LECTURE NOTES ON LABORATORY PRACTICE

FOR DIPLOMA CLASSES

INTRODUCTION

LABORATORY PRACTICE

Is the study of responsibilities of laboratory personnel, this includes safety, cleaning, storage of equipment, disposal and first aid.

TOPIC 1

LABORATORY DESIGN

Objectives

- Explain the main features of laboratory layout
- Explain the need for proper sitting, orientation and size of the lab
- Describe the various fittings and service
- Describe the main features of lab benches

- Describe the main features of sinks, drainage system and distribution
- State the importance of various materials used for floor surfaces
- Explain a given type of ventilation
- Explain the need for various aspects of lighting in in the lab
- Outline the requirements needed to renovate an existing building into a lab

LABORATORY LAYOUT

Factors to consider includes

- Sitting and orientation
- Fittings and services

Siting

Several factors are considered when deciding where to site a laboratory within an institution, this is because there are no similar institution in terms of their needs and environmental surroundings.

The following points should be put into mind before coming to a decision as to where to site the a lab

Lab being close together: This has several advantages

- The movement of staff and apparatus should is reduced
- Facilities can be shared e.g. resource Centre
- Availability of technical assistance is increased
- Interrelated projects can be conducted much more easily.

Access to delivery points

Steps along corridors connecting labs on the same level e.g. ground level must be avoided so that trolleys can be used to move apparatus without problems

A storied science block should have a service lift or hoist to move equipment from one floor to the other without stairs

Isolation from other buildings

A lab should be isolated from other buildings such as cafeteria, food store, drug store a hospital dining hall. This is to avoid contamination of food with fumes and aerosols produced in the lab.

Proximity to other buildings

It should be sited close to workshops, green house, animal house, wards, causality department and mortuary. This reduces staff movement hence saves time. In case of a storied science block, a biology lab should be at the ground level.

ORIENTATION OF THE LAB AND ENVIRONMENTAL CONSIDERATION

In tropical countries, the east-west orientation of the lab is recommended so that the windows face north and south. The orientation reduces the extent which strong sunlight enters the lab directly through the windows. This also avoids the use of curtains which would be used to protect direct sunlight

NB: A biology lab may require one sunny bench with grey curtains to control the sunshine. This bench can be used to grow potted plants and perform certain experiments.

The sun shining on a non-luminous Bunsen flame or on a chemical in the shelves can be dangerous since one can get burnt easily or some chemicals might explode while photosensitive ones may deteriorate.

Windows should not be sited adjacent to chalk board or overhead projector screens in order to avoid visibility problems, which may arise as lighting entering through is reflected from the board or screen.

The wind direction especially during the hottest time of the year or day must be considered hence it may be necessary to arrive at a compromise orientation of the lab.

Wind breakers may be planted to block the winds around the lab.

Size of the lab

This is determined by several factors:

Linear bench space

The length and width of a bench is determined by size and number of apparatus to be used.

Circulation space

There should be approximately 1.7m of space between the ends of benches and walls to provide circulation space and room for furniture.

Storage space

Space for cupboards and shelves in the lab for storage of apparatus and other materials

Permanent equipment

Space for installation of non-movable equipment e.g. water still furnace and aquaria.

Wall space

Space for apparatus which are fixed in a vertical plane e.g. fortin barometer

Fittings and services

Fittings include benches sinks and taps, floors, fume cupboards fire extinguishers drainage system. Services includes water, gas, electricity, compressed air, steam and vacuum

LABORATORY BENCHES

There are three main types:

- **Island**
- **Peninsular**
- **Wall benches**

Formally benches were built in fixed and permanent style but today unit assembly benches are very popular. This is because the benches can be dismantled and assembled in other ways; this allows flexibility of the lab where work may change from time to time something that cannot be done with fixed benches. Initially the furniture for unit assemblies may be slightly expensive; therefore benches are of two main patterns

- Fixed benches

- Unit constructed or movable benches

Note the fixed benches may have removable units. This allows access to service maintenance, repair and inspection e.g. drainage pipes gas and water pipes.

Unit construction is especially suitable when there is need to change the lab layout when work demands new bench arrangements, other advantage of unit constructed benches includes:

- It saves on cost when lab- layout re-arrangement becomes necessary
- The lab is flexible
- Furniture and fittings can be quickly installed.

TYPES OF BENCHES

Island benches

Gangways are opened in all sides, benches may be fixed or unit constructed i.e. Movable. If it is fixed, it requires cutting of the floor to install services i.e. water, gas and electricity. Storage cabinets can be fixed under the bench.

Services may be provided through the umbilical cord system above the bench.

DIAGRAM

Wall bench

Benches with one of the length, long side, fixed against the wall of the lab. Storage cabinets are fixed under the bench. Services may be installed on the bench from above or under the bench top. The bench has a reduced space for groupwork.

DIAGRAM

Peninsular bench

Is made up of movable unit pushed against a wall bench near a service station, It is a good set up for group work and discussion. This flexibility can only be achieved in a modern laboratory.

DIAGRAM

DIMENSION OF BENCHES

Height of the bench

It is governed by;

- The average height of the person using them
- Whether they will work while sitting or standing

In general, a bench height of 0.75m to 0.85m is suitable for standing work and a height of 0.7m to 0.75m for sitting work.

For advanced labs, a height of 0.9m is best for males and 0.85m for females. A sitting height of 0.75m is suitable for both. Bench height can be adjusted for difference between the young, short, person and adults where work will be done standing. This can be made possible if part of the bench can be made at a different height from that of

the remainder e.g. 3m long peninsular bench can be made to accommodate two persons.

A 2.25m length of the top can be made 0.9m high and the rest, nearest to the wall, reduced to 0.75m in height. This reduced height can also provide a writing desk.

