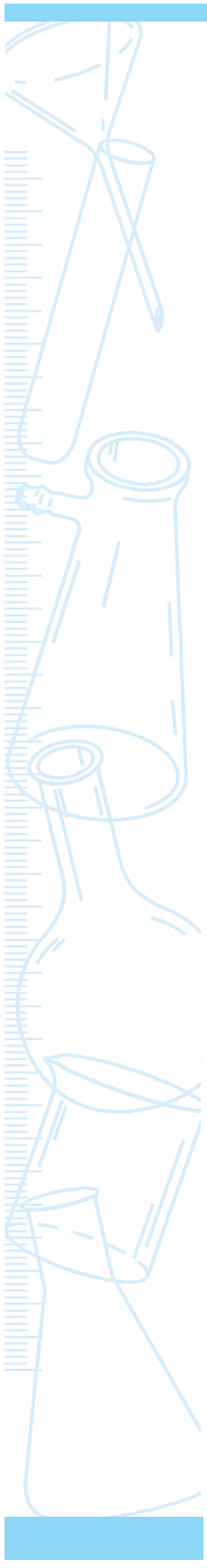
INTRODUCTION



Experiments play a crucial role in the progress of science. A large number of path breaking discoveries and inventions have been possible through investigations done usually in laboratories. The experimental work is, therefore, an essential component of any course in science. A course on practical work in science curricula in schools at the secondary stage is essentially designed to acquaint the learners with the basic tools and techniques used in a science laboratory. It also envisages developing problem-solving skills. These skills help the learner to acquire ability to identify a problem, to design and to set up the experiment, to collect and analyse data through experiment, and to interpret data to arrive at plausible solution in due course of time. These are, in fact, the long term objectives of laboratory work and become the nucleus of the philosophy of construction of knowledge by the learner.

A school science laboratory is a place where basic experimental skills are learnt by systematically performing a set of prescribed and suitably designed experiments. Performing experiments by one's own hands is not only a thrilling experience but is also important because it entails *learning by doing*. It also facilitates understanding the concepts of science. The experiments and project work suggested at the secondary stage intend to develop basic skills of measurement; handling of some common measuring instruments, equipment and chemicals; setting simple apparatus; handling microscope and preparing slides; making observations; collecting data and presenting it in appropriate format; interpreting and drawing conclusions; and preparation of report.

There are certain rules and regulations that every student must be familiar with before undertaking practical work in a laboratory. A student is required to be acquainted with the general facilities and the equipment available in the laboratory and follow the rules and regulations. Generally, in the beginning of the session, the teacher takes the students around the

laboratory to familiarise them with the general facilities available in the laboratory and informs them about certain do's and don'ts while performing the experiments in the laboratory.

Laboratory Manual in Science for Class IX is an exercise to familiarise pupil with the general facilities, equipment, measuring instruments, chemicals and glassware, specimen available in a school science laboratory. The precautions and measures for safety to be observed in a laboratory are also mentioned. The format adopted for description of experiments includes the aim of the experiment, theory or the principle involved in the experiment, list of materials required on the basis of method to perform the experiment, steps involved in performing the experiment, recording observations, the formula required for calculations and stating the results. An emphasis on drawing conclusions and initiating discussions is also made. Though the precautions that are necessary to be taken care of in performing the experiments are merged with the procedure itself, these along with the possible sources of errors are also mentioned separately with more reasoning. There could be some certain prerequisites for preparing the laboratory for performing an experiment, and additional information to teachers on a particular experiment. Such issues have been raised in almost all experiments in column titled *Note for the Teacher*. Authors have also used this column to communicate with teachers. It is hoped that teachers would find this column useful. The method used in the experiment may also be used to extend understanding in some applications. A column titled *Applications* has been added occasionally for addressing such issues. At the end of every experiment some thought provoking questions are also included. These questions are based on the procedures involved in the experiment. Many questions provoke pupil for relating their everyday life experiences with scientific principles. It is believed that such questions will be helpful in inculcating scientific temper and attitude among students. In these write-ups, it can be seen that the columns such as *Materials Required* and *Note for the Teacher* often address the issues related with the alternate materials and even alternate procedures that can be used for performing the experiment. It is however important to mention that the suggestions given for conducting the experiments are suggestive and may be modified depending on the facilities available in a particular situation. For example, if the material suggested for a particular experiment is not available, a suitable alternate material may be used. In addition to these experiments, a student may also conduct any other experiment of interest. However, it is important that every student of science must pay proper attention to the practical work and should try to acquire basic laboratory skills and develop a keen sense of observation and acquire a sound training in the reporting of the work done. Many experiments are so chosen that these can be performed using low cost and locally available materials without loosing the rigor

