Management of a science laboratory aimed to cover the qualitative and quantitative aspects of practical work. Better management of a science laboratory plays significant role in achievements of aims and objectives of laboratory work.

Looking into the Pakistani context, the research reveals that the main reason for lack of interest and enthusiasm among students towards the laboratory work in our poor management of laboratories. Unfortunately our laboratories are not providing congenial working environment to the students and teachers.

This unit will cover many important aspects of laboratory management ranging from staffing to the maintenance of equipment and materials. Special emphasis has been given to the laboratories of Physics, Chemistry, and Biology. Management of a science laboratory, as in any enterprise, is of vital importance requires special attention by all those who are using it. Good management of s science laboratory will help to ensure that the laboratory achieves its intended purposes to enhance and consolidate the theoretical science teaching in classrooms. On the contrary, if a science laboratory is poorly managed, it is only will fail to achieve its intended purposes but will probably affect the student’s interest and enthusiasm in learning science. Such a sad state of affairs should be avoided considering the importance of science and technology in this modern world and the tremendous amount of money incurred in building and furnishing laboratories.

It is generally observed that in South East Asian countries, laboratory management is seldom included in the normal curriculum for both the pre-service and in-service training programme for teachers. This usually leads to the situation in which science teachers are unaware of the importance of proper laboratory management and misunderstanding in the work arises out of this. It is hoped that this chapter will furnish the readers with enough knowledge on proper laboratory management and it is strongly suggested that the individual countries will take the initiative to see that all those involved in the use of science laboratory be given proper and adequate training in laboratory management.

**OBJECTIVES**

After reading this unit, it is hoped that you will be able to:

1. prepare the budget and procure the equipment and material for laboratories
2. preserve and store the materials
3. inspect and repair the laboratories equipment
4. establish science library in laboratories

**2.1 Staffing**

In a normal, reasonably-sized secondary school the staff for the science department consists of the following:

1. Headmaster or Principal
2. Senior Science Teacher
3. Senior Subject Teachers
4. Science Teachers, and possibly
5. Laboratory Assistants or Attendants

As science laboratories are only part of the whole school administration, the headmaster is therefore responsible for the overall supervision of the laboratory management. His duties are those that are normal for a head of the school administration, that is, to see that the laboratories are properly managed so as to create an atmosphere conducive to the teaching and learning of science. He has to make decisions on all the matters connected with the laboratories and this he does with frequent consultations with the senior science teacher.

The senior science teacher is the most important member of the people that work in the science laboratories. He is the right-handed man of the headmaster and has to give advice to him indecision-making process. He must have the expertise on all matters related to the science laboratory. Generally, he has to see that all instructions and rule, issued by the school authorities.

Are strictly adhered to by all the staff of the science laboratories. He has to make sure that all the laboratories are well looked after and equipped. He is responsible to the headmaster only.

Usually the school administration appoints senior teachers for each science subject taught in the school. And the school science laboratories are normally categorized into Biology laboratory, Physics laboratory, Chemistry laboratory/Integrated Science laboratory and General Science laboratory. In such a case, a senior subject teacher to look after the administration of his assigned laboratory or laboratories, he is solely responsible to the science teacher.

The next group of laboratory staff is the other science teachers who make use of the laboratories for their practical lessons. Even though they may not be officially assigned any specific duty, nevertheless they are required to supply information to the various senior subject teachers and senior science teacher on any need in the laboratories. They should be immediately answerable to the senior science teacher.

**Fig.2.1: Staffing in the Science Department**

The last category of laboratory staff is the laboratory assistant and attendant who will be incharge of the cleanliness of the laboratory, supplying and setting up apparatus for any practical lesson, cleanliness of apparatus and any other odd job assigned by the senior science teacher. He should be answerable to the senior subject teacher who is incharge of the laboratory.

It should be pointed out that generally schools in South-East Asian countries face an acute shortage of laboratory attendants. In some schools, there is not even a single laboratory attendant and the science teachers themselves have to do all the odd jobs in addition to the already over-loaded teaching schedules.

**Self Assessment Questions**

Q.1: Write duties of Senior teacher and laboratory assistant.

Q.2:What do you know about staffing?

**2.2 Finance**

For the operation of any enterprise, financial resources must be available to meet all the financial requirements. The school science laboratories are of no exception. The laboratories need financial aids or grants to meet all the operational costs involved in the management.

In Malaysia, Singapore, Thailand, Indonesia, Philippines, and Pakistan the government aided schools rely mainly on their governments for financial assistances. The amount of science from a government normally depends on the enrolment pupils in the school and also on the categories of pupils and types of science subjects taught in the school. In cases when a new science curriculum is introduced to a school, this school will normally receive a special grant and also some expensive and new equipment necessary for the new science curriculum. Other than subsidy from the government, a school also channels some of its private fund to the science department. This private fund is either raised from fund raising projects of the school or from donations by the public and charitable organizations. In special cases like in Singapore, the government is responsible for bearing the initial cost of building and equipping new science laboratories. Subsequent financial resources for maintenance of the laboratories will be from 10% of the total pupil’s tuition fees.

Generally teachers in the member countries of SEAMEO feel that the science grants allotted by their governments are not enough to meet the ever rising prices for science equipment and apparatus. Furthermore the increasing emphasis on practical work in science teaching has increased the demand for more sets of equipment in the laboratories.

**Fig. 2.2: Financial resources of school science fund**

**2.3 Budgeting**

With the limited and insufficient amount of science grant allotted, it is of vital importance to ensure that every cent of it is well-spent on essential items and to avoid purchase of equipment and apparatus that are not essential for practical science teaching. It is not uncommon to find in some science laboratories that certain items of equipment are over purchased in quantity: whereas there is a great shortage of other important equipment. It is also found that some equipment or apparatus need not be purchased as they can either be easily improvised or substituted by cheaper materials. Indeed there are other instances that indicate clearly that money has not been well-spent. This is quite a sad state of affairs and the main reason for this is poor budgeting.

In simple terms, budgeting is a process that involves systematic planning of expenditure of a certain amount of allotted money. It is a process that needs careful and serious considerations so that the allotted money is utilized to achieve maximum benefits.

Budgeting for science laboratories should always be done two or three months before the end of the school year so that sufficient time is given for preliminary considerations, deletions/additions, finalization, subsequent ordering and purchasing so that can be available in the beginning of the coming year for use in the laboratory. The senior science teacher and the various subject teachers are responsible for preparing the overall budget and final decision will be in the hands of the headmaster who usually consults the teachers first before making any decision.

The sequence of actions for preparing a budget for science laboratories is suggested below; it is in no way a standard procedure. It may be varied according to different administrations of schools.

1. Check all the stocks in the laboratories to ascertain the quantity of stock available for every item.
2. With the help of the science teachers and the laboratory assistants and attendants, each senior subject teacher will have to find out the following information:
3. The annual consumption of all consumable items.
4. Which period of the year a consumable item is usually required for use;
5. The types of apparatus that are in acute shortage;
6. New apparatus is required for the coming year and
7. Items of equipment and apparatus that have been damaged or stolen.
8. To obtain information on the projected enrolment of science students in the school for the coming year.
9. Each senior subject teacher will have to check the remaining facilities of the laboratories under his supervision other than apparatus and equipment. These remaining facilities include water supply, electricity supply, gas piping, furniture and others.
10. To check the current prices for all the items in the laboratories and to make projections on the prices for the coming year.
11. With information obtained step 1 to 5 and after consultation with the science teachers concerned, each senior subject teacher should then prepare a list of goods needed for the coming year. The list should include the type of equipment, its model and the quantity required, together with the expected expenditure. Preferably the list should also indicate the time of the year when an item should be purchased. The list of requirement should generally include the following:
12. Consumable materials
13. Capital materials
14. Glassware, plasticware and metalware
15. Biological specimens and slides
16. Gas, water and electricity supply
17. Office equipment
18. Furniture
19. Science books
20. Workshop tools and equipment
21. Miscellaneous
22. A meeting should probably be called among the headmaster, senior science teacher and senior subject teachers to discuss critically all the requirements submitted. With the knowledge of the amount of science grant available for the coming year, the meeting should decide and select all the items to be purchased. In considering this, it must be remembered that some funds have to be allotted for miscellaneous purposes and contingencies.