Diagram

It is not necessary to adjust the bench if the work will be done sitting by all the persons.

WIDTH OF THE BENCHES

The effective working width of benches is reduced by services installed on them; the width is governed mainly by the need of having reagents and equipment on the shelves or bench scaffolds, which must be easily reached safely.

Bench sizes are generally 0.9m high (0.75m for sitting benches) and 0.7m wide for single sided and wall benches.

Wall benches used for large equipment e.g. ovens, incubators or muffle furnace and at the back of which wall shelves are not fitted should be 0.75m wide. Benches in which work should be done on both sides should be 1.2m –1.5m wide. In most labs, a bench 1.4mwide is suitable.

Reagents shelves

The design of reagent shelves depends mainly on the number and type of bottles to be kept on them. Service pipes may also affect the details of their construction. The average height of the shelf units is very important. Reagent shelves should be made of hardwood, they may be single or double sided. The shelves may have one or two tiers. The upper surface of the shelves should be covered with vitrolite, glass or other resistant material as protection against spillage that may run down the sides of

the bottle. The edge of the bench should have a hardwood beading, slightly thicker than the shelf hence forming a hip to prevent bottles being knocked off the shelves. Spacing between shelves should be about 190mm in order to accommodate the various sizes of reagent bottles.

Space between benches

When considering the layout of benches, it is important to consider on the space left between them. One should consider the following factors;

- Whether work should be done while sitting or standing
- The allowance should be made for opening cupboard doors
- The size of traffic of people that passes i.e. the number of students
- Whether the trolleys are to be used in the lab
- Whether the lab is meant for routine or advanced purpose

In a well-planned lab enough space is given for supervision, servicing and comfortable working. It is also important that services such as fume chamber, side reagent bottles, balance rooms and shared equipment be well positioned in order to provide least possible movement of lab population. The least space allowance between benches is 1.2m.

BENCH TOPS

They are made up of several materials, the factors to consider when selecting the bench top includes

- The availability
- Durability
- Resistance to chemical attack
- The cost of installation

The choice of material is determined by the nature of the work to be undertaken on the bench, the bench top is expected to withstand;

- Heat,

- Moisture and dumbness,
- Chemical attack,
- Pest
- Contamination

The properties of the material for the bench top includes the following

- Resistance
- Electrical properties
- Ease of cleaning
- General appearance

Wooden bench top

They are made with timber from hard wood such as camphor, teak, Oak, Ebony, Mahogany. Bench tops of manufactured boards are also used; the boards are also veneered and lipped with hardwood such as teak. The minimum thickness of the veneer should be 3mm. Before installation of any wooden bench top, the wood must be;

- Properly seasoned

- Free from pests
- Moisture content must not exceed 10-12% in heated lab conditions

The building itself should be allowed to dry before installing benches, adequate drying-out time in a well-ventilated conditions must be allowed when the benches are first installed. Bench tops may be made from either wide or narrow boards, wide boards tend to warp, bend, than narrow boards. Jointed tops from narrow boards also tend to buckle in dump conditions at positions where they are cut to accommodate sinks.

Treatment of wooden bench top after installation

- Apply several coats of raw linseed oil for weeks and then scrap it off.
- Then apply a mixture of high melting point bench wax.
- Dissolve the wax in heated xylene
- Apply two coats of the hot mixture with a paint brush

- Allow the wax to harden for 48hrs
- Rub it off with steel wool very lightly
- Apply several coats of wax polish before using the bench
- This treatment protects the bench from chemicals and acid attacks
- Regularly wax the bench top

Acid-proofing wooden bench top

Solutions of potassium chlorate, copper sulphate, hydrochloric acids and analine are applied in sequence. This results in a black wooden surface which is resistant to acid attack.

NB: Oil and wax finishes for wooden bench tops is the best, other good finishes include polyurethane which dries to form a hard and smooth finish. Polyurethane has a long life, is resistant to water and other solvents but is affected by con acids and alkalis.

Renovation of wooden benches

Plane the bench until the shavings are clean using a jark plane

Smoothen the surface with a sand paper of emery cloth

Apply wood dust evenly on the surface

Apply raw linseed oil on the surface for two weeks. This makes the wood stronger

Rub the raw linseed oil with a metallic scrapper or steel wool lightly.

Apply several coats of high melting point bench wax dissolves the wax in hot xylene

Allow the wax to harden for 48hrs

Rub the wax lightly with a metallic scrapper or steel wool

Then apply several coats of wood polish to make the surface shine

Metallic bench top

Several metals are used as bench tops. This includes

- Stainless steel
- Monel metal

- Nickel
- Aluminium
- Zinc
- Lead
- Galvanized iron

Stainless steel

- Has a good appearance
- Resistant to chemicals but is attacked by $H_2SO_4$and HCL acids to some extent
- Expensive
- Used in food laboratories, darkroom wet benches radioactive lab and biochemical labs

Monel metal

- Fairly good in appearance
- Fairly resistance to chemical attack but tend to darken
- Expensive

- Used in food, darkroom, wet benches, radioactive and biochemical labs

Lead

- Poor in appearance
- Tends to buckle with heat
- Attacked by mercury
- Expensive

Used in battery charging bench, darkroom wet bench, chemical preparation bench and washing up rooms.

