from the bottle kept on side shelf, take the test tube or the beaker to the shelf. Do not bring the bottle to your seat.
- **Avoid using excessive amounts of reagents** unless you are advised to do so.
- **Never return unused chemicals to the stock bottles.** If you commit a mistake in putting the material back into the correct bottle, experiments of other students will be spoiled.
- **Never mix the chemicals** unless it is required in the experiment. Failure in following this rule may result in serious accidents.
- **Use only properly cleaned droppers, spatulas or pipettes** etc. to take out the reagents from the stock solutions and reagent bottles.
- **Do not keep the stopper of the bottle on the table.** Impurities may stick to it and the content of the bottle may be contaminated. Whenever you require a chemical from the reagent bottle, pick up the bottle with one hand and remove or replace the stopper with the other hand and keep it on a clean glazed tile. To take out dry solid reagents use spatula and **keep it on watch glass, never use filter papers. Do not keep the reagent on your palm or touch it with your fingers.**
- **Never throw** used match sticks, litmus papers, broken glass apparatus, filter papers or any other **insoluble solid material into the sink** or on the floor. Dispose them off in the waste bin provided at your seat. Only waste liquids should be thrown in the sink while keeping the tap water running so that nothing stinks and sticks and the waste liquid is drained completely.
- **Do not waste water or gas.** Close the taps whenever they are not in use. Do not leave the lighted burner under the wire gauze when nothing is being heated. Extinguish it.
- Hot apparatus should not be placed on working table directly because it may spoil the working table. Place it on a glazed tile or a wire gauze.
- Do not heat the apparatus which is made of thick glass, e.g., graduated cylinder, bottles, measuring flasks etc., as these break on heating. Also heating distorts the glass and calibrations on the measuring apparatus may become invalid. Test tubes may break if they are heated above the level of the liquid filled in them. Crucibles may be heated to red-hot.

INTERNATIONAL HAZARD SYMBOLS



Harmful



Inflammable



Corrosive



Toxic



Explosive



Oxidising



Radioactive

Note : Look for these symbols on the labels of bottles of chemicals.

- Do not heat the test tube containing solution with its mouth towards yourself or your neighbour as the spurting of content may harm you or your neighbour (Fig 1.1). Do not heat the test tube continuously in one position. Keep it moving and shaking while heating so that heating is uniform.
- Clean every piece of apparatus as soon as the work is finished and keep these at proper place. A dirty seat and apparatus indicate careless habit and it hinders successful performance of the experiment.

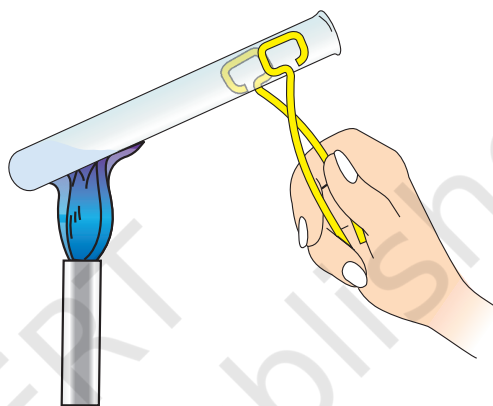


Fig. 1.1 : Correct method of heating solution in a test tube

The indication for cleanliness of glass apparatus is that after rinsing with water and holding it in position, water flows out readily and droplets do not stick to the surface. If water droplets stick to the glass surface it means that apparatus is greasy. In that case it should be washed with 5% NaOH solution or with soap and then thoroughly rinsed with water. If it still remains dirty or some stain remains sticking to it, then warm concentrated nitric acid can be used for cleaning. If some stain is still not cleaned then chromic acid, (also called chromosulphuric acid) can be used for cleaning. To prepare one litre of chromic acid solution, 100 g of potassium dichromate is dissolved in one litre of conc. sulphuric acid. **It is highly corrosive liquid and all care should be taken to avoid its contact with the skin and clothes.**

- Use fume cupboard for performing experiments in which poisonous and irritating fumes are evolved.
- Keep the doors and windows open and the exhaust fan on while working in the laboratory, so that poisonous vapours are quickly sucked out and flow of fresh air is facilitated.

- If you will follow the Do's and Don'ts outlined above, your experience of learning basic scientific techniques will surely be full of joy.

In the following pages you will be introduced to basic laboratory equipments, procedures and techniques required for working in a chemistry laboratory. Let us begin with the introduction to type of analytical methods used in chemistry.

1.2 ANALYTICAL METHODS

Elements and their compounds may be detected by their physical features such as physical state, colour, odour, lustre, melting point, boiling point, sublimation, colour imparted to the flame on heating, hardness, crystalline state or amorphous state, solubility in water and other solvents, etc., but sometimes it is impossible to identify the substance on the basis of physical properties only, therefore, chemical methods such as reaction with alkalies, acids, oxidising agents, reducing agents and other compounds are employed for the identification of substances. A substance is analysed to establish its qualitative and quantitative chemical composition. Therefore, analysis may be either qualitative or quantitative. **Qualitative analysis** is used to detect the elemental composition of the substance; it may involve detection of ions formed, and the type of molecules present in the substance. The methods of qualitative analysis are very diverse. They not only allow us to determine the elements which constitute the substances known on the Earth, but also the composition of celestial bodies which are away from the Earth. **Quantitative analysis** helps to establish the quantity of the constituents of substances. It helps in measurement of energy changes etc.