**SAQ 2.2**

**Q.1: Give short answers to the following:**

a). What is financing?

b). Write difference between financing and budgeting.

Q.2: Explain procedure of budgeting for laboratory.

**2.4 Guidelines in Preparing Lists of Requirement**

In preparing lists of requirement, the sensor subject teacher should consider carefully the following points:

1. What items are urgently needed?
2. What items can be improvised?
3. What items can be substituted by cheaper ones?
4. What items can be replaced by unwanted items from home, shops or schools?
5. What maintenance service can be performed by pupils?
6. What items can be made by the science clubs?

**2.4.1 ORDERING AND PURCHASING**

Purchasing of goods for science laboratory is usually handled by the headmaster but in certain cases, the senior science teacher is given such responsibility because of the heavy duties of the headmaster and also because the senior science teacher has a better knowledge on the nature of the items to be purchased. Nevertheless all correspondence, including payments, must be signed by the headmaster and not the senior science teacher.

Before an item is purchased, it is important to know the amount of science grant still available at the time of making the purchase and also the amount of money approved for expenditure on the item as approved in the budget. Permission must be obtained from the headmaster, if the purchase is over the amount of money approved.

The following are some important considerations connected with purchasing of scientific items:

1. It is important to ascertain that the item to be purchased is not in the lists of government contract items. Usually the government makes contracts with certain firms to supply certain items in bulk at reduce prices. The lists of contracts items are normally circulated to all schools. It is much cheaper to purchase the items from the contract firms. However the normal snag is the time of delivery. Orders have to be made well in advance and goods usually arrive rather late. Sometimes the goods are not up to standard. However it is the standing ruling of the government that where an item is in the list of contract items, such an item must be purchased from the contractor. As such, the school has to adjust its time of purchase so that the goods can be delivered in time for use.
2. Purchase of an item can either be in bulk or in small quantity at a time. Purchase in bulk is often much cheaper than purchase in small quantity. The main deciding factor as to what type of purchase to be made is the nature of the item itself. Usually it is not advisable to make bulk purchases for chemicals because their qualities tend to deteriorate with time. Apparatus like glassware, wire, lenses, mirrors and others should preferably be purchased in bulk. Neighbouring schools in a region can group together to purchase an item in bulk in case such an item is required only in small quantity by the schools concerned.
3. The purchase of an item is to be considered carefully. Because of their unique nature, chemicals have to be purchased at different times accordingly. Some chemicals are required fresh and as such must be purchased only when they are needed. Some chemicals cannot be kept too long and their purchases can only be made when the stocks run to the minimum. For apparatus and teaching aids they can be purchased at any time of the year. But because the science grant from the government is issued quarterly to the school, a decision has to be made as to what apparatus to be purchased first.
4. Items are usually more expensive when they are purchased from companies that deal mainly with scientific equipment. As such, they should be the last sources of suppliers to be looked for. Efforts must be made to look for other potential suppliers such as electrical shops, retailers, junk shops, bicycle shops and many others. For example, ball bearings can be obtained at low prices from bicycle shops. Mirrors can be obtained free from junk shop. Indeed quite a number of items can always be obtained from this type of suppliers at cheaper prices than the normal suppliers of scientific equipment. Science teachers should help the school in this matter to save money for other important purchases.

**2.4.2 Procedure of Purchases**

The following is the normal procedure involved in the purchase of scientific items.

1. **Quotations**

When certain items are not available from sources other than agents for scientific equipment, the normal practice is to write to all the local agents for quotation of prices for the items required. It is important to include in the letter complete details and specifications of items required, including the quantity to be purchased. If items are found in catalogues of certain companies, references to catalogue numbers must also make. The letter should also specify the date by which the quotation should be sent to the school. Carbon copies of every letter sent should be filed.

1. **Selection of Suppliers**

When all the quotations have been received, the next important task is to select the suppliers. Usually different suppliers are;

An example of a letter calling for quotations might be selected for different items. The price of an item is, of course, the key factor in the selection of supplier. However, qualities of goods, reputation of supplier and after-sale service are also important factor to be considered requests can always be made to suppliers to send samples of items for careful inspection of quality. This should always be done if the purchase involves a big sum of money. Consultations from local science teachers associations, science education officers and colleagues from neighboring schools can be made in the process of selection of suitable suppliers. All quotations again should be filled.

1. **Ordering**

After the suppliers have been selected, order forms should then be sent to them. A carbon copy of every order form should be properly filed.

1. **Acknowledgment**

A company will send an acknowledgment letter to the school once it has received the order form. This acknowledgement letter should be filled together with the order form.

1. **Delivery Note**

When the company is ready to deliver goods, a delivery note will be sent to the school stating the time and date the goods will be sent to the address as written in order form. The delivery note also spells out the items and their quantities to be delivered. The senior science teacher, upon receipt of the delivery note should make arrangement to receive the goods. The delivery note should again be filled together with the rest of documents.

1. **Receipt of Goods**

Three copies of delivery notes, same as above, are usually accompanied together with the goods to be delivered. If time permits, all the goods must be checked thoroughly against order forms before endorsing the delivery notes are sent back to the supplier and the other copy kept by the school.

Usually the suppliers send the goods in cartons or boxes through a transport company. In such a case, only endorse receipt of the correct quantity of cartoons or boxes as issued by the transport company. Do not endorse on the accompanied delivery notes because once they are endorsed, this automatically implies that goods are received in good condition and no further claim will be entertained by the supplier. Open the boxes or cartoons as soon as possible and check all the items against the specifications in the original order form. If the goods are up to specifications, the delivery notes will be endorsed. In case of any anomaly in the goods supplied, the supplier should be first notified by phone and immediately followed with a letter stating clearly the complete details of the anomalies found. Do not endorse the delivery notes until all the anomalies have been corrected.

1. **Invoice**

Upon receipt of endorsed delivery notes, the company will send the invoice together with copy of endorsed delivery note to the school for payment. The senior science teacher should check the invoice against the previous quotations from the suppliers. The invoice will then be passed to the school office e for payment.

**SAQ 2.3**

Q.1: Give short answers to the followings:

a) What is importance of invoice?

b) What is difference between delivery note and acknowledgement.

c) Give a list of articles which can be bought without following purchase procedures.

Q.2: List points of considerations while preparing a demand list for laboratory materials.

Q.3: Give a comprehensive note for the procedure of purchase.

**2.5 Storage and Preservation of Materials**

**Types of Stores**

In most secondary schools, there are found two types of stores namely the main stores and the dispensing stores. For the science section, there is a main science store and the materials housed are applicable to the science teaching in the school. Petty issues to individuals are not allowed from the main store. The main science store only issues out complete containers and case to individual dispensing stores such as the Biology, Chemistry, and Physics stores. The dispensing stores, located at each laboratory, are set up mainly for the purpose of issuing out equipment and apparatus to students at that particular laboratory.

**Characteristics of Stores**

Ideally the main science store should be located at the rear of the building and at the ground floor convenience of delivery of goods. The store must be large enough to accommodate all the necessary stock and yet leave ample room for trolleys to move about.

Good lighting is essential in the store. The fittings must be placed high enough above the stacks to give good distribution of light in the day and should wherever possible be spaced between stacks so as to give illumination to the gangway.

All necessary safety precautions must be adopted in the stores.

**2.5.1 System of Location of Items**

In the laboratories, storerooms, preparation rooms and workshops, there are always found storage spaces such as cabinets, cupboards, shelve s, racks, side bench drawers and many others. The types of facilities vary according to different schools. Nevertheless, all the storage spaces must be clearly labeled to indicate the types of materials being stored. Besides clear labeling, the storage spaces must be suitably coded. By this it means every storage space is given a code and this is a means of locating the item in the process of stock-checking. For example, there may be five cabinets in Physics laboratory number one and five more in Physics laboratory number two. No doubt, all the items contained in the cabinets are clearly indicated on the outside of the individual cabinets; but in the process of stock-checking, it is often more convenient to check every item in accordance with the stock-cards which are usually arranged in alphabetical order and also contain information on location of every item in a coded form. For example, 10 ohm resistors may be located at PIC3. This code means the resistors are kept in Physics laboratory number 1 and cabinet number 3. Hence any person doing stock-checking cans easily pin-point the location of any item. The types of codes used may be different but they must be simple and do not cause confusion.