Pure aluminium and its alloy

- Fairly good in appearance
- Fairly resistant to chemical attack but attacked by alkalis and mercury
- In alloy form is very resistant to heat
- It is cheap
- It is used in explosive labs benches

Zinc

- Poor in appearance
- Attacked by chemicals
- Cheap
- Used in physical and textile labs

Advantages of metal bench tops over wooden

- Not attacked by pest
- Fire proof
- Free from shrinkage
- Free from warping
- Free from distortion
- Have greater mechanical strength

General advantages of metal bench top

- Durable
- Water resistant
- Easy to sterilize
- Fire resistant
- Easy to clean
- Do not shrink

- Have mechanical strength

General disadvantage

- Are expensive
- Noisy when work is done on them
- Not chemical resistant
- Not easy to renovate after years of service
- No natural warmth
- If chipped it may rust

Glass bench tops

Toughened glass and opal glass are the best for lab use. Thick toughened glass may be used for working tops of fume cupboards in order to withstand mechanical shock but it is very expensive

Opal glass is used for filtration bench tops. It is also used for reagent bottle shelves.

Advantages of glass

- Easy to clean
- Easy to sterilize

- Resistant to most strong acids and alkalis
- Good in appearance

Disadvantages of glass

- Expensive
- Have no mechanical strength, easily damaged by sharp impact
- Damaged by heat

Plastic tops

They are mainly used in radioactive and other labs where cleanliness and sterility is very important.

They are used in form of thin veneers which are glued or affixed to a base material e.g. blackboard. In labs where general work is done the veneer may be damaged by heavy equipments. Some of the plastic material used are pvc, polythene laminated plastics and PTFE,polytetrafluoroethylene, which is better than the others

Advantages of PTFE Plastics

- Easy to clean
- Easy to sterilize
- Water resistant
- Not damaged by pest
- Durable
- Unattached by most chemicals and acids
- Has a good electrical property
- Unattached by solvents

Disadvantages of PTFE

- It is expensive
- Not easy to renovate
- Can be damage by heavy instruments
- Not very attractive

The other bench tops are used for specific purpose

They include; Rubber, linoleum, quarry tiles, ceramic tiles slates soapstone, cement asbestos-cement composition and soft asbestos

Asbestos cement composition

In chemical labs, it is used in construction of fume cupboards and combustion benches. This is because it can withstand high temperatures and is resistant to fire. It has good appearance. Can resist acid attack and is resistant to water.

Slate

Is suitable for balance bench because it is solid and heavy

Fairly resistant to chemicals, may be attacked by chromic acid and sulphuric acid.

Its surface tends to flake hence may require carefully selection before installation.

It is not recommended for use in fume cupboards.

Rubber or linoleum

They are limited in their general application but are mostly used in physical labs

They are both kind to glass ware

Linoleum is used in darkroom benches,it is quiet, warm and fairly resistant to chemicals but it is attacked by strong alkalis

Rubber is attached by solvents

Soft asbestos

Used for glass blowing benches. It tends to cling to clothing and this can be annoying, hence glass blower prefers compressed asbestos cement bench tops to soft asbestos.

Quarry tiles

They are suitable for combustible bench tops. This is providing the jointing material and the bedding material are good and resistant to chemical attack. The surface should be level.

Glaze earthenware ceramic tiles

Glazed white tiles are used for filtration benches. They also used for the working tops and backs of fume cupboards

Disadvantages

- When crazing of the glazed surface occurs, chemical penetrate the surface and the bench appearance deteriorates.
- They are easily damaged by sharp impact.

The undersurface of the benches

Materials used for the understructures should be selected with some care as the bench should be made of good quality hardwood.

Its moisture content should not cause it to warp through shrinkage

Its construction should be in such a way that it allows accessibility for repairs as it houses the services of the bench.

Plumbing and other services should be brought to the benches in several ways and they should be accessible at any point along the length of the benches.

One of the following methods may be used to service benches.

All service being above bench level

Is a cheap method of servicing a bench

It allows pipes to be easily repainted and maintained

The service pipes may be brought down from the ceiling or carried at suspended levels to feed the island benches, again affecting the appearance of the lab.

The umbilical cord system also:

Restricts use of the other fittings above the bench level

Hampers work in the sink areas.

The services pipes may be enclosed in a box

The box may be made of same material as bench top

This does not affect the appearance of the bench

Similar boxes may be used for wall bench service pipes

The boxes may be attached to the bench or to the wall.

If the boxes are attached to the wall, the bench units may be slid in below them.

No cabinet work below the bench

Here the pipes run below the bench top, there are no cabinets below the bench. Hence the benches of this type

have limited use since it is important to have lockers and drawers next to the working area.

Bench top support

The bench top may be supported in one of the three ways

As an intergral part of the bench itself

On legs brackets or cantilevers

Mounted on the carcase units

Diagram

SINKS AND DRAINAGE

Almost all benches require a water supply hence should have sinks and drainage system.

Materials for sinks and troughs

Sinks receive very harsh treatment in the labs much of the materials are corrosive and may be left to lie in the sink for a sometime, hence careful choice of materials for sinks is important.

To avoid heavy wear in the sinks, reversible plug materials should be fitted in the sink waste outlet. The

plug allows a thin layer of water to remain in the sink and this water dilutes any corrosive material poured in.
The plug also prevents splashing esp. when more than one person are using the sink at the sometime or if the fancets/ taps are placed too high above the sink. Laboratory sinks are made of several materials:

- Plastic ceramic
- Fiber glass
- Stainless steel

Glazed fire clay (ceramic) sinks

They are available in a wide range of different sizes and shapes; they have various rim finishes, termed
External rimmed sink
Rimless
With both internal and external rims
The function of the internal rim is to reduce splashing

All sinks differ from others in that they have weir-type overflow outlet.