1.3 BASIC LABORATORY EQUIPMENT AND PROCEDURES

Heating, filtration, decantation, measuring volumes and weighing solids and liquids are some of the basic laboratory procedures, which are required frequently during the experimentations in the chemistry laboratory. Some of the specific equipment required for this purpose are shown in Fig. 1.2 and 1.3. You will learn about the use of these while performing experiments. Guidelines for using some of the common apparatus are as follows :

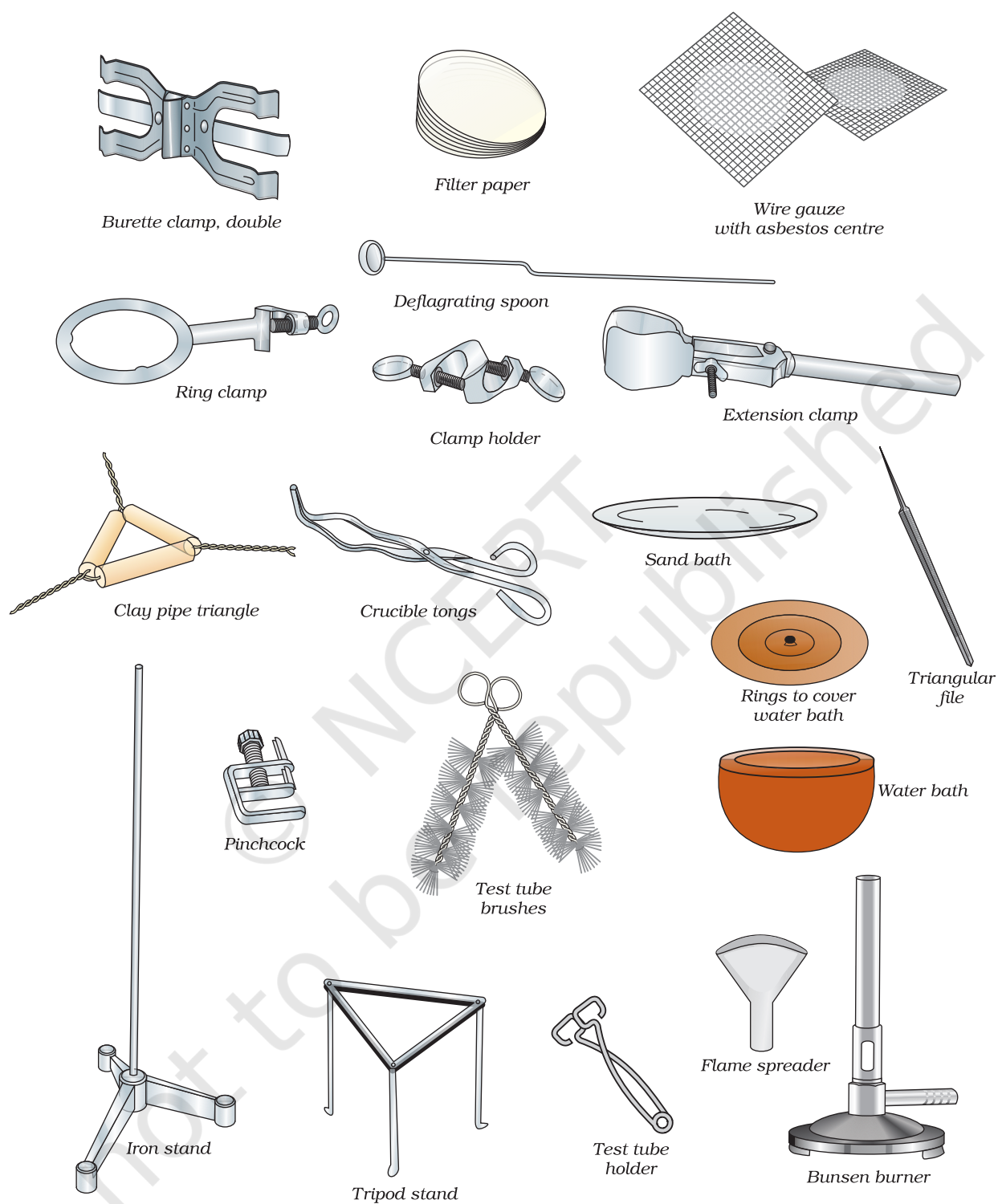


Fig. 1.2 : Common laboratory equipments

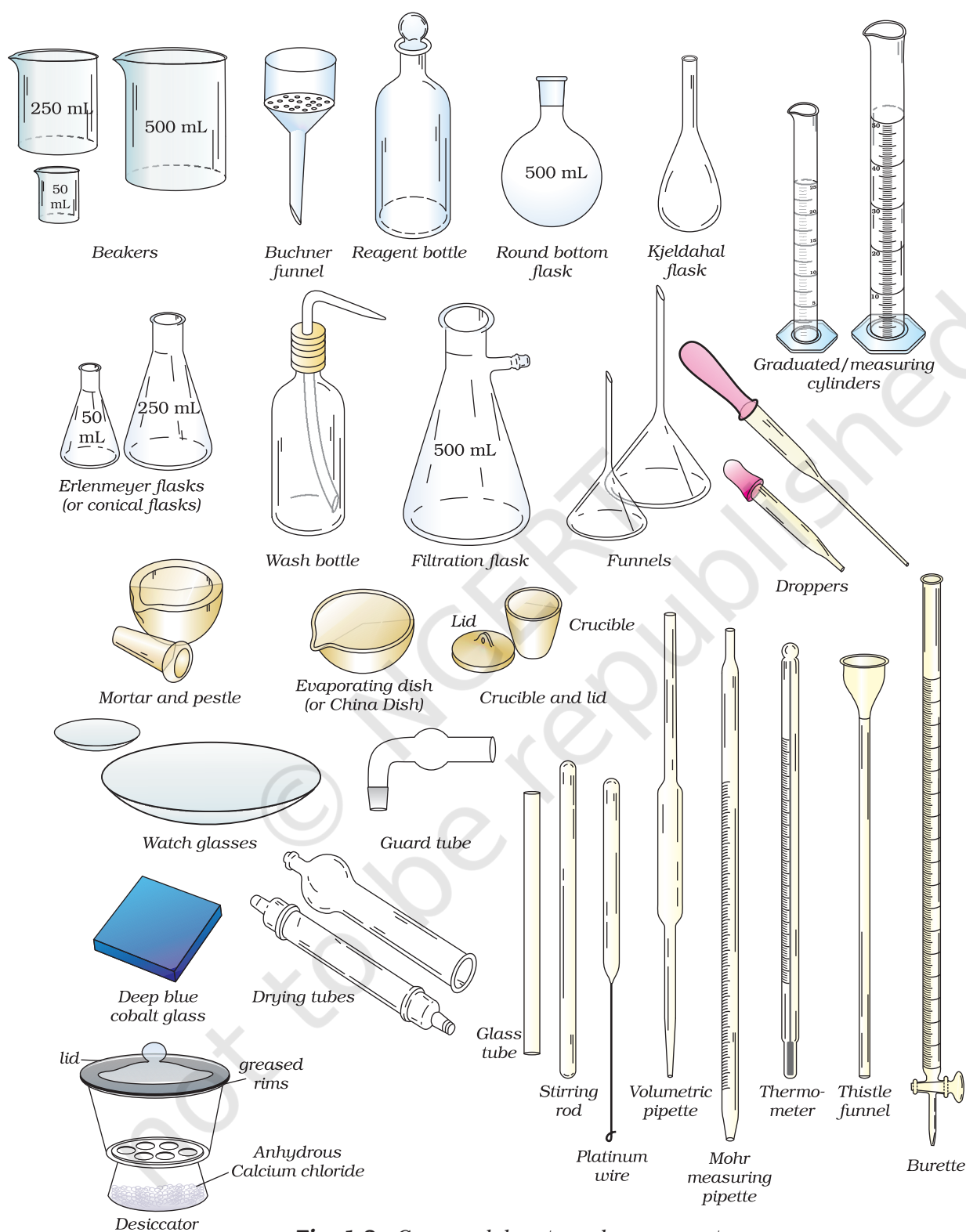


Fig. 1.3 : Common laboratory glass apparatus

Test Tubes

Test tubes of different volumes are available but usually for this level of chemistry practical work, test tubes of 125 mm (length) \times 15 mm (diameter), 150 mm (length) \times 15 mm (diameter) and 150 mm (length) \times 25 mm (diameter) are used. Test tubes are available with or without rim around the mouth. Test tubes of smaller width are used for carrying out reactions, which do not require heating or when heating is required for a short period. **Only one third of the test tube should be filled while carrying out a reaction.** The test tube of bigger diameter is called **boiling tube**. It is used when large volume of solution is required to be heated. Test tube holder is used to hold a test tube while heating a mixture or solution in it. Test tube stand should be used to keep test tubes containing solutions in the upright position (Fig. 1.4).