Coding of storage spaces not only helps in stock-checking but also helps solve some teething problems. Too often it is found that only the laboratory attendant in a particular laboratory knows where items are kept. A science teacher who needs any set of items is too used to inform the laboratory attendant and get them from him. Troubles usually arise when this laboratory attendant is on leave or being transferred. No one seems to know where a certain piece of item is kept and the poor science teacher has to hunt every storage space to locate for this item. Sometimes a certain experiment has to be abandoned because a particular item cannot be found. Such a thing would occur if the storage space is properly coded. The science teacher has only to check the stock card for location of any item.

But one implementation rule that must be strictly adhered to is that every item that has been issued must be returned to its original position after use. If such a rule is not observed, items may be then misplaced and it is extremely difficult to locate them again especially for small items like capacitors, resistors and others.

**2.5.2 Important Documents in Stores**

Important documents in the stores must be properly filed and kept in locked cabinets. Except for the laboratory staff, no other persons should be allowed to have access to these documents unless with prior permission from the senior science teacher. References to these documents should only be carried out in the laboratories and loaning them out of the laboratories should be discouraged unless it is absolutely necessary.

The following are some of the important documents usually kept in the stores:

1. Quotations
2. Orders
3. Acknowledgement letters
4. Delivery notes
5. Invoices
6. Instructional manuals
7. Catalogues
8. Pamphlets
9. Stock-cards
10. Others

Except for stock-cards, all the documents above are common documents and needed no further description. Stock-cards are the most important documents in the stores as they contain relevant information to every single item kept in the store. An involved system of recording is unnecessary as paper work must be kept to a minimum. Nevertheless they should contain enough relevant information to all the items kept in the laboratory.

Stock-cards are usually arranged in alphabetical order and it is useful to separate chemicals from the other apparatus, that is, there are two types of stock-cards, one for chemicals and one for apparatus and equipment.

**2.5.3 Chemicals**

It is necessary that chemicals should be segregated from other equipment and apparatus. When it comes to the matter of storage, this is necessary because of the unique nature of the chemicals such as hydroscopic, poisonous, deliquescent and others generally chemicals may be grouped under two main categories: Inorganic and organic.

Because chemicals tend to deteriorate with age, a constant check at regular intervals on their condition of stock is, therefore, necessary. The old stock should be used up before the new and in this respect the easiest way is to stamp (or write) the date on each bottle as it is received and to place the new stock at the back of the shelves.

For dangerous chemicals, it is important that they should be clearly labeled and stored under lock and key in special cupboards. Periodic checks on these bottles for dropping or fading of labels are required and replacement made if necessary. Chemicals are stored in alphabetical order.

**a) Inorganic Chemicals**

 These should be arranged under the name of the metal. The shelves should be labeled accordingly. Double compounds such as ammonium nickel sulphate or ferrous ammonium sulphate or ferrous ammonium sulphate tend to create some confusion but this can be overcome if the normal method of labeling, as adopted by the suppliers of chemicals are placed in the shelves accordingly, in any case such as matters are put right by the adoption of a procedure suitable to the store and by cross reference and location marks on the stock cards.

The prefixes to the names of chemicals, such as di, tri, ortho, and meta are ignored for storage purposes and such chemicals are stored in the normal way under the name of the metal.

For example, triammonium orthophosphate would be stored with the ammonium compounds. Ferric and ferrous are stored under the metal iron.

**b) Organic Chemicals**

Organic chemicals present much more difficulty storage of these chemicals in classes such as alcohol, ether and acid may be convenient for the selection of substances or certain class exercises, but the system is not convenient for storage purposes, organic chemicals should be kept in alphabetical order in employing this system the prefixes such as o, m and p are ignored. Other prefixes, however such as di, and tri, should be taken into account for purposes of alphabetical location. This is generally done m suppliers catalogues so that if the normal system of the chemical supplier is adopted it simplifies the store arrangement.

**c) Glassware**

The size of the items of glass apparatus stored should be standardized as for as possible. They should not be placed too high and mixed with heavy apparatus or metal articles. Tall glass apparatus should be stored at the back of shelves and smaller pieces in front. Special pieces of glassware, for example, Kipp’s apparatus, are stored as far as possible in their original packing and paper containers. Make sure the packages are labeled.

Glassware is stored according 10 its type and size. All flasks, for instance, should be stored in neighboring bins but separated according to size. Flat bottom vessels may stand upright but round bottom vessels should be stored in a bin with high front small glassware, such as clock glasses, specimen tubes, Petri dishes and microscopic slides, are best kept in shelf trays. Burettes require a long padded drawer or a stand. All expensive glassware should be separately packed in soft wadding. Thermometer should be kept in their cardboard-cases and stored according to type and range.

**d) Glass Tubing and Rods**

Horizontal storage for glass tubing or glass rod is undoubtedly the best. The tubing must be well supported along its length to prevent sagging which is often noticeable in glass tubing which has been stored vertically large-diameter tubing’s must be plugged at the ends to keep out dust Soda glass and hard glass should be kept as far apart as possible.

Glass tubing should be stored by weight (i.e. light, medium and heavy wall) and each weight of tubing is stored according to STS outer diameter. It is convenient if a table of sizes, including wall thickness and allowed tolerances is hung close to the glass tubing storage racks. The tubing is normally delivered in 1.5m lengths and keeps much cleaner if stored in its original packing.

**e) Plastics**

Plastics apparatus should be stored away from heart sources if it is brittle, it should not be stored with heavy apparatus.

**f) Metal wares**

Metal wares such as clamps, boss heads, tripod stands, Bunsen burners should be stored together and they need periodic maintenance.

**g) Apparatus**

The numerous small items found in the laboratory are usually kept in drawers or trays. Optical items such as lenses, mirrors and prisms are kept in drawers with packets of silica gel to maintain dryness.

Bigger apparatus are always arranged in shelves. Those heavy ones are placed below and the lighter ones a top of the shelves.

**h) Electrical Parts**

Electrical equipment and components should be stored in a group, away from fumes and chemicals. Valves transistors and other delicate items should be wrapped in cotton wool and placed in individual casings.

**2.6 Inspection and Maintenance of Laboratories and Equipment**

The school laboratories house expensive science equipment and chemicals which could get damaged rapidly through dampness of ceilings and walls of store-rooms. Regular inspection on the laboratories and equipment prevent this. The senior science teacher can carry out regular inspections with the help of fellow science teachers. The frequency is at the discretion of the senior science teacher. Such efforts bring about efficient services to science teaching in schools.

The general practice in secondary schools is to appoint senior subject teachers to take charge of Biology, Chemistry and Physics Laboratories respectively. The senior subject teacher, who comes into regular contact with the equipment and apparatus, is the most suitable person to carry out inspection. The head should train the laboratory staff to carry out a major part of the inspection and maintenance work. A separate book, equipment inspection book, should keep track of the maintenance work done on faulty equipment.

**2.6.1 Laboratory Inspection**

**a) Inspection Book**

 For each laboratory inspection a record must be made in the laboratory inspection book of repairs to be done on items like windows, gas taps and furniture.

Action must be taken immediately as delayed action could result in further deterioration in the condition of the item, and then a major repair will be necessary.

**b) Paint-work**

Carry out touch-ups of paintwork of the laboratories and facilities to check deterioration until the usual general painting carried out by the Ministry of Education.

**c) Lighting**

Most school laboratories have glass louvers. When glass panes are used, sunlight gets in, heating up the science laboratories, and the reflection of light from bench tops can give distracting glares. The use curtains or bamboo blinds overcomes this problem.