Advantages of ceramic sinks

- Have an excellent resistance to chemical attack
- Non-inflammable
- Durable
- Easy to clean

Disadvantages

- Expensive to purchase
- Expensive to install
- Not kind to glassware
- Chipping and cracking exposes the absorbent core hence staining the sink
- Can be broken by heavy physical shock

Diagram

Glass fibre sinks

Consists of glass fibre bonded by resins and molded into a sink

Advantages

- Not very expensive to purchase
- Not expensive to install
- Kind to glassware

Disadvantages

May be attacked by some acids or organic solvent

Are flammable

Stainless or metal lined sink

Some have a draining board which form an integral part of the sink

Advantages

- Are simple to install
- Show excellent resistance to chemicals and solvents
- Can withstand heavy physical shock
- Pleasant in appearance

- Resists temperature changes
- Easy to clean and sterilize
- Kind to glass

Disadvantages

- Are expensive resistant to attack by an acid depends on grade of steel used in manufacture
- Tend to be noisy

Porcelain on metal sinks

The base metal for the sink is iron or steel

The main problem with the sinks is the tendency of the porcelain to chip off from the base metal.

When chipping occurs the sink is liable to attack by corrosive substances, hence they are not suitable for heavy wear. They are easily scratched and may become stained after a period of time.

Advantages

Some as for stainless steel except that it may not withstand heavy physical shock.

Drip cups

Are used where sink is not necessary or where the sink will take up the valuable bench space but where a drainage outlet is necessary, hence they are used in fume cupboards

Drip cups are circular or oval in shape, may be bench or wall mounted. They are made of polythene, glazed fireclay or glass.

Diagram

Fitting a sink onto bench top

Sink with a rim are fitted flush to the bench top. Here the bench top is first recessed/ cut to accommodate the rim. The sink may also be fitted below the bench top so that the top overhangs the sink. Rimless sinks are fitted so that part of the top of the sink is showing. The bench top is shaped to fit closely to the sink. A beading round the rim of the sink may be fixed. No gap should be left between the sink and the bench top and any gap can be filled using a sealing compound. Where the bench top overhangs the

sink and the sink has no internal rim, the bench itself prevents splashing.
In this case the overhanging portion of the top is grooved underneath to prevent water from coming into contact with the sealing compound.
Sinks fitted in this way have the advantage that water spilled on the bench top may be swept into the sink with the bench squeegee.

Care and maintenance of sinks

- Do not pour concentrated acids and alkalis into the sinks; dilute them before disposing through the drainage.
- Do not pour flammable solvent into the sink. Some may distort or damage the sink esp. plastic sinks.
- Clean the sinks thoroughly and remove any stains immediately after use
- If stained, use diluted nitric acid to remove them

- Remove any solids regularly and de-clog the bottle trap.

SINKS OUTLETS

The outlet must be of reasonable size, for small outlet will constantly choke forcing the user to remove the outlet grilles. Removing the grilles will make the debris to drain and collect at various points in the drainage system, hence blocking it.

Standing overflow tubes are useful in the sinks since the sink may be used as a cooling bath.

Sinks outlets should have fixed grilles because loose ones may be removed and lost resulting to blockage of the drainage.

The drop pipe from the outlet should be made of glass or polythene. The waste pipe should be of acid resistant material. If the sink is to be used for hot water or steam condensate, a glass type is better to use than a polythene pipe for glass is resistant to acids and heat than polythene.

Sinks for washing glassware

A large sink for washing glassware should be installed at a selected area in the lab. If a lot of washing is to be done, a double sink is an advantage for it allows adequate rinsing of glassware.

The wall behind the sink should be protected by adequate splash back e.g. wall tiles. Water taps should have a large discharge outlet than those provided for bench sinks. If hot water is also provided the water mixer type of tap is useful.

A special tap with fet nozzle outlet should be fixed high on the wall for washing biurettes. A draining board must also be provided, preferably made of same material as the sink.

Draining boards should not slope steeply towards the sink to avoid glassware falling into the sink.

The board should have draining grooves with flat lands. A peg board with inclined hardwood or plastic peg should be fixed to the wall for draining glassware. The front of the board should be covered with a 3mm thick rubber

sheet to prevent the lips or rims of glass vessels from becoming chipped. The pegs should very in diameter to accommodate various neck sizes of apparatus to drain. A board for strong cleaning material should be provided below the wash-up unit.

Drainage waste pipes

Waste pipes suffer heavy wear, hence must be well sloped. The nature and temperature of the effluents affect the choice of material for the waste pipes.

Main materials used for waste pipes are chemical stoneware, cast iron, vitreous enamel lining, lead, polypropene, rigid PVC and glass.

Chemical stoneware pipes

They are not commonly used today

They are in form of open channels used for drainage

The glazed type is the most suitable

Advantages

- It is strong
- Unaffected by corrosive except hydrofluoric acid

- Easily cleaned
- Does not tend to retain solids suspended matter because is smooth.

Disadvantage

May be broken by a sharp impact, hence should not be exposed in exposed places.

Polythene waste pipes

They are being widely used nowadays for waste line; they are black in colour due to the pigment which protects them from being attacked by sunlight, unlike other polythene.

Advantages

- At room temperature it is resistant to acids alkalis and most solvents especially when it is first diluted by water that flows in the pipe.
- It is not affected by soft water and mercury
- It is suitable for water up to 700c

- It is elastic and can be used in exposed conditions without damage and can be bent easily

Disadvantage

- Chlorine attacks polythene at the surface
- Bromine and iodine are adsorbed and this makes the material to become brittle.
- Above 600c it is attached by some oxidizing agents, aromatic and aliphatic hydrocarbons

Glass pipes

Borosilicate glass is used. It is resistant to corrosion by chemicals

Blockage can easily be seen and removed

Easy to installation cost are low.