of science. The suggestions for maintaining the equipment have also been given wherever possible.

Questions at the end of each experiment may be dealt with meticulously and must be discussed with peers and teachers to arrive at appropriate and convincing answers.

1.1 General Laboratory Facilities

In a science laboratory, we usually find working tables, some items of common utility and space for storing equipment, chemicals and glassware. The working tables in a science laboratory are usually provided with–

- Sinks with water taps for washing purposes and liquid waste disposal. It is expected that the students will use taps only when required and will not waste the water. A regular cleaning of sinks is essential.
- Reagent columns for keeping bottles of chemicals and reagents of frequent use. These reagent bottles are arranged in a definite order.
- Heating facilities provided in the form of gas taps fitted with a burner or spirit lamp. A gas tap should be opened only when the gas is required for lighting the burner. Leakage, if any, should be immediately brought to the notice of the teacher or other laboratory staff. Every laboratory must be equipped with a few fire extinguishers fixed at convenient places.
- In the science laboratory, the equipment and glassware of common use are stored separately in an almirah. They are generally issued to the students at the time of performing experiments.
- In some laboratories, equipment like balances and microscopes may be permanently placed in a place as these are used quite frequently. The type of balance used depends on how accurate the weighing must be and what to balance? At secondary stage, a physical balance is a good choice. Teachers are advised to train students appropriately to use a physical balance before they are asked to perform experiment that requires weighing measurements (Fig. 1). For weighing powders or solid materials, one must use weighing tubes or butter paper depending on the nature of the material. The pan of the balance must be kept clean. The microscopes (Fig. 2) must be placed near the window to ensure the availability of sufficient sunlight needed.
- A water distillation plant should also preferably be installed in the laboratory. However a proper arrangement for water supply and drainage should also be made close to the place of installation of distillation plant. Ensure the water supply through the plant before switching ON the electric power.
- Provision for fuming hood or exhaust may be made in the laboratory for gases.