Laboratory doors are required to be kept open at most times. Too often the doors are closed because the door hooks, which have been damaged, have not been replaced. Closed doors shut out light and cut ventilation and can cause safety hazards.

Faulty ceiling lamps must be attended to immediately. In most cases the faults are due to fused bulbs, fluorescent tubes or spoilt starters. A stock of these items must be kept to meet emergency.

**d) Ventilation**

Science laboratories require good ventilation, especially the chemistry laboratories. It is good practice to keep louvers and doors open. Ceiling fans, suction fans and fume-cupboard fans help tremendously in the ventilation of laboratories. Therefore they must be kept in good operational condition. Ceiling fans require minimum operation care. They must be kept clean and when the regulators are worn out, get the contractor to change them.

Suction fans should be cleaned regularly and lubricating oil applied sparingly. Fume-cupboards fan units are normally sealed to protect them from corrosive fumes. It is important to switch on the fan regularly to keep them in good working order when a fan fails to work get it repaired immediately.

**e) Water System**

Most schools have piped water. The waste is carried off by galvanized iron pipes or plastic pipes. Where galvanized iron is used for drainage purposes, the pipes are corroded by concentrated solutions of chemicals and especially acids. These must be highly diluted before disposed into the sink. For plastic pipes, care must be taken in the disposal of organic liquids such as carbon disulphide, propanone and trichloromethane. These dissolve the plastic pipes. These liquids are best kept in a container and allowed to evaporate or disposed off on waste ground.

**f) Water Taps**

The taps should be trouble free. Regular change on a once a year basis of rubber washers should rule out leaking taps. This procedure is recommended because it cuts down the number of emergency changes of worn-out washers during laboratory lessons. It is important to carry a stock of rubber washers.

**g) Sinks**

Students have a tendency to throw solid and liquid waste into the sinks despite repeated reminders to stop the bad practice. One way good way to overcome this is to mount a strip of wood with three plastic containers.

It is found that students find it more convenient to use this system of disposal than the usual rubbish bins, hence less littering of the sinks. At the end of the working day the laboratory staff goes round to dear the containers.

Porcelain sinks are easily stained by chemicals. Stains marks are readily removed by rubbing with cleansing powder. A persistent stain however can only be removed by treatment with a mixture of equal volume of concentrated nitric and hydrochloric acids. Naturally care should be taken especially with fumes.

Sink traps need periodic cleaning out this reduces untimely yoking up of sinks during laboratory lessons.

**h) Drains and Pipes**

Most chemistry laboratories have central drains with cement slab covers. The drains require periodic flushing to clear the dirt and chemicals dropped in them. During each washing out remember to check on the gal vanished iron pipes lay along the drain. When they show corrosion carry out immediate maintenance work. Clean the corroded parts by sandpapering to bare metal and then apply two to three coats of good quality paint. Should the corrosion become excessive arrange for immediate replacement?

**i) Waste Sump**

Laboratory waste is usually trapped in a waste sump. Regular clean-out, say every 6 months is necessity.

**j) Gas System**

Most school laboratories have piped gas. Some schools have instead portable gas tanks of LPG butane gas and portable gas burners. LPG cylinders can be kept in cupboards under laboratory benches.

**j) Gas Taps**

Schools with piped gas have permanently fixed gas taps on bench tops. Generally each gas tap unit until will carry two taps. Problems arising from gas taps are:

1. A jammed stop cock

This is often due to poor lubrication or chemical corrosion. A jammed stop-cock is repaired by overhauling the tap. Remove the lock nut and spring assembly; gently tap the stop-cock from its socket. Use fine emery paper to clean the stop-cock and socket. Do not rub excessively. Smear a thin layer of lubricant on the stop-cock. Check that the hole is not blocked. Replace the stop-cock into the socket and replace the spring and nut assembly. Gas taps should be serviced regularly, twice 0 year, to prevent this fault.

1. Faulty-locking gas taps

Most gas taps have a built in locking system. Wrong fitting of spring and lock assembly can give a non-locking gas tap. This must be taken apart and fixed correctly.

Some gas taps have catches to stop the stop-cock at both open and close position. These can be broken and should be repaired as necessary.

**k) Gas Burners**

Most schools use Bunsen burners. These should be trouble free. Maintenance should include lubrication of the air regular and re-painting of long service burners. If a suck back occurs in a burner this is caused by the jet being either too high or too low relative to the air hole. This can be corrected by trial and error.

Portable gas burners are very useful, particularly in flexible laboratories. They provide hot flames and are ideal for most chemistry and science purposes. They can be maintained in a similar manner as Bunsen burners.

**m) Gas Tanks**

These keep signified butane at high pressure. The tanks are often kept in the open so regular checks of tanks, pipes and gas cocks must be performed. Grease the gas cock regularly. When a tank is empty switch on to the spare tank and contacts the rifling company immediately.

**2.6.2 Electrical Fittings and Appliances**

Electrical fittings and appliances need careful inspections and maintenance.

**a) Fuse Box**

Check the fuses to see that they carry the correct fuse-wires for their circuits. Often incorrect fuses are substituted through ignorance and this can cause a potential hazard in the laboratory.

**b) Socket and Plugs**

Bakelite sockets and plugs should be checked for cracks, and if found faulty they should be replaced. Typing with insulting tapes should only be a temporary measure.

Sockets must also be inspected to ensure that the wire terminals have not blackened through prolonged use or become loose. When a fused plug is used checks the condition of the fuse and replaces it if necessary.

Schools should carry stock of sockets plugs and fuses.

**c) Wires**

Most schools have a conduit electrical wiring system. In this case the wires are protected. However, if the wires are not in conduit a periodic checking of their conditions will detect any deterioration in wires.

The wires should be periodically brushed with a soft brush to remove any corrosive grit on their surface.

**d) Ovens**

Schools which have ovens normally use them for drying glassware, specimens or even the evaporation of chemical solutions. All these activities can damage the interior rapidly. Frequent checking and cleaning is essential. If the interior is corroded, clean the parts with fine emery paper and then repaint with good quality paint. Switch on the oven and bake the paint to dryness.

**e) Refrigerators and Freezers**

Regular defrosting of both refrigerators and freezers prolongs the working life of the motor and also helps to reduce electricity consumption. If the refrigerator is used to store volatile chemicals a careful check u\must be made of interiors. Corrosion is mainly found on metal grill supports and these must be repainted regularly.

The exterior casing of refrigerators and freezers can be corroded quickly in science laboratories if the outer paint surface is scratched or broken. Check and clean exterior surfaces regularly.

It may be necessary to top up refrigerators and freezers with Freon gas but the service company should be contacted, say every five year to do this.

**f) Distillations and Deionizers**

When an electric distillatory is used to produce distilled water frequent decaling of the heating element must be carried out. This decaling will improve efficiency and reduce electricity consumption.

Decaling is probably best done by treating the heating element with dilute mineral acid. When the cast iron exterior becomes rusty, sandpaper and repaints with aluminum paint. If a deionizer is used little maintenance is necessary. When the conductivity reading exceeds the specified value on the meter the resins should be charged as they are no longer effective as ion-exchangers. A new cartridge should be used and the old resin regenerated. It is a good practice to keep spare cartridges of resins.

**2.6.3. Laboratory Furniture**

The state of the furniture in the science laboratories is often a reflection of the extent of maintenance work being carried out. Benches, cupboards, chalkboards and curtains should be well maintained so that their appearance forms part of a pleasant environment for students to work in.

**a) Benches**

A well-maintained laboratory is reflected in the general appearance of benches and furniture. Tropical school laboratories usually have hard wood for bench tops and legs. The side paneling, drawers and cupboards are usually plywood or poorer quality wood. Bench tops are easily damaged by students dragging heavy objects over them, placing hot objects on them and leaving spillages of chemicals unwired. Such harsh treatment will result in unsightly bench tops. Good teacher supervision and instructions will help minimize damage.