Disadvantages

- It is expensive
- Reasonable care is required during installation
- Not easy to remove once broken

Chemical receivers and trap

The effluent from the lab should be diluted before allowed to enter the main drains. The effluent should be discharged into chemical receivers where it is diluted. The solid matter in the effluent is also retained in the receiver. The receivers should be outsides the lab Use of receivers inside the lab is not recommended since they accumulate hazardous material.

The waste material should be discharged from bench sinks through drop pipes into a closed pipe and not into open channels as used to be some years back.

Open channels had the advantage of being quickly inspected or easily cleaned out but the fumes from them corrode adjacent service pipes and they are unhygienic.

The closed pipes should be made of material which can withstand the effects of the chemical effluents being discharged, since at this point the effluents may be undiluted hence highly concentrated.

For most conditions, polythene or glass is suitable.

The diameter of this pipe should be fairly large to avoid being blocked by various objects that may find their way down the sink. Chemical receivers are available in several shapes but two types are in general use, these are siphon trap and settling tank.

Diagram 21

Both traps acts as mercury and silts traps as well as dilution tanks, but recovery of mercury from them is not an easy task. Today dilution of effluents is usually done by use of catch pot.

The catch pot encloses the effluents completely and also prevents the escape of fumes and smells experience with the open type of receivers.

The catch may have one to three inlets of different sizes; it may be of 4.5 litres or 9.0 litres in size

To clean the catch pot, the liquid contents are first removed through the drain plug. The whole catch pot is then removed. The lower half is then unscrewed and emptied. Other catch pot has a dilution chamber made or

borosilicate glass. This type is suitable for waste system where solid matter is involved and the amount of solids collected in the glass portion, which is removable is easily seen.

The lead S bend traps are not recommended for lab use.

Below sinks a trap made of polythene PVC are suitable for use in labs where sinks are subjected to normal use.

The trap with the visual glass is particularly good for the easy recovery of spilled mercury.

Diagram 22

NB All traps require be inspecting and cleaning regularly.

BENCH SERVICES

The bench services include: cold water, electrical, hot water, gas, steam, vacuum and compressed gas supplies.

Various services are identified by colours, part of the pipe may be painted with the service colour or by means of

coloured adhesive tapes. Painting the full length of the pipe is best not only for identification but also the paint protects the pipe especially in chemical labs

The colour codes for laboratory pipes

s/no	**Service**	**Ground colour**	**Colour band**
1	Compressed air upto 13.8 bar	White	-
2	Compressed air over 13.8 bar	White	red
3	Electrical services	Light orange	-
4	drainage	Black	-
5	Fire installation	Red	-
6	gas	Yellow	-
7	Heating steam	White	Black
8	Cooling water	Yellow	-
9	Drinking water	Sea green	-
10	Cold water from	Brilliant	-

	storage tank	green	
11	Hot water	Cau-de-nil(yellow)	-

Another way to distinguish services is by the colours of wheels and levers attached to taps or valves. Electricity outlets, sockets, should be fixed away from wet areas e.g. near sinks, water, sink outlet i.e. on the wall above the bench top level or on the bench below the bench top. Control valves (main) for all services can be fixed near the exit and be colour coded.

Service outlet

The taps cocks or valves used to control lab services require careful selection, they should be;

- Pleasing to the eye
- Easy to clean
- Resistant to the conditions in which they are to be used

Fittings will last longer if cleaned with warm soapy water followed by rubbing with a lightly oiled rag

Diagram 25

Leakage of water through tap may occur through

- Through the spindle
- Through the nozzle

Leakage through the spindle is due to

- Worn out spindle

- Worn out packing material

Remedy;

  - Replace the spindle threads
  - Replace the packing material

Leakage through the nozzle is due to

- Worn out washer
- Foreign matter on the valve seat

Remedy

- Replace the washer
- Remove the foreign matter

WATER OUTLETS

Modern water fittings have a standard threaded outlet in order to allow the nozzles of all types, vacuum pumps e.tc

to be fitted to them and changed at will.

Water taps may be classified into three main classes;

- pipe mounting
- bench mounting
- vertical surface mounting

Within the three they are various types of taps e.g. bib taps, drop taps, angle taps, swan neck taps.

In some cases, a combination of these various types of taps maybe incorporated in one fitting

e.g. you can have one fitting consisting of bib valves and one swan neck outlet.

FLOOR SURFACES [FLOORINGS]

Floorings are the exposed top surfaces of floors.

The floor is the solid construction below the top surface.

Floors are classified into;

- Timber floors
- composite floors

Composite floors are those that are composed of more than one material

Factors that affect the selection of floor material:

Appearance

It should be of desired appearance

It should produce the colour effect in conformation with the use of the floor

Ease of cleaning

It should be easily and effectively cleaned

Resistance to spillage

It should have effective resistance against absorption of oil, grease or other spillages

Warmth to touch

It should give comfort when used i.e. if a material has good thermal insulation it gives comfort to the user of the building

Cost

The cost of flooring material should be reasonable as compared to the use of the building

Damp resistance

It should be resistant against dampness in order to give a health environment within the building.

Resistance to wear (durability)

It should be resistant against wear, tear, chemical action, temp changes.

Fire resistance

The floor should not be flammable. It is more important for upper floors so that it should offer adequate fire barrier between different levels of a building.

Maintenance

It should require minimum maintenance, however, when maintenance is required, it should be possible to carry them out speedily, easily and with minimum cost.

Noise

If noise is created by the use of flooring material, it leads to discomfort, hence it should not be used where silence is required and flooring materials giving less noise should be used.

Safety of users

The floor surface should be smooth but at the same time not too slippery to cause trip accidents.

Resistant to indentation

It should be resilient, it should be able to recover its original shape or condition after being pressed or pulled.

The material used for lab floor surfaces should be selected according to the work done in the lab.