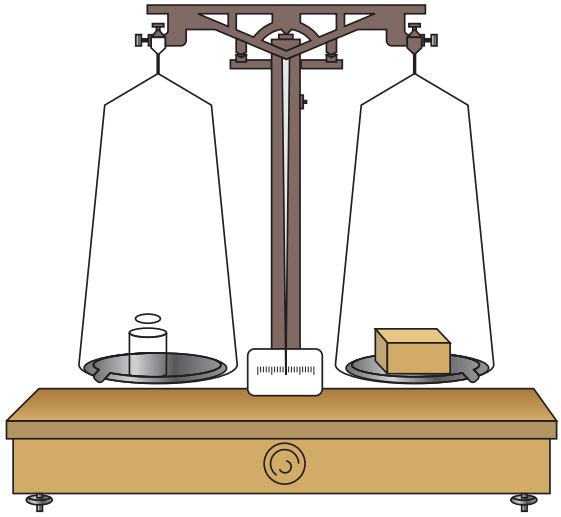


Fig. 1 : *A physical balance*

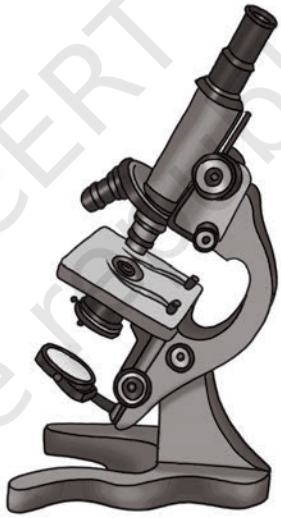
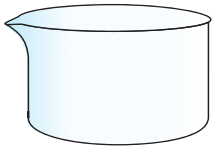
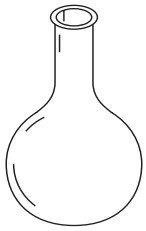


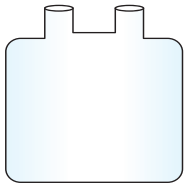
Fig. 2 : *A compound microscope*

- Electrical connections must be provided with all working tables for performing electricity and magnetism experiments.
- Utility items like soldering rod, hammer, drill machine with drill bits, pliers, hacksaw, cutter, screw driver set, spanners, torchlight etc. must be placed at a convenient place inside the laboratory. Common electrical measuring devices such as a multimeter may also be placed.
- A demonstration table is relevant for teacher demonstration.
- For the purpose of disposal of solid waste, a dustbin may be provided either near each working table or at a common place in the laboratory.


Plastic squeeze bottle (wash bottle)