Bench tops require at least once year maintenance. They should first be cleaned with detergent and water. The dry bench tops are then rubbed with fine sand paper following the grain of the wood. This should remove scratches and persistent stains. The finishing of benches may best be done in a number of ways:

Restoration of natural oils, all hardwoods have high natural oil content. Oils in laboratory bench tops are gradually lost. These lost oils can be replaced by rubbing on wax polish. This is preferred to linseed oil because the linseed oil can stain students clothing and books.

This treatment is good enough for bench tops in most laboratories but for chemistry the benches will probably require coatings that are not stained or corroded by chemicals.

Shellac and epoxy paint treatment. The dry bench tops are first coated with lacquer or shellac. This gives a tone to the bench tops. When this coating has dried rub over with dry sand paper. Clean and then apply epoxy paint. There are two main types; the normal epoxy paint is water proof and acid proof but not alkali proof. The activated epoxy paint costs more but is water proof, acid and alkali proof and is usually stain proof as well.

The disadvantage with epoxy paint is that the glass type finishing can blister from the heat from Bunsen burners if these are used on naked bench tops. Asbestos boards must be used whenever Bunsen’s are used on epoxy painted benches. With care the epoxy paint benches will last for more than two or three years. Cleaning of the benches is also much easier.

The plywood panels, cupboards and drawers on laboratory benches also need regular checking. Damp plywood will wrap and finally break up. Cupboards and drawers must be kept dry. Damp places also promote mould growth and provide breeding places for insects. The interiors of drawers and cupboards should ideally be lacquered. This will waterproof the interior and dirt can be more easily removed.

Students will often leave laboratory classes with the bench tops, drawers and cupboards littered and wet. Teachers should give surprise checks and make students stay back to clean up. Rags should be provided for cleaning up and teachers should insist on spillage being cleaned up immediately.

**b) Stools**

Stools are usually made of hardwood tops with wooden or metal legs. Maintenance of stools will usually consist of sandpapering and re-painting or lacquering.

It is often a good practice to stick pieces of rubber to the bottom of stool legs. This will reduce the noise level caused by shifting and dragging stools across the floor. Strong epoxy glue is recommended.

Stools with rubber studs should be checked regularly and where necessary the rubber studs should be replaced. It is advisable to carry a stock of these studs.

Broken stools should be repaired as soon as possible. Students should be instructed not to rest their weight on one or two legs of their stools. This if enforced will reduce breakages.

**c) Chalkboards**

Students usually get their instructions from chalkboards in laboratories. These are important items and must be maintained and adequate light provided.

Chalkboard paints may fade after long usage. The board should be washed with detergent and water and when dry, rubbed down with fine sandpapers and re-painted with gtreen or black chalkboard paints.

Avoid the use of thumbtacks to post charts up on a chalkboard. Sticking tape or masking tape can be used. A soft felt or soft cloth bundle for erasing chalk marks is best. Rough materials will soon scratch the surface. When washing the chalkboard use a minimum of water. Water may be soaked up and wrap the chalkboard.

**d) Cupboards**

It is cupboards supplied preferable to have built-in along the walls but ordinary seems to be more commonly cupboards should have glass doors which allow easy identification and checking of apparatus and glassware and allow entry of light. In the absence of light moulds will grow rapidly on apparatus and glassware. This is particularly true in humid conditions.

Cupboards should preferably be lacquered inside as well as outside. This makes cleaning easier and at the same time waterproofs the wood. Periodic cleaning of the cupboards will rid them of dust as well as insects. This acts as a check for termites. Dirty glass doors can be cleaned with a solution of dilute ammonia in methylated spirits.

If the cupboards have Socks lubricate them to prevent rusting and jamming. Regular painting will ensure long service.

**e) Display Cupboards**

Some schools have display cupboards for highlighting student’s science projects or for enriching the students with materials or recent discoveries. Such cupboard should be kept in a convenient place for students to see, inevitably the glass covers get dirtied by students so regular cleaning with ammonia-methylated spirits must be carried out. The exhibits should be changed at intervals to maintain student interest. Display cupboards need a new coat of paint or lacquered at regular say yearly intervals.

**f) Notice boards**

Notice boards supplement the function of display cupboards. Most schools have uncovered notice-boards made of soft board. These tend to become damaged after long periods of use. It is quite easy to replace the soft board and paint it in the desired color.

Large Styrofoam sheets make good notice-boards. Styrofoam is not damaged by water. Notice-boards should be used by teachers to assist them in effective science teaching. Notice boards can be used to display current science events and newspapers clippings and to provide an exhibition place for science projects.

**g) Curtains**

Curtains are mainly used in the dark room and physics laboratory where some light experiments can best be carried out in dim sight.

Truck black or dark colored cloth may DC difficult to get or if they are available they are expensive. Normal, brightly colored materials can be used but they should be backed with ordinary black material. The curtains are best hung with the colored side facing the outside and the black cloth lining facing inwards. Such an arrangement will give a dark laboratory when needed, and a colorful exterior.

When aluminum curtain rails are used sufficient supports must be attached to prevent the rails from sagging under the weight of the curtains. The rails and rings should be lubricated regularly to ensure smooth running. If iron rings are used these be painted to prevent rust. Dirty curtains are best cleaned by brushing off the dust and if necessary washing with detergent and water.

When curtains are not in use they should be drawn to the sides and tied up to prevent students pulling at them or using them as hand towels.

**h) Shelves**

Schools use shelves for storage purpose. They are uncovered and often the equipment stored on them gathers dust rapidly. Vary regular cleaning will help keep them dust free. Wooden shelves are best lacquered or painted to enable easy cleaning. Equipment stored on them should be wrapped in plastic bags to keep dust free, if the shelves are supported by metal brackets these should be checked for loosening. Shelves should have a front ledge so that items will not slip off the front.

**i) Reagent Racks**

There are usually fixed on bench tops or along the sides of laboratory. Some side benches have reagent racks. These should be cleaned regularly as they gather dust quickly. A weekly cleaning schedule is best and should be adhered to. This will also enable a check to be made of the conditions of the bottles and stoppers. The levels of solutions and the amount of solid chemicals left, cases of contamination and missing labels can all be checked by a regular inspection. When reagent racks are badly stained by chemical spillages they can be cleaned, lacquered and sanded. It is preferable to finish them with epoxy paints.

**j) Burette and Pipette Racks**

Burettes and pipettes are best kept in wooden racks. This allows for easy checking, and good drainage.

**2.7 Management of Physics Laboratory**

Equipment in the physics laboratory is general affected by the high humidity and dust. Rusting poses another problem therefore periodic inspector is needed.

**a) Lead Accumulator**

Fully charged accumulators slowly leak when left idle. Over a period of 2 to 4 months they become completely uncharged and if still left unattended they cannot be charged up again. It is therefore important to charge the lead accumulators during the long school vacation.

Lead accumulators sent out for laboratory work need checking, when they reach the specified danger, S.G. 1.15, they should be withdrawn from use and charged up to S.G. 1.25. Always avoid letting the accumulators to go “flat”.

Lead accumulators should best be charged at low current, one ampere is recommended, and for a longer period of time. This ensures fine, uniform and firm deposits on the lead plates. At times high current charging is carried out to meet the need of laboratory work, which results in porous deposit on the lead plates; the deposit tends to fall thus shortening the working life of the accumulator.

Lead accumulators which have been in use for 1-2 years need a complete clean out to remove the loose deposits on the plates and the sediment. Their removal cuts down the risk of short-circuiting between lead plates. The accumulators are fully charged up first then they are flushed with water. They are filled immediately with correctly prepared sulphuric acid. S.G. 1.25, and then they are charged up and the S.G tested with a battery hydrometer. This maintenance work ensures a longer working life, sometimes 3V2 to 4 years. The accumulator terminals need motor grease to lubricate the threading and to prevent the formation of undesired lead salt deposits.

**b) Alkaline Accumulator**

The alkaline nikel-iron accumulators can stand rough handling, large current can be drawn from the accumulator for a prolonged time and the accumulator can also be short circuited with a wire across the terminals. The accumulators need charging when the cell emf drops from 1.4v to 1.1v. After every 2 years of service the accumulator, at full charge, is cleaned out with water and then filled with freshly prepared solution of potassium hydroxide, S.G. 1.19. The accumulators is charged up and then tested. Nickel-iron accumulators can last for 15 years or more whereas the lead accumulator can last for 3 years only but the lead accumulator costs much less initially. When the level of the liquid in any type of accumulator falls, top it up to 5mm over the plates with distilled water. Charge up and then test.