Common material used for flooring

Wood floor

The timber flooring can be carried out in one of the three types

Strip flooring

This consists of wooden planks or boards. The strips are grooved and tongued at the edges and ends.

Block flooring

Consists of wooden blocks which are laid over a concrete base, their thickness vary from 2 cm to 4 cm.

Parquet flooring

This are similar to blocks but their thickness do not exceed 1 cm. the blocks are fixed by means of hot glue, then nailed with the help of panel pins.
Hardwood floors are well suited for use in the labs. The hardwoods used are teak, oak, iroko and beech.

Advantages

- Withstand harsh treatment i.e. resistant to wear
- Less affected by substance spilled on them
- Have a good natural appearance which is enhanced by polishing with wax
- Not slippery
- It is not noisy
- Warm and confortable to stand on
- They are kind to glassware and reduces glass breakages

The most suitable for lab floor is the strip or strip parquet. Wood blocks are recommended for lab floors and rooms which are dry.

LINOLEUM

It may be purchased in roll form or tiles of various gauges. It is mostly used in radioactive labs, in rooms where mercury is most likely to be spilled and also in balance rooms.

This floor material is a mixture of linseed oil, gums and resins, pigments, wood flour, cork dust and other fillings. It should be laid on the dumb proof course. The lighter gauges are useful for offices while in labs, the heavier grades (4.5mm-6mm) thick are the best.

The linoleum can be cemented on wood of cement floors, which checks its tendency to stretch and prevents water from seeping beneath it resulting to deterioration.

Advantages

- It is quiet
- Comfortable

- Attractive
- Cheap
- Resilient

Disadvantages

- May rot when kept wet
- Flammable
- Not resistant to chemical attack

TERRAZZO

It consist of small marble chips mixed with cement, the desired colours may be obtained by using marble chips of different shades or sizes together with tinted cement. It is used in labs where very hygienic conditions are necessary.

It is used in corridors and hallways where there is heavy traffic, also suitable for heavy working conditions such as those in engineering labs. A workshop is where granite chips are used instead of marble chips hence known as granolithic paving.

Advantages

- Attractive
- Durable
- Hygienic material
- Easily cleaned by washing
- Non-slippery
- Does not absorb water or reagents
- Non-flammable

Disadvantages

- Hard
- Noisy
- Cold
- Attacked by acids
- Expensive to install
- Expensive to renovate

CONCRETE FLOORS

The thickness of the concrete layer is about 40mm. it is carried out in a proportion of 1 part cement, 2 parts sand and 4 parts course aggregate.

Advantages

- Not expensive
- Resistant to acids if cement has high silicon content
- Resistant to spillages

Disadvantages

- Dusty
- Cold
- Uncomfortable to stand on
- Poor in appearance
- Not easy to sterilize

ASPHALT MASTIC FLOORS

Used in dark rooms and other places where damp conditions exists

Advantages

- Fairly resistant to acids and alkalis
- Water resistant

Disadvantages

- Attacked by solvents
- Easily indented by heavy equipment

QUARRY TILES

They vary in thickness between 16-50mm thick. May be laid on a solid concrete foundation

Advantages

- Resistant to chemicals and acids
- Not slippery

Disadvantages

- Noisy
- Not resilient

ASPHALT TILES

It is also known as thermoplastic tiles, suitable for laboratories

Advantages

- Attractive
- Quiet
- Easily cleaned

Disadvantages

- Not suitable where the floor may become wet e.g. darkroom
- May be indented by heavy objects
- Attacked by solvents

P.V.C TILES

They are similar in appearance to asphalt tiles, can be obtained in roll form. They have similar properties as asphalt tiles

Advantages

- Resistant to solvents and acids
- Fairly resistant to indentation
- Quiet easily cleaned and attractive

NB: any spillage of chemicals or solvents should be immediately wiped out and not allowed to lie on PVC tiles.

CORK TILES

They are not suitable for laboratories

Advantages

- Warm
- Comfortable
- Quiet

Disadvantages

- Affected by grease
- Attacked by acids and alkalis
- Attacked by solvents

VENTILATION

The term ventilation means the free passage of clean air in a structure, i.e. the removal of all vitiated stale air from a building and its replacement with fresh air.

Good general ventilation is important in the lab to rid the atmosphere of fumes which are given off from normal bench processes, lab reagents, gas burners, furnaces and hot plates, other air contaminants such as body heat, body odours, excess carbon dioxides, airborne micro-organism, and dust should be removed.

Dust should also be removed by the system. This is normally done at the source of the dust, by a local ventilating device. A good ventilation system also regulates the temperature in the room.

Importance of ventilation

- Aroom which is not properly ventilated results in accumulation of carbon dioxide, breathing becomes difficult when the amount of CO_2 in the air reaches 6 % by volume, a person loses consciousness when the amount reaches 10 %, and for comfortable working the amount of carbon dioxide should not exceed 0.6% by volume.

- It controls the amount of dust and impurities in the air.
- It suppresses odours, smoke, fumes, and concentration of bacteria in the air.
- Proper and sufficient ventilation results in absence of condensation. The difference between the inside and outside air may result in deposition of vapours on room surfaces and equipment
- It removes body heat generated or liberated by occupants. In order to prevent formation of conditions that may lead to suffocation in the room.

Factors affecting ventilation

- Air changes
- Humidity
- Quality of air
- Temperature
- Use of building

Air changes

The minimum and maximum changes of air in the premises are one and sixty times per hour. If the rate of air change is more than 60 per hour, it would results into discomfort due to high velocity in the room.

The rate of air changes depends on:

- Volume of the room
- Type of activity in the room
- Number of persons occupying the room
- Velocity of incoming air
- Quality of heat moisture and oduor present in the room

Fans may be used to increase the air movements. The ventilation system should be such a way that there is smooth air current movement and that there is no stagnation of air at any spot in the room.