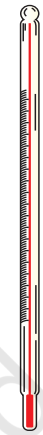

Trough


Round bottom flask

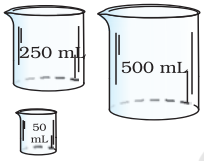

Woulfe's bottle


Petridish


Coverslip


Thermometer

Bar Magnet



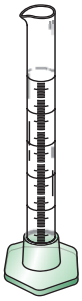
Beakers


Convex lens

Concave mirror


Slide

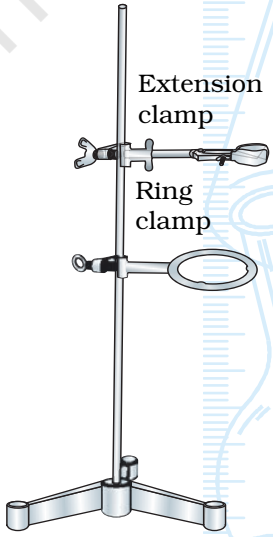

Test tube


Measuring cylinder

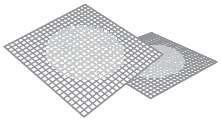

Boiling tube


Delivery tube

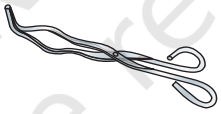

Test tube holder



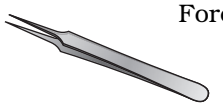
Laboratory stand

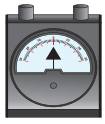

Wire gauze


Tripod stand


Crucible tongs


H-base burner

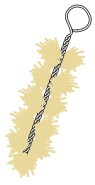

Forceps


Galvanometer


Magnifying lens


Sprit lamp


Rheostat


Test tube brushes


Stopwatch

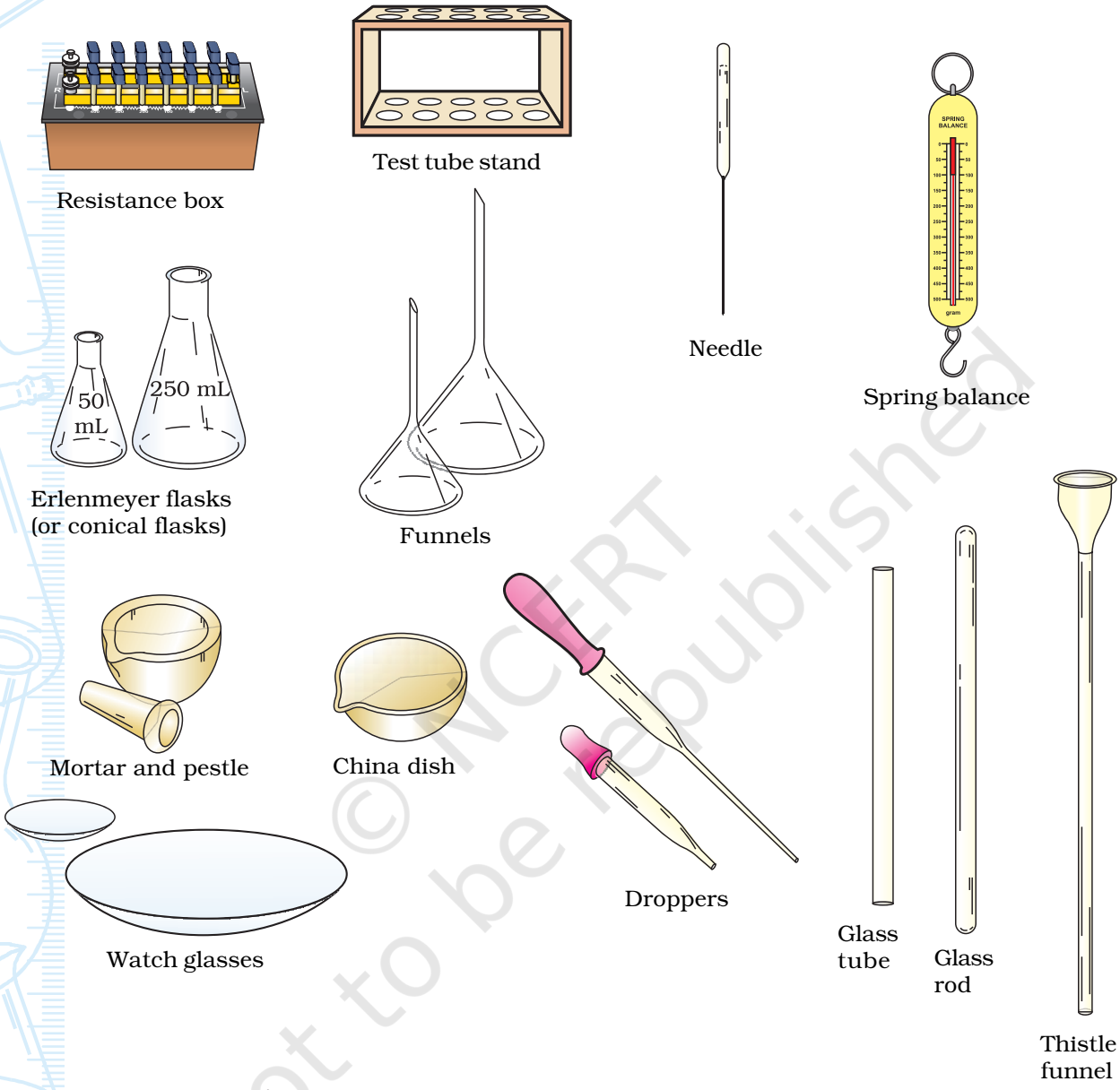


Fig. 3 : *Common laboratory equipment and glassware*

- Equipment, glassware, and reagent bottles are kept at proper and specified place. Some of the common laboratory equipment and glassware are shown in Fig. 3.

1.2 Preparing Students for Laboratory Work

Students must be groomed for laboratory work and experience in order to benefit from them. Students must know why they are expected to participate

in an activity and what they will derive from it. Science teachers are expected to facilitate students in arranging pre-laboratory discussion, giving directions, and post-laboratory discussions.