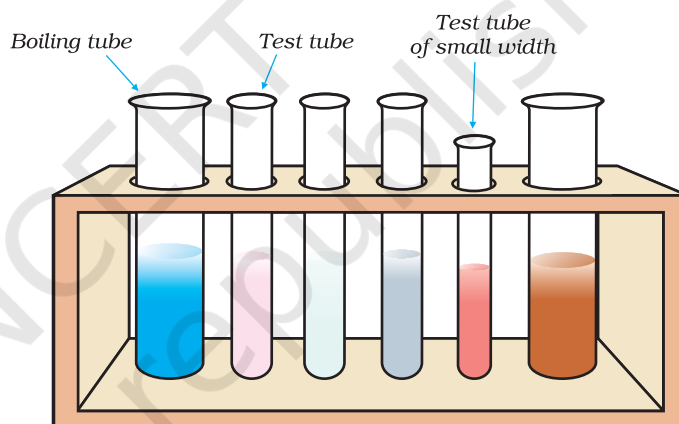


Fig. 1.4 : Stand carrying boiling tubes and test tubes of different sizes

Flasks

Mostly round bottom and conical flasks (also called Erlenmeyer flask) are used in chemistry laboratory. These are available in various capacities ranging from 5 mL-2000 mL. Choice of the size and type depends upon the amount of solution to be handled and the type of reaction to be carried out. Generally, for heating or refluxing a reaction mixture contained in a round bottom flask, direct flame / sand bath / water bath, is used. Conical flasks are employed for carrying out certain reactions at room temperature or lower temperatures. These are specially used for carrying out volumetric titrations.

Beakers

Beakers of various capacities ranging from 5 mL to 2000 mL are available and are employed for the purpose of preparing solutions, for carrying out precipitation reactions and for evaporation of solvents etc.

Separating Funnels

These are used for separating immiscible liquids. Separating funnels of various sizes and shapes are available (Fig. 1.5).

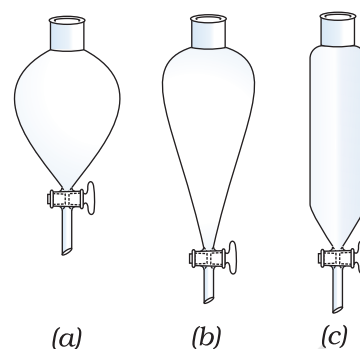


Fig. 1.5 : Separating funnels of various shapes

Condensers

Condensers are used to condense the vapour back to the liquid phase. Generally two types of condensers are used in the laboratory, (a) air condensers and (b) water condensers. Air condenser is shown in Fig. 1.6 (a). Length and diameter of the glass tube of air condensers vary. There is a rapid transfer of heat from the hot vapour to the surrounding air and vapour condenses.

Water condenser has an inner tube surrounded by an outer jacket [Fig. 1.6 (b)] with an inlet and an outlet for circulating water. Inlet is connected to the tap. Heat is transferred from hot vapour to the surrounding water.

For refluxing and distillation of solutions or liquids with high boiling point, air condensers are used. For low boiling liquids water condensers are used.

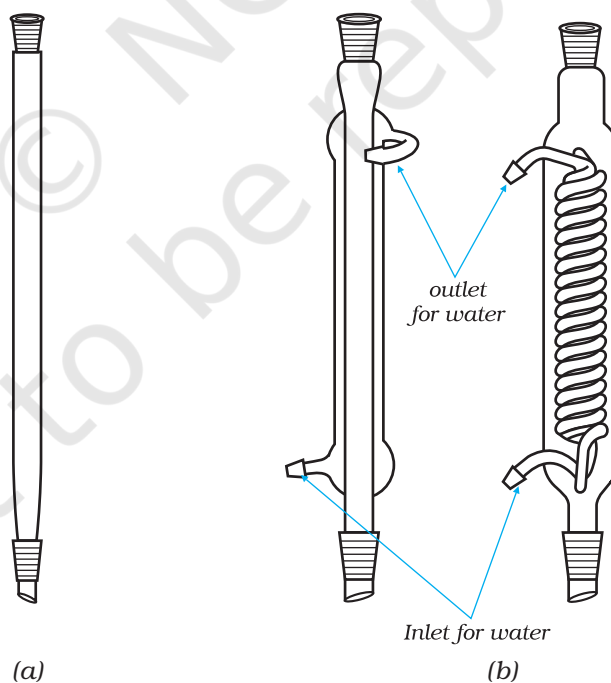


Fig. 1.6 : (a) Air condenser
(b) Water condensers

Ground Glass Joints

Now-a-days ground glass joints are fixed to inlets or outlets of the apparatus described above to minimize the use of corks. Apparatus with ground glass joints of various sizes are available.