Humidity

For working at room temperature of about 21^0c, a range of 30-70% relative humidity is desirable.

At high temperature, a low humidity and greater air movement are necessary for removing a greater amount of heat from the body.

Quality of air

Air purity plays an important role in the comfort of persons affected by the ventilation system. The air should be free from odours, organic matter, inorganic dust and fumes of gases such as CO, CO_2, and SO_2 etc.

The ventilating system should be designed to give pure air, hence the entry of ventilating air should not be situated near to urinals, chimney etc.

Temperature

With regard to human comfort, the term effective temperature is term effective temp is used. It is an index which combines the effects of air movements, humidity and temperature. The value of depends effective

temperature depends on the type of activity, climatic conditions e.t.c

Use of the building

The quality of fresh air to be supplied in the room depends on the use of the building, and other factors such as number of occupants, type of activity and period of working

Design requirements for a good ventilating system.

- The design should be such that the required quantity of fresh air is admitted in the premises and that the vitiated air is extracted from the premises.
- The value of the desired relative humidity is maintained
- The effective temperature should be maintained for comfortable working conditions.
- The air movement should be uniform, and that pockets of stagnant air are not formed

- The incoming air should be free from impurities e.g. dust.

Types of ventilation

Ventilation may be broadly divided into two categories

- Natural
- Artificial

NATURAL VENTILATION

In this system, doors, windows, ventilators and skylights are used to make the room well ventilated.

It is cheaper than mechanical means since no special equipment are used. The following points should be remembered in relation to natural ventilation

The location, size and type of windows play a great role in imparting the natural ventilation

Windows also supply light and protect against the weather. These factors should be considered when deciding a compromise location for windows.

Windows should be located in such a way that they do not create draughts and affect burners

Windows ventilation with a combination of radiation, deflector and exhaust gives better results.

Diagram 32

Radiations are situated below sill level of windows. They extend the full length of windows. The exhaust duct is near the ceiling of the opposite side wall and acts like a chimney.

Windows open from bottom. The deflectors may be of curved vanes.

If gas is to burn in the room, e.g. from burners, the quantity of air supplied by natural ventilation should be ventilate the room.

Roof ventilators

Use of roof ventilators creates suction and draws air from the room irrespective of wind direction. They can be

adjusted to control the degree of ventilation. RV is also assisted by natural displacement of air, as warm air rises inside the room. The siting of radiators, heating ducts, heater cabinets and fresh air heater cabinets, the latter which drains fresh air from outside should cause little interference with the efficient use of available space.

The type of heating system adopted depends on the needs of the science department and also because of the flexibility it allows in meeting particular needs. Fresh air heater cabinet is recommended for a chemistry lab and lecture rooms as they can be designed to produce a given number of air changes per hour while the stale air and fumes are extracted along ducts which terminate in a fan-powered roof extraction unit operated by a switch.

Eight changes of air per hour are recommended for photographic dark room which also requires a fan-powered extraction unit. Rooms with a high proportion of fixed wall benches can be heated by a perimeter heating

ducts whose outlet grilles are placed under windows at sill height

Heater cabinets can be used in rooms with little side wall benches. The temperature and humidity in labs in which certain experiments are being done can raise rapidly, hence one need to anticipate such fluctuations by increasing ventilations to maintain confortable working conditions.

MECHANICAL VENTILATION

Here some mechanical arrangements is adopted to provide enough ventilation. A ventilation system should provide air of qualities regarding humidity and temperature to make the room comfortable to work in, however the system is expensive.

The methods of artificial ventilation include the following:

- Exhaust system
- Supply system

- Combined exhaust and supply system
- Plenum process
- Air conditioning

Exhaust system

In this process, the stale air is expelled from the room by fans and blowers; this creates a partial vacuum or negative pressure in the room. This sets up currents of fresh air from outside to move inside the room through the doors and windows. The fans and blowers are usually installed at suitable places on the outside walls. This system is suitable for removing smoke, dust, and odour. The ducts are placed near the place of formation (source) of smoke, dust, odour etc.

Supply system

This system is the opposite of the exhaust system, it consists of supplying the room with fresh air by using input fans placed on the outside walls this system is suitable for ventilating rooms where high quantities of

heat, fumes, and odours are not produced, and it is not suitable for the lab.

Combined exhaust and supply system

This is a combination of the two systems, exhaust fans and inputs fans are installed at suitable places on the outside walls. This causes a current of fresh air from outside to enter the room and the system gives a better results.

Plenum process

In this process, fresh air is forced into the room; this creates a positive pressure in the room. The vitiated air may be allowed to leave the room by itself or may be extracted by outlet (extraction) fans. The incoming air maybe passed through screens or filters or streams of water at the point of entry. Disinfection of incoming air can be achieved by adding ozone at the point of entry, thus is possible to control the quality, humidity and temperature of incoming air. The plenum process can be applied for both downward and upward ventilation. In

downward ventilation, air is allowed to enter at the ceiling height while mixing with the vitiated air during its downward flow. In upward ventilation, fresh air enters at floor level and the outlet is located at the ceiling height. Mechanical ventilation may be effected by the use of either a central ventilation system or a local ventilation system. When choosing between the two systems the ventilation problems applicable to a particular laboratory should be considered e.g. a central system may be suitable for blocks of labs with no special fume or dust hazards but problems may arise when a number of labs with varying degree of hazards are involved.