Pre-laboratory discussion must give students the clearest possible picture and understanding of what they are to do in the laboratory. This will help the students concentrate on what they are doing and make the experience more meaningful. If special equipment or difficult procedures are involved, the teacher should show the students how to use the equipment and procedures. Pre-laboratory discussions should be as concise but meaningful enough to thoroughly orient the students in the laboratory work. Sometimes these discussions are given a day before the laboratory period to give students plenty of time for the assigned laboratory activity.

The directions for laboratory exercises must be explicit and clear. They can be given orally or in written form or discussed during the pre-laboratory session. Sometimes it may also be helpful to summarise directions on the blackboard that have already been given.

Students should present and analyse their data during the post-laboratory discussion. Here the information can be analysed and related to the objectives of the experiment. The post-laboratory discussion is very helpful in broadening students' understanding the content and processes of science.

1.3 General Laboratory Rules

In a science laboratory, the following rules are to be observed by all users–

- Students prepare in advance for the experiment they would perform in the laboratory.
- Students must accompany/carry their practical notebook, laboratory manual, geometry box, pencil, sharpener, and eraser to the practical class. They should also wear laboratory coat or apron, if available, while working in the laboratory.
- Students follow strictly the instructions given by the teacher and perform the experiments carefully at the allotted places. They should not move around unnecessarily in the laboratory. The teacher may be consulted for any help or guidance. Disposal of reagents must be done with care.
- All equipment such as microscope, physical balance, measuring items and glassware must be handled with care and after understanding their functions.
- Labels on the reagent bottles should be read carefully before using. The reagent bottles and chemicals must be kept back at their specified places after use. Cap the bottle with the stopper immediately after using a chemical reagent. To prevent contamination of reagents glass rods, filter papers, dropper should never be dipped directly into the

reagent bottles. Partially used material should not be poured back into the reagent bottles.

- The mouth of the test tube should not be pointed towards any pupil including you while heating or adding a reagent (Fig. 4).

Fig.4 : *Correct method of heating a boiling tube and to know the smell (or odour)*

- For smelling the vapours, fan the vapours gently with your hands towards the nose (Fig. 5). Avoid direct smelling of chemicals or vapours.

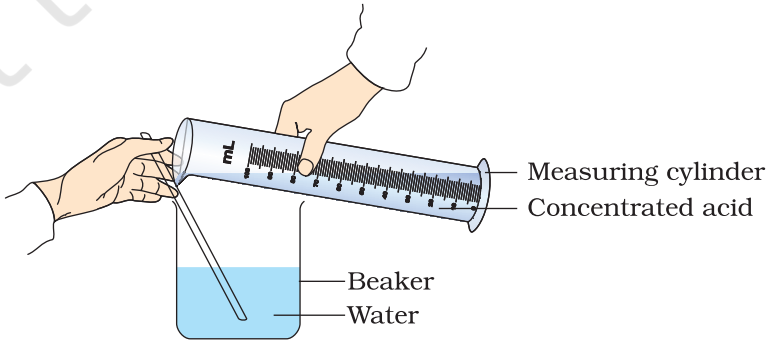


Fig.5 : *Correct way of adding acid to water for dilution*

- Acid is diluted by adding water. Never add water to acid. (Fig. 5).
- Do not handle chemicals with hands and do **not** taste any chemical.
- Keep your working table and surroundings clean. Replace all laboratory equipment to its assigned place in the laboratory once the practical work is over.
- Do not eat or drink in the laboratory. Always wash your hands after the laboratory class.
- Be acquainted with the handling of first aid kit and fire extinguisher. In case of any accident or injury or breakage of apparatus, report to the teacher immediately.

1.4 First Aid Treatment

A first aid kit is an essential part of any science laboratory, which is placed at an easily accessible place. Accident occur in the science laboratory mostly due to the lack of attention. In such a case, first aid treatment must be provided immediately. The victim should be taken to the doctor, if required. Some common injuries caused due to accidents and their first aid treatments are given below.