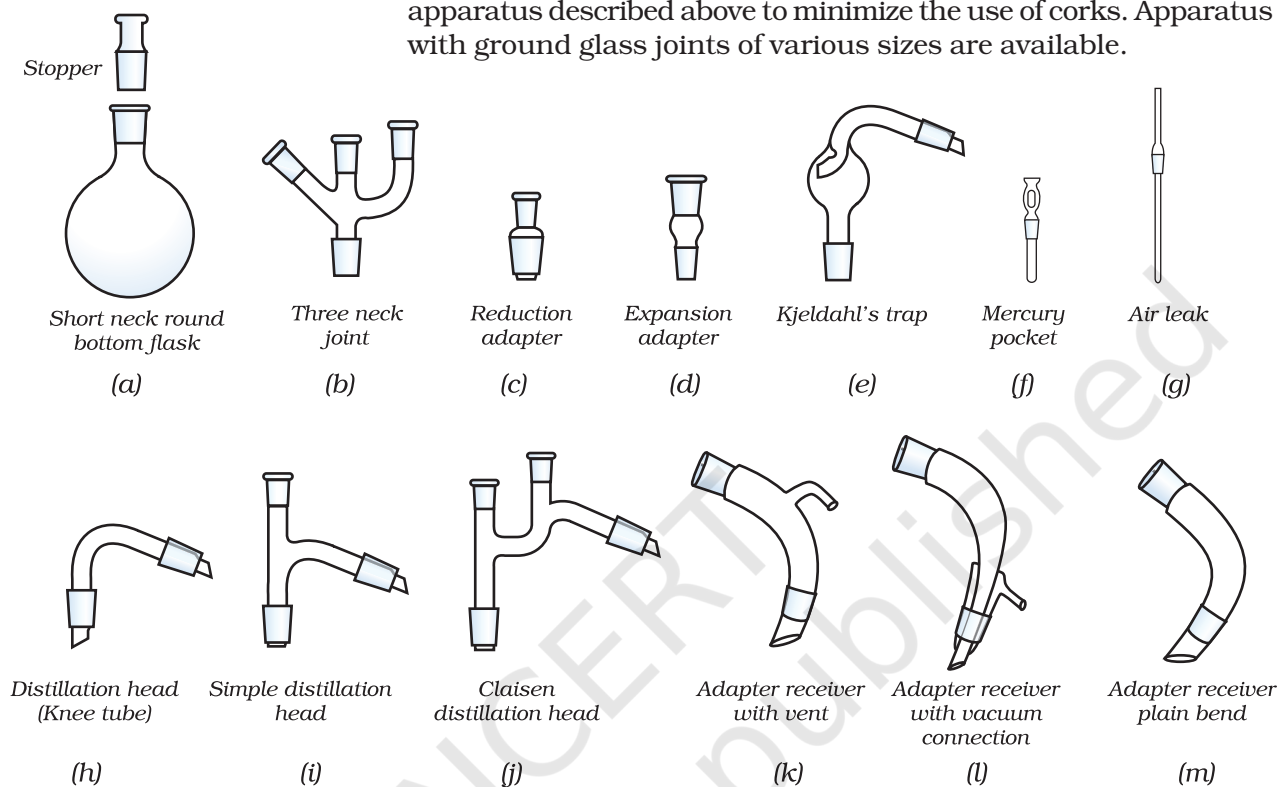


Fig. 1.7 : Apparatus with ground glass joints

1.4 HANDLING REAGENT BOTTLES

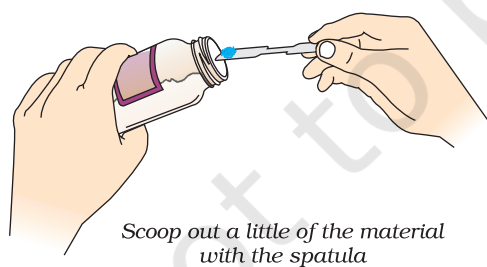


Fig. 1.8 : Method for taking out solid from the reagent bottle

Correct methods for taking out solid and liquid reagents from reagent bottles are shown in Fig. 1.8 and 1.9 respectively. Before taking out any reagent from the bottle one should double-check the name written on label to make sure that correct reagent is being taken out. Liquid reagents are stored either in reagent bottle of small mouth with glass stoppers or dropping bottles. While using reagent bottles with stopper, put the stopper on a clean glazed tile. Never put the stopper on the table because dirt from the table may stick to it and contaminate the reagent. Replace the stopper immediately after taking out the reagent. The proper way of pouring liquid from the bottle is shown in Fig. 1.9. When adding liquids directly from bottles into the beaker, a glass rod is held against the mouth of the bottle so as to permit the flow of liquid along the rod without splashing.