**c) Battery Charger and Power Pack**

Most schools have battery chargers which could double as alternate sources of d.c power supply. They are better than accumulators because they need less maintenance. Power packs are similar to battery charges. However, they either have control knobs to vary the power output or terminals for different voltages for example, 6v, 12v, 24v etc. The terminals have cut-out fuses which safeguard the power packs. A stock of the type fuses used must be kept. When their casings have faded paint work, remove them; clean them with emery paper and then paint. Take this opportunity to clean off the dust on the transformer.

**d) Ammeters and Voltmeters**

They come with suitability designed plastic mountings and appropriately colored terminals, red for positive and black for negative. Ammeters and voltmeters are trouble free. Overloading the meters should be avoided because the coils burn out easily. Then they cost more to repair than buying new ones. When the meters are required to measure values other than those obtainable on the scales, appropriate adaptors can be fixed on.

**e) Galvanometers**

Galvanometers are easily damage; a few thousandths of an ampere can burn the coil. Therefore a galvanometer must be protected with an arrangement of a press on switch and a calculated guard resistor. The value of the resistor varies with the types of galvanometer. Corrected galvanometer shows small deflections when used in wheat stone bridge circuit but its sensitivity is restored when the switch is pressed on during the final determination of reading.

**f) Wheatstone Bridges**

The chrome wire on a wheat stone bridge board becomes ‘kinky’ and ‘worn out’ after prolonged usage. A new wire of same S.W.G is used for replacement. If the wire is soldered on check that the soldered wire is conducting. When the brass terminals and plates are tarnished, remove them and clean them with metal polish. This ensures good conduction. The wooden board needs coatings of shellac yearly.

**g) Resistance Boxes**

They require little maintenance. Only the brass plugs and sockets need polishing with metal polish to ensure good contact. To prevent tarnishing of the brass plugs and sockets, resistance boxes are wrapped in plastic bags.

**h) Magnets**

It is a common fault to keep bar magnets side by side without the protection of magnet-keepers, which are pieces of soft iron. Unpainted magnets rust readily. These are cleaned with emery paper and then thinly coated with paints red for the North Pole and blue for the south. The weak magnets can only be greased. The magnets with keepers are then wrapped in plastic bag. Avoid the use of cloth to wrap them, cloth quickness the rusting of magnets.

**i) Lenses and Prisms**

Lenses and prisms are scratched when they are placed unprotected in trays. A good method of storing lenses is to slot them into cut out in the polystyrene blocks. This method assures ease of issuing, and checking at the end of the lesson because of a lens or a prism is missing it will be noticed immediately. This method should be adopted for storing and dispensing other small items in the chemistry and biology laboratories. Dirty lenses and prisms are cleaned with silicone solutions, then dried and stored. They must be checked for fungal attack.

**j) Thermometers**

Thermometers are fragile, the bulbs are thin and easily breakable, therefore they must be in their casings or Styrofoam blocks. The markings on some thermometers are easily rubbed off, but etchings of the scale are permanent. A temporary way out is to shade the scale with the lead pencil, sometimes colored chalk will do. A permanent solution is to apply the commercial thermometer ink and then bake the thermometers in an oven at 50-70ofor a day. Sometimes the mercury thread breaks leaving a part of the thread in the stem. To join up the thread again, heat the bulb of the thermometer in an oil bath until the mercury, thread reaches the top and joins up. Allow thermometer to cool.

**k) Calipers and Vernier Calipers**

They rust readily in tropical weather conditions. Rusts are rubbed off with fine emery paper then properly greased. And they are wrapped in plastic bags. A permanent solution is to send them for commercial chrome-plating.

**2.8 Management of Chemistry Laboratory**

The acidic fumes have very corrosive effects on equipment and apparatus in the chemistry laboratories. Most inspections at closer intervals should be carried out.

**a) Fume Cupboards**

Most fume cupboards have the walls and the bases lined with white tiles, which are slowly corroded by acidic fumes evolved from experiments carried out in the fume cupboards. Regular cleaning will cut down the corrosion of the tiles. When a tile is corroded prompt replacement would save the surrounding tiles from being corroded by acids seeping underneath them. The use of a large piece of asbestos or a piece of 5mm glass will protect the tiles on the base from spillage of acids. The sliding glass door of a fume cupboard is normally coated with chemical dust. Cleaning with a solution of ammonia methylated spirit is more effective than using detergents. If gas taps are installed in fume cupboards regular servicing will keep them in good working order. These gas taps should be given coatings of epoxy paint to protect them from acids. It is a practice to keep gas generator and chemicals which give off noxious or corrosive fumes in fume cupboards. It is recommended that the fume cupboard suction fan is switched on prior to the start of laboratory lessons.

**b) Gas Generators**

Kipp’s apparatus are used to generate common gases like carbon dioxide and hydrogen sulphide. With carbon dioxide gas, there is little need to maintain the apparatus. However, with hydrogen sulphide gas, the Kipp’s apparatus is rabidly coated with the deposit of sulpher and impurities which choke the gas outlet. Periodic cleaning out with cleansing powder and detergent, and then recharging the apparatus would ensure no disruption in the gas supply. For economic purposes use industrial concentrated hydrochloric acid to fill the Kipp’s apparatus. In exacting laboratory work it is required to fix an assembly of wash bottles to clean the gas and then finally dry the gas before use. A small-scale generator for use with class sets can be made using a test-tube with a hole blown in the bottom. The inner test-tube is lowered into a larger tube containing acid. The acid enters, reacts with the carbonate and the gas passes through the delivery tube. To stop the operation the inner tube is drained and immersed in water.

**c) Chemical Balances**

Most schools have double pan, some with dial-o-gram and few have electronic balances. Balances are best kept in a room away from corrosive fumes of the chemistry laboratories. Normally the store-room or preparation room is used.

**d) Double Pans Balances**

These balances are kept in glass cases which reduce exposure to corrosive fumes and dust, and also serve to protect the balances from air draft during weighing. If balances are without glass cases, large plastic bags are recommended. The usual clearing of pans and weights must be a ritual after each weighting session. When powdery deposits appear on the prompt maintenance must be carried out. Use fine emery paper to clean the affected parts and then apply a light coat of shellac or clear epoxy paint. Do the same with the chrome-plated pans when they are corroded by chemicals. The brass weights tarnish after prolonged usage. Clean them with metal polish and apply a thin coat of clear epoxy paint to prevent further tarnishings.

**e) Dial-O-Grams**

These balances are preferred to the double pans balances. They can stand rough handling. The aluminum alloy beams will undergo atmospheric oxidation at parts where the paint peels off. Carry out immediate maintenance. Put a little oil onto the pivot and the moving parts of the dial knob.

**f) Electric Balances**

These balances are meant for accurate work. They get jammed by rough handling. Repairs are normally done by the technician from the agent company. In most cases the man win be willing to teach the laboratory staff to trouble-shoot simple faults. Encourage the laboratory staff to learn and write description of repairs for record purpose, so that similar faults can be repaired by newly appointed laboratory staff.

**g) Reagent Bottles**

Reagent bottles and glass stoppers need weekly checking for chipped edges. When they are badly chipped, it would be best to replace them. If slightly chipped, round the edge with grinding stone or rough sandpaper. These soda glass items crack on fire polishing and therefore it should be avoided. It is common for schools to keep using glass stoppers for reagent bottles when there are plastic stoppers on sale. Plastic stoppers have no danger of sharp cutting edges and they need minimum maintenance. They also do away with the problem of jammed stoppers ever present in reagent bottles used to keep alkaline solutions such as sodium hydroxide and sodium carbonate.