Burns

In the laboratory, burns can be caused due to steam, hot water, acids or alkali. The first aid treatment required for burns caused due to each one of them is different. The first treatment to be provided for some of them is as follows–

- For burns caused by steam or hot water, wash the affected part with cold running water. Do not use ice. Once the affected part is cool, dry it gently with clean cloth and then apply an antiseptic ointment.
- For an acid burn, wash the wounded part with water and apply a dilute solution of sodium hydrogen carbonate. Wash again with water. Dry gently with a clean cloth and apply an antiseptic ointment.
- For an alkali burn, wash with ample of water to remove all the alkali and then wash with dilute acetic acid. Dry the affected part with a clean cloth and apply an antiseptic ointment.

Glass Cuts and Wounds

Carefully remove all the visible pieces of glass from the wound. Protect the wound from dirt and dust. Wash with cold water to remove smaller pieces of glass sticking to the wound, if any. Control the bleeding by pressing a clean piece of cotton or cloth on the wound. Apply on antiseptic solution antiseptic cream. Take the victim to the doctor, if required.

Eye Injuries

In case of injury to eyes, wash the eyes with cold water. Do not rub the eyes. Consult the doctor immediately.

Fires

One should not run around if clothes catch fire. Immediately lie down on the floor and roll. If a container with inflammable liquid catches fire while heating, turn off the gas burner immediately, and take the container away from all reagents and chemicals. Cover the mouth of the container with a damp cloth. Fire extinguishers should be used if the fire goes out of control. In case the fire is because of the short-circuiting of electrical circuits, switch off the main switch of the electric supply and through soil in the affected area. Do not use water in such a case.

Inhalation of Gases

If gases such as sulphur dioxide, chlorine or bromine are inhaled by any student, take the student at once to the open air and let the victim breathe deeply and then ammonia vapours. If the gas inhaled is ammonia, drink any fruit juice or lemon juice. Inhale dilute ammonium hydroxide if acid vapours are inhaled.

Report the accident to your teacher immediately to get the medical attention at the earliest.

1.5 Recording of Experiment

Preparing a report on each practical performed in the laboratory and maintaining a record of the work done is an essential requirement. The report on each experiment should be such that it informs all steps involved in performing the experiment and the result obtained. It is therefore imperative that the report on an experiment should be presented under different headings so that it is easily understood. A format for presentation of report is suggested below.

Aim

It should explicitly state the objective of the experiment.

Theory

It must explain the basic principle(s), laws or theories on which the experiment is based or which it is meant to verify. Wherever necessary, the

fundamental laws involved in the experiment should be supplemented with mathematical formulae or equations or with neat and labeled diagrams.

Materials Required

List all equipment, measuring devices and other items or materials to be used for performing the experiment.

Procedure

Various steps followed in carrying out the experiment should be mentioned sequentially under this heading. Labeled diagrams, if any, should be drawn to present a pictorial view of the experimental set up.

Observations

All observations taken while performing the experiment must be recorded as observed and properly. This may be in a tabular form, drawings, or statements or a combination of them depending on the nature of the observations. All measurements must be expressed with their proper units.

Calculations

In case, calculations based on the observations are required to obtain the result of an experiment, correct formulae and units must be used while substituting the data. All calculations must be carried out carefully. The result or the answer should be stated with proper SI units. In some experiments, drawing of graphs may also be required as a part of calculations.

Results and Discussion

All results and findings of an experiment must be stated in clear and unambiguous language.

Precautions and Sources of Errors

All the precautions taken or observed while performing an experiment should be noted and the same should be stated in the report. Although some of the precautions taken during some experiments may be common, these usually change from one experiment to another depending on the nature of the experiment, the available facilities and equipment. In addition

to precautions, the possible sources of errors (that arise because of limitation of equipment, due to change in atmospheric conditions or any other reason) should also be stated.

The report on each experiment must begin from a fresh page and a proper index of the experiments performed should be made in the beginning of the practical notebook.