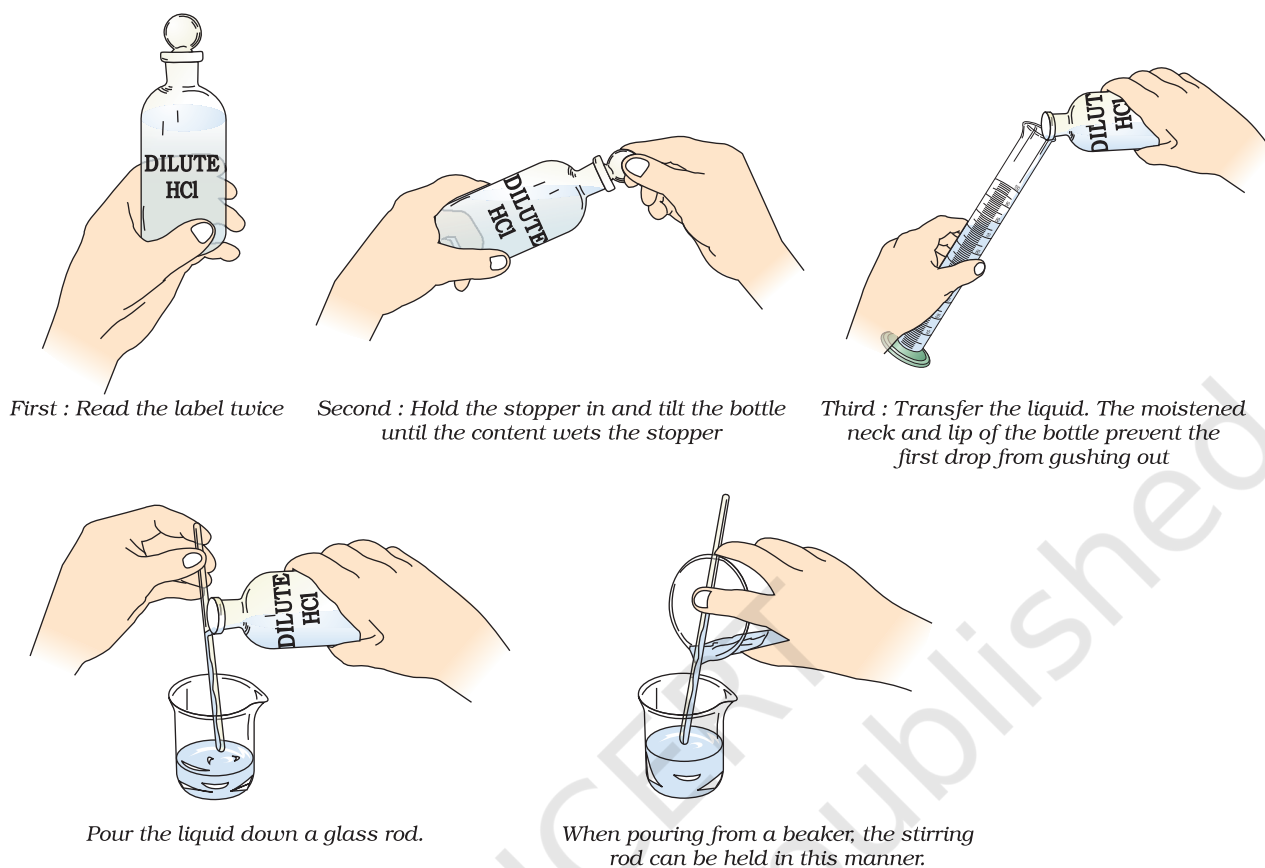


Fig. 1.9 : Methods of pouring liquids

If dropper is used for transferring the liquid, it should not touch the content of the container while transferring the reagent. Correct way of transferring liquid with a dropper is shown in Fig. 1.10. Droppers of bottles should never be exchanged. Now-a-days, use of dropping bottles is considered more convenient and safe.

1.5 HEATING DEVICES

Heating during the laboratory work can be done with the help of a gas burner, spirit lamp or a kerosene lamp. The gas burner used in the laboratory is usually Bunsen burner (Fig. 1.11). Various parts of Bunsen burner are shown in Fig. 1.12. The description of these parts is as follows :

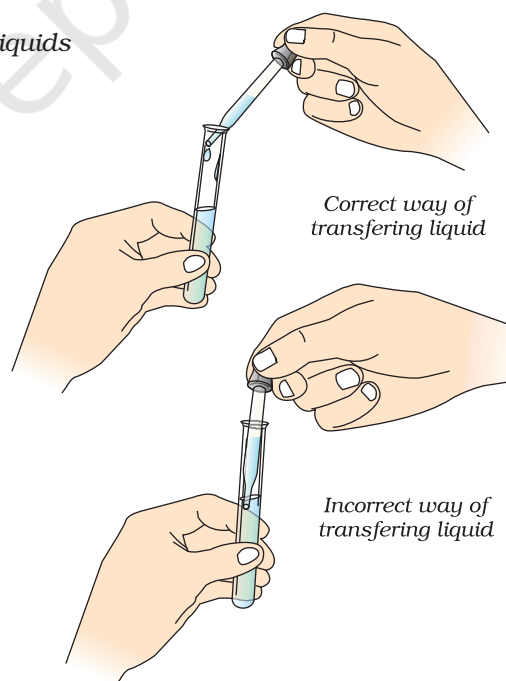


Fig. 1.10 : Transferring liquid through dropper

BUNSEN BURNER

(A) Parts of Bunsen Burner

1. The Base

Heavy metallic base is connected to a side tube called gas tube. Gas from the source enters the burner through the gas tube and passes through a small hole called *Nipple* or *Nozzle* and enters into the burner tube under increased pressure and can be burnt at the upper end of the burner tube.

2. The Burner Tube

It is a long metallic tube having two holes diametrically opposite to each other near the lower end which form the air vent. The tube can be screwed at the base. The gas coming from the nozzle mixes with the air coming through the air vent and burns at its upper end.

3. The Air Regulator

It is a short metallic cylindrical sleeve with two holes diametrically opposite to each other. When it is fitted to the burner tube, it surrounds the air vent of the burner tube. To control the flow of air through the air vent, size of its hole is adjusted by rotating the sleeve.