Etched reagent bottles are expensive but they have no labelling problem. Dymo tape labels on reagent bottles last but they lack vital information. Good labels must carry the following information:

1. Hazards symbol, if any
2. Name and formula of chemical
3. Strength of solution

The labels are lightly glued onto the reagent bottles. Each label is protected with a piece of clear broad sellotape. It waterproofs the label which will last till the sellotape cracks up. This can be in a year’s time or longer. Heavy duty clear plastic tape is recommended if a longer period of 3 years or more is required.

**h) Aspirators and Jugs**

Plastic aspirators are fast replacing the glass ones. These are not easily broken and they can withstand thermal shocks. However, they can be badly stained by some colored chemical solutions. Copper II sulphate stains some plastic aspirators reddish brown, and the purple manganite VI solution stains them brown, Tedious washings with cleansing powder should remove the stain. Sometimes the stain is removed by treatment t with chemicals. For example, the brown stain left on plastic aspirators by manganite VI solution is due to hydrated manganese IV oxide which can be removed by treatment with a mixture of hydrogen peroxide and dilute sulphuric acid. Most plastic aspirators have taps. These serve well as dispenser of distilled water and chemical solution. Plastic jugs are graduated. They come with handles which enable easy holding whereas a 2 liter glass beaker lacks this and hence the large glass beaker so often slips and breaks. It is recommended that schools use plastic jugs for preparation of chemical solutions.

**i) Tripod Stand**

Tripod stands become scaly after prolonged usage. When left unmaintained the scales drop off messing up the storage space as well as the bench top when they are being used. Chip off the scales with a cold chisel and rub down to bare metal with sandpaper. Clean and then apply a coat of aluminum paint.

**j) Retort Stand**

Retort stands are rapidly corroded by acid and chemical spillages. The usual maintenance work like cleaning with sandpaper and painting must be carried out regularly. Retort clamps are trouble free, however they must be lubricated periodically to ensure smooth turning of the butterfly bolt. The rubber tubing’s on the clamp are worn out or burnt sometimes, then get them replaced. Clean the clamps and paint them on a yearly basis. This too applies to the Boss Heads. The bolts of the boss head need lubricating oil periodically.

**k) Cork Borer**

These are made of brass tubes. The edges are blunted easily. It is bad practice to heat up a cork borer in a Bunsen flame and then use it to bore holes in rubber bungs. This softens the borer and the rubber residue inside the borer will prevent a clean cut in subsequent cork boring. It is best done by using a sharp borer and bore slowly applying soap solution now and then. Often the handles of the borers get loose, in such cases soldering or brazing will fix them.

**i) Glassware**

Schools generally use soda and borosilicate glassware. Slightly chipped soda glassware can only be rounded off by grinding with sandpaper or oil stone, or carborundum paste. Borosilicate glassware can be rounded off with fine polishing. Dirty and stained glassware are cleaned by usual cleansing powder and detergent. A mixture of dichromate VI and varying strength of sulphuric acid is a good cleansing solution for glassware used in accurate laboratory work. The procedure is to soak the glassware in the chromic acid bath for a day and then rinse with water, then stand or hang on drying boards or racks.

**m) Burettes and Pipettes**

The normal practice is to keep acids in the burette. Should an alkali be kept in it, prompt rinsing after use with acid and then water will prevent the alkali from etching the glass and misting the burette. This applies to pipettes too. Slightly broken tops of burettes and pipettes can be cut off and then rounded up. Most burettes have rubber tubing, clip and glass jet attachments. The rubber tubing tends to become plastic after prolonged use, then it is time to change them. With stop-cock burettes regular greasing is recommended in order to prevent jammed stop-cork.

**n) Syringes**

Plastic syringes are trouble free. However, they easily stained by are chemicals. When washing fails to remove the stains keep them aside for rough work. Glass syringes require good care. When glass syringes are not in use, the pistons are kept separate from the body to prevent them getting stuck. They need thorough cleaning; any dust would result in scratched surfaces thus damaging the fine tolerance between the piston and the body.

**o) Safety Glasses**

Safety glasses have clear plastic lenses which are shatter-proof but not scratch-proof. When the plastic lenses are lightly scratched, rubbing with a cloth soaked with metal polish may remove them. If the scratches are deep, then nothing can be done; however scratches can be prevented during storage if they are hung up separately rather than lumped together in trays or boxes. Regular washing of the safety glasses ensures the removal of chemical dust which may get into the students eyes.

**p) Mortar Pestle**

Often a porcelain mortar and pestle can get stained by chemicals. To remove the stains, pour a mixture of equal volumes of concentrated nitric and hydrocholoric acids into the mortar, put in the pestle. Let them stand for a few hours in a fume cupboard, then wash off with water.

**q) Trolleys**

This frame and is an important equipment in the laboratory. Keep it in good working condition. Grease the casters regularly, if they wear out them. The frame and boards should be painted once a year.

**2.9 The Biology Laboratory**

Animals, aquaria and microscopes need daily checking and care. Other equipment need periodic inspection and maintenance.

**a) Microscopes**

Microscopes are precision instruments and they are fragile. Students must be carefully trained in the correct use of microscopes. Exercises on focusing, carrying and cleaning microscopes are recommended. In most schools the microscopes are kept in microscope boxes. The dark, stagnant, humid air can promote the rapid growth of molds on the microscopes and lenses.

Keeping microscopes in boxes with packets of activated moisture absorbing silica gel helps to prevent mould formation. If schools have a large number of microscopes, for example about ten, it is advisable to construct a special cupboard for storage.

The cupboard interiors are lined with galvanized iron sheets leaving a small hole for air. An arrangement of a thermostatic heater and two or three electric light bulbs can be fitted inside. If the thermostat is not available, just two or three light bulbs say 25 watt each, would probably be good enough. Microscopes kept in such cup-board have a circulation of air and a well-lit environment. This will prevent the growth of an microscopes.

If schools do not have a microscope cupboard a simple alternative is to wrap the microscopes in clear, plastic bags with packets of activated silica gel. The gel must be regularly checked to ensure proper functioning, it is best to use blue silica gels which turn pink when they lost their properties. Heat up the exhausted silica gel, in an oven preferably, until the color is restored. Pack the gel up for use again.

Dirty objectives and eyepieces are with lens paper, not tissue or cloth to scratching of the lenses. Microscopes sent out for laboratory lessons must be thoroughly cleaned before storing. The eyepiece, objective and the stage of the light condenser system be checked for cleanliness and dryness. Students should be taught to do this and if laboratory assistants are available they should check these features regularly.

Microscopes with fungal growth on should be sent to the agents for proper servicing. After their return take to store them and maintain fungus free.

**b) Microscope Lamps**

 A good quality lamp is usually safe and trouble free. If pooper Quality lamps are used they checking for faults. Switches are faulty and it is probably best to remove faulty press-on switches and replace the controls at the power point.Lead wires must be checked right up to the in the plug.

 Care must be taken when using lamps anywhere near water. This is a hazard in some biology laboratories.

**c) Magnifying Lenses or Glasses**

It is common practice to keep these small items in trays or boxes’. This storage method can result in scratches on the lenses. A better method is to place the lenses in slots cut in polystyrene blocks (Styrofoam). This also provides a quick way of checking whether all the lenses are present or not. Dirty hand lenses should be cleaned with lens paper before storage.

**d) Slides and Slide Boxes**

 Slides should be arranged into categories and labeled. They are best kept in slide boxes. These boxes, with slots will prevent scratching of the slides while in storage. An index is necessary. In indexed slide box can provide a very useful method of storage.

Slides which have been used in a laboratory class need though cleaning with tissue before storing.

Schools with large collections of slides need microscope slide cabinets to give orderliness in storing and ease of issue. Packets of activated silica gel should be included in the cabinets.

Cover slips although expendable are not cheap and with care can be used again and again. A good idea is to store cleaned cover slips in a small jar of methylated spirits. They can be taken out with forceps and the alcohol dries quickly in the atmosphere.

**e) Dissection Sets**

The instruments are usually kept in cloth bags and sometimes in plastic cases. The number of instruments are checked before and after each laboratory lesson. Used instruments should be cleaned and dried before storing, this prevents rusting of the instruments. Rusty instruments are cleaned with fine emery paper and then lightly greased. Instruments which have become blunt need sharpening on oil stone.