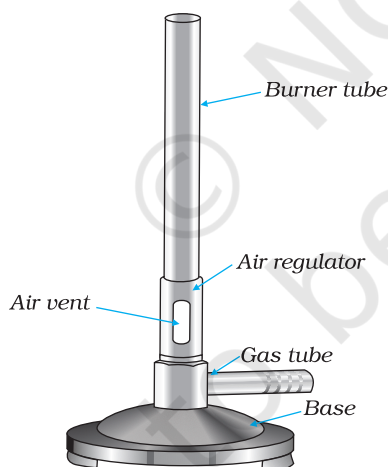


Fig. 1.11 : Bunsen burner

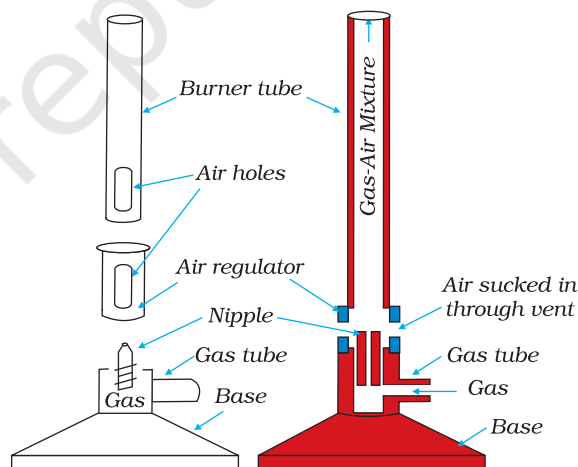


Fig. 1.12 : Parts of Bunsen burner

If the air vent is closed and the gas is ignited, the flame will be large and luminous (smoky and yellow in colour). The light emitted by the flame is due to the radiations given off by the hot carbon particles of partially burnt fuel. The temperature of the flame in this situation is low. If adjustment of sleeve on vent is such that gas mixed with air is fed into the flame, the flame becomes less

luminous and finally turns blue. When the flow of air is correctly adjusted, the temperature of the flame becomes quite high. This is called non-luminous flame. Various zones of flame are shown below in Fig. 1.13.

Three distinctly visible parts of the Bunsen flame are described below:

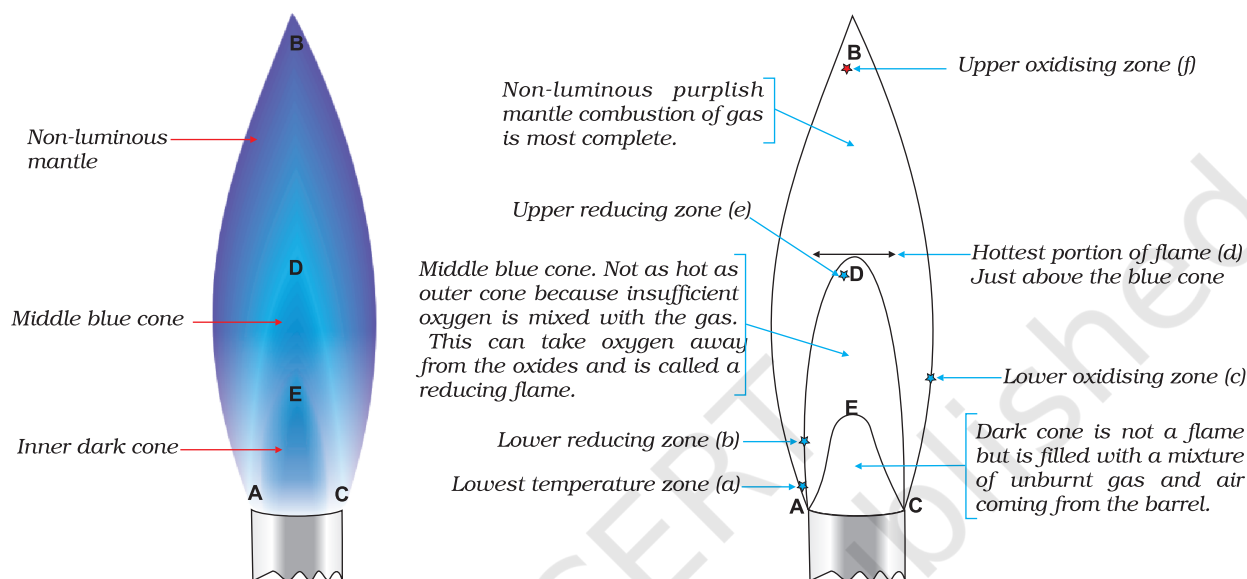


Fig. 1.13 : Zones of flame of Bunsen burner

(B) Principal Parts of Bunsen Flame

1. The Inner Dark Cone, A E C

This is innermost dark cone, which is just above the burner tube. It consists of unburnt gases. This zone is the coldest zone of the flame and no combustion takes place here.

2. The Middle Blue Cone, A D C E A

This is middle part of the flame. This becomes luminous when the air vent is slightly closed. Luminosity of this part is due to the presence of unburnt carbon particles produced by decomposition of some gas. These particles get heated up to incandescence and glow but do not burn. Since the combustion is not complete in this part, the temperature is not very high.

3. The Outer Non-luminous Mantle, A B C D A

This is purplish outer cone. It is the hottest part of the flame. It is in direct contact with the atmosphere and combustion is quite complete in this zone.

Bunsen identified six different regions in these three principal parts of the flame:

(i) The upper oxidising zone (f)

Its location is in the **non-luminous tip of the flame** which is in the air. In comparison to inner portions of the flame large excess of oxygen is present here. The temperature is not as high as in region (c) described below. It may be used for all oxidation processes in which highest temperature of the flame is not required.

(ii) Upper reducing zone (e)

This zone is at the **tip of the inner blue cone** and is rich in incandescent carbon. It is especially useful for reducing oxide incrustations to the metals.

(iii) Hottest portion of flame (d)

It is the fusion zone. It lies at about one-third of the height of the flame and is approximately equidistant from inside and outside of the mantle i.e. the outermost cone of the flame. Fusibility of the substance can be tested in this region. It can also be employed for testing relative volatility of substances or a mixture of substances.

(iv) Lower oxidising zone (c)

It is located on the outer border of the mantle near the lower part of the flame and may be used for the oxidation of substances dissolved in beads of borax or sodium carbonate etc.

(v) Lower reducing zone (b)

It is situated in the inner edge of the outer mantle near to the blue cone and here reducing gases mix with the oxygen of the air. It is a less powerful reducing zone than (e) and may be employed for the reduction of fused borax and similar beads.

(vi) Lowest temperature zone (a)

Zone (a) of the flame has lowest temperature. It is used for testing volatile substances to determine whether they impart colour to the flame.

[C] Striking Back of the Bunsen Burner

Striking back is the phenomenon in which flame travels down the burner tube and begins to burn at the nozzle near the base. This happens when vents are fully open. The flow of much air and less gas makes the flame become irregular and it strikes back.

The tube becomes very hot and it may produce burns on touching. This may melt attached rubber tube also. If it happens, put off the burner and cool it under the tap and light it again by keeping the air vent partially opened.

SPIRIT LAMP

If Bunsen burner is not available in the laboratory then spirit lamp can be used for heating. It is a device in which one end of a wick of cotton thread is dipped in a spirit container and the other end of the wick protrudes out of the nozzle at upper end of the container (Fig. 1.14). Spirit rises upto the upper end of the wick due to the capillary action and can be burnt. The flame is non luminous hence can be used for all heating purposes in the laboratory. To put off the lamp, burning wick is covered with the cover. **Never try to put off the lighted burner by blowing at the flame.**

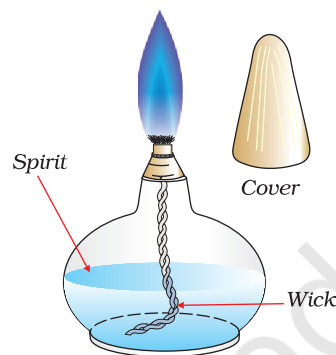


Fig. 1.14 : The spirit lamp

KEROSENE HEATING LAMP

A kerosene lamp has been developed by National Council of Educational Research and Training (NCERT), which is a versatile and cheaper substitute of spirit lamp. It may be used in laboratories as a source of heat wherever spirit and gas burner are not available. Parts of kerosene lamp are shown in Fig. 1.15.

Working of the Kerosene Lamp

More than half of the container is filled with kerosene. Outer sleeve is removed for lighting the wicks. As the outer sleeve is placed back in position, the flames of four wicks combine to form a big soot-free blue flame.

The lighted heating lamp can be put off only by covering the top of the outer sleeve with a metal or asbestos sheet.

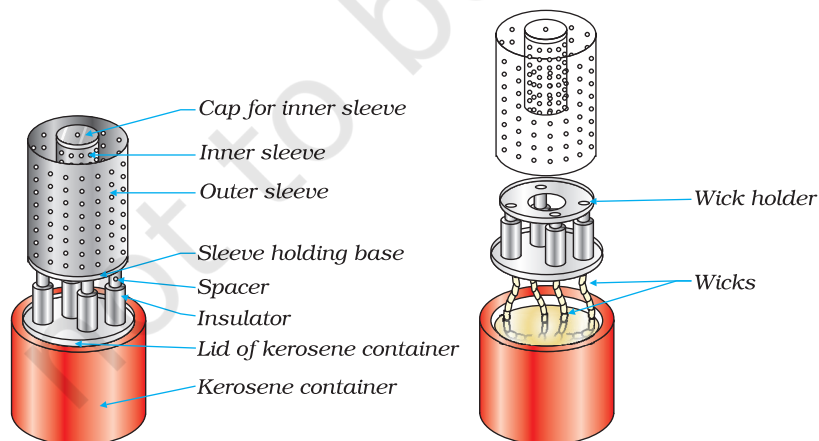


Fig. 1.15 : Parts of Kerosene Heating Lamp