**f) Wax Trays and Styrofoams**

Wax trays are usually made of galvanized iron sheet. When the trays are rusty, carry out maintenance work.

The wax surface must be cleaned with water after dissection exercises. And when the wax surface is spoilt by excessive insections of dissecting pins, heat the tray on an electric hot plate or over heated wire gauze until the wax melts. Use a fine wire gauze or wire mesh to scrape off dirt, then allow to reset.

A good substitute for wax is to use Styrofoam or polystyrene slabs of 2 cm thick. Cut the foam to the exact sizes of the trays. Place them inside the trays.

When water is not used during the dissections, then just pieces of Styrofoam will do. They are better than wax.

**2.10 Science Library**

Some schools have built up good Science Libraries for teachers and laboratory staff for reference purposes, should be given access to reference books when they are carrying out science projects.

**a) Books**

It is good practice to shop for science books coming into the market Science teachers should be encouraged to browse in book-shops. Books bought should be charged under Science Fund from which a sum of money is set aside yearly for the purchase of books and magazines. New books are catalogued lists of them should be circularized among science teachers to keep them informed.

Books should be kept in cupboards with glass doors which allow easy browsing by teachers.

Books should be on a loan-out basis. Popular books should be kept in duplicates to meet demand.

Books kept in wooden cupboards without glass doors invite growth of moulds and attack by silverfish and cockroaches. Regular cleaning and airing them in sunlight are a well-practised maintenance procedure. Hanging plastic bags of camphor would keep silverfish and cockroaches away.

**b) Magazines**

Magazines are more informative then books. The articles in them are up-to-date. It is recommended that should subscribe to a few useful magazines.

It is difficult to make direct subscription because of billing problems. This can be overcome by special arrangement with a local book company to supply the magazines and then bill the school in local currency.

Magazines have soft covers therefore they are easily torn. They need extra care. Torn magazines should be attended to promptly and covers repaired when necessary.

The yearly collections of magazines should be categorized and placed in labeled boxes. The more informative magazines could be sent for binding for easy reference. (See Appendix for some addresses).

Good articles are photocopied and put up on pupils’ notice boards for their general reading. After that they are filed separately.

**c) Catalogues**

Most scientific companies will send their catalogues free of charge to schools. They often have a yearly catalogue. Schools which do not receive them should write to the companies or their local agents.

Catalogues are useful. Science teachers should refer to them before making a commitment to purchase an item of equipment Often, for the same price, on company may have a piece of equipment of better performance than another.

Teachers can also refer to catalogues to get ideas for design and improvisation of apparatus using local materials.

Outdated catalogues can be given away or the diagrams used as labels on cupboards and shelves in the laboratory. Students often enjoy browsing through old catalogues too.

**d) Instruction Booklets or Sheets**

Elaborate science instruments have accompanying instruction booklets or sheets. These are referred to for operational as well as maintenance information. They are useful, therefore they should be put in separate files, labeled and kept in the library for teachers references.

Too often school lose them leaving expensive equipments without proper operational and maintenance instruction. Generally photocopies of them are kept as safeguards.

Encourage teachers and laboratory staff to refer to them for optimum use of the equipments.

**e) Pamphlets and Newsletters**

Scientific companies sent out pamphlets and newsletters to keep schools informed on their new products. These should be filed. Teachers should be informed of the purposes of this file.

**2.11 Tools**

Schools should purchase a set of commonly used tools for maintenance and improvisation of equipment. It is important that these tools be used for the purpose for which they have been designed. The correct procedures for using tools are found in the Handbook section on Techniques. It is recommended that tools are placed on a shadow board for ease of checking.

**a) Saws**

 There are saws for different purposes.

They are meant for sawing wood and planks. When the teeth become blunt, use a fine toothed flat file to sharpen them.

The blade and teeth need a thin layer of oil or grease (e.g silicone) to prevent rusting.

**b) Hack Saws**

They are used for cutting metals, rods, and bolts, but not hard steel like files. The steel blade must be fitted with it teeth facing forwards.

Drip lubricating oil on the metal cuts while sawing, this reduces friction and gives longer life to the blade.

Replace the blade” when it becomes blunt. Keep a stock for various types of hack saw blades.

**c) Coping Saw**

 This is used for cutting holes and circular pieces of wood.

 Keep a stock of the blades.

**d) Files**

 Use the correct file for the job.

**e) Rasp**

 This file has very coarse teeth and it can only be used for woodwork.

**f) Flat File**

Flat files are either coarse toothed or fine-toothed. They are meant for metal work, however they can also be used for woodwork. If they have been used for filing wood they need to be cleaned with steel or brass brush before storing.

**g) Triangle File**

It is used for working on angular objects, I can be used for cutting glass turing.

**h) Round File**

This is used for rounding up holes. Generally the files should be cleaned and greased before storing.

**i) Cold Chisels**

Use chisels to cut metal plates, sheets, and thick wires. When they are blunt, sharpen them on the grinding stone or file them. A wood chisel is to cut wooden articles only. When it is blunt sharpen it on an oil stone, and then grease it.

**j) Screw Drivers**

Often screw drivers are used for opening tin cans or cutting wires. Avoid this. It chips the edge of the screw drivers. The chipped edges of the screw-drivers should be filed to their original shapes. Use the correct screwdrivers for a given width of screw, this will prevent screw heads becoming burred or spilt.

**k) Cutters**

Use tin snips for cutting tin cans, thin metal sheet but not nails and thick wires. If used correctly the tin snips require little maintenance.

Oil the bolt-nut periodically. If the cutting edges are blunt, file them to the correct angle.

**l) Pliers**

Use pliers to cut mild steel wire and iron nails, not guitar wires.Avoid using pliers to tighten nuts and bolts which get damaged in the process.

**m) Hammers**

Use the big hammer for heavy jobs. Check that the metal head is tightly fitted onto the wooden handle.Use a small hammer for driving small nails.

**n) Soildering Irons**

Electric soldering iron is most convenient to use. The solder bit is filed clean before use. Dip the hot bit into solder flux-zinc chloride paste will do and then apply the hot bit to the solder wire. A clean solder bit picks up solder easily. Electric soldering iron must be checked for faulty circuit. The worm-out solder bit is replaceable. Normal soldering iron needs strong heating over bunsen flame or kerosene stove.

**o) Hand-Drill and Drill Bits**

The cogs need lubrication regularly. Also put oil into the chuck. Drill bits must be greased before storing. When they become blunt sharpen them first on a grinding stone or file them, then go onto an oilstone for final touch.

**p) Clamps**

G-clamps need cleaning of the threads and greasing once a year. It they are rusty, clean them and paint up.

**q) Oil Stone**

Oilstone is compressed carborundum. Generally one side is fine and the other side is coarse. Use oil in sharpening tools. Water will make the sharpened edges rusty.

**r) Sandpapers**

Sandpapers are widely used for finishing work. Keep a good stock of coarse and fine sandpaper.

**s) Emery Papers**

Emery papers are made of coarse and fine carborundum. They are used for cleaning and grinding metallic articles. Oil or kerosene added will help to speed up the job. Again water should be avoided for iron or steel articles.

**t) Oil Can**

This is good tool to have in the laboratory. A nozzled oil bottle $s preferred. This can reach less easy accessible oil spots on equipments.

**u) Adjustable-Spanner**

This is the correct tool for tightening and loosening nuts and bolts, not pliers. It should be carefully maintained and kept rust free.

**Self-Assessment Questions**

Q.1: How will you locate an item frequently during a practical?

Q.2: Why chemicals require special attention for their storage?

Q.3: When material is not properly stored in laboratory, what will be the expected consequences. Give your answer with the help of examples?

Q.4: What are considerations of laboratory inspection?

Q.5: Give detailed note of furniture required for Science laboratories.

Q.6: How will you look after physics laboratory?

Q.7: How will you look after Biology laboratory?

Q.8: How will you look after Chemistry Laboratory?