For this reasons, labs with similar ventilation and heating problems are grouped together. Where this is not possible, both central and local ventilation system may be necessary. Whichever system is used, certain standards of ventilation must be adhered to as follows:

s/no	**Type of lab**	**Air changes per**

		hour
1	chemical	4-15
2	Chemical stores	5-10
3	physical	3-5
4	Rooms for obnoxious fumes	15-30
5	radioactive	15-30
6	biological	4-6
7	Animal	4-20

To affect the required number of changes, fresh air is introduced through inlets situated at low level, window sill level or at ceiling level. In most cases it is best to introduce the air at a low floor level and extract it at high level, but if dangerous heavy fumes are involved, it may be necessary to reverse the position of the inlet and outlet vents i.e. use of downward ventilation. The position of the inlet and outlet vents relative to one another must be such

that the whole working area is cleansed by fresh air and draughts are avoided. It is important that the obnoxious fumes to be contained within the lab and then removed by the ventilation system. This means that a negative pressure should exist in the lab. In labs where sterile or other special conditions necessitate the exclusion of the outside air, a positive pressure should exist. This prevents the entry and contaminants through cracks and crevices. In special cases it may involve the use of windowless rooms or rooms with sealed windows, air locks may also have to be provided between the positive area and adjacent rooms or corridors. Mechanical ventilation methods involves fans which force air in by a plenum or propulsion system or draw air out by an extraction system.

Plenum system creates a positive pressure while extraction ventilation creates a negative pressure.

Central ventilating system

It consists of a large ventilating plant. They are simple to maintain, they usually make heavy demands on space hence, if required, provision for its installation should be made early during the lab design. It consists of large extract fan which serves all the labs and rooms. The fan used in this system usually has one exhaust, which is must be situated at a safe level and may involve a high stack.

Local ventilating systems

They involve the use of fans which are usually situated in individual labs. The system is usually used in conjunction with fume cupboards or fume hoods. The method is used in labs where dangerous fumes or dust hazards exist. The propeller fans may be used to change air in the lab. The fans are placed in the wall opposite windows or air inlets. The inlets must be large enough not to increase the velocity of incoming air and hence create draughts. Fans opening in the walls should be protected from the wind and rain by hoods, the fan may be made to discharge the

foul air clear the building by vertical ducts, both the fan and the open end of the duct should be well protected. Each of the two systems has its own advantages. The main advantages of the two system of extraction are:

Local system

An operator has complete control of his own fume extraction and the cupboard can be independently operated.

The operator has a better control over the fume extraction and can adjust the cupboard to suit the hazardous nature of the fumes being produced.

It avoids the possibility of the hazards occurring due to the mixing of fumes in the same exhaust ducts coming from the several cupboards.

Repairs in the fume chamber can be done independently without affecting the whole system.

Central extraction system

Since only one central exhaust point is used, the discharge can be sited at the best position with regard to other neighboring building

There is saving on the cost as it involves multiple fan installations.

The large ducts used in the system makes them easy to clean.

If the fans are installed, the extraction can be continued in case one breaks down.

Two important conditions must be met whichever of the two methods of the fume extraction is used;

- Fumes or dust should not escape back into the lab
- Should not cause uncomfortable working conditions in the lab.

Air filtration

In order to remove dust, bacteria etc from incoming air and in some cases, to prevent extraction of harmful dust or microorganism, to install air filters in ventilating system, various types of filters are disposable. In case of

radioactive labs, disposable arrangement requires maximum care. To allow easy removal of the filters, they must be easily accessible. There are four types of filters

- Dry filters
- Viscous filters
- Water sprays
- Electric precipitates

Dry filters

They are made of cloth and discarded when they become dirty.

Viscous filters

They are made of mats and glass wool etc and coated with non-drying viscous oil. As air passes through the filters, dust is trapped,

Water sprays

In this type air is allowed to pass through water sprays. The drops of water trap and carry down the dust particles contained in the air.

Electrical precipitators

These are valuable in collecting the valuable chemical or mineral dusts. It consists of strong electrical field where the dust particles are attracted towards the negative electrode as they pass through the field.

Air conditioning

Air conditioning is the controlling or conditioning air with respect to humidity, temperature and movement of air, odour, bacteria content, dust content etc so that to make the air to suit the physiological conditions of the human body or to the needs of industrial process. This is the most effective system of artificial ventilation. This system is independent of outside weather conditions. It can be used in conjunction with general ventilation system. If the cost of general is high, air conditioning units can be installed in rooms or labs that require them. The main advantage of locally controlled air conditioning units is that they can be adjusted to meet the different temperature and specific

requirements of various labs. Air conditioning fulfills special needs e.g. micro analytical labs and also allows delicate instruments, which would rather be housed in special rooms, to be used in the working laboratories

FUME EXHAUST SYSTEM

All dangerous fumes and dusts should be generated in fume cupboard or under a fume hood and received by an extraction system. Fume may escape back to the lab from fume hoods or cupboards due to various conditions, such as cross draughts outside the cupboard, air disturbance caused by human traffic, and conventional currents caused by burners and hot plates inside the cupboards may all cause escape of fumes. Due to these reasons fume cupboards are better than fume hoods since by lowering the sash, fume escape can be prevented. The design of the fume cupboard may be determined by the nature of the dangerous fumes or dust produced in them. Sometimes the fumes may have to be neutralized to make them safe

before discharge. In some cases, the fumes must be extracted at the source, where they are being produced.

General methods of fume extraction

The two general methods are

- Positive system
- Ejector system

The design of fume cupboard may be based on the nature of the dangerous dust and/or fumes produced in them

Diagram 37

In positive system, the fumes pass through the extractor fan. The motor of the fan is sealed completely so that it does not come into contact with the fumes. The centrifugal fans are noisy. If possible the fans should be fixed on the walls outside the building.

Ejector system

It is an indirect system of fume extraction. It is suitable where fumes are highly corrosive. The fans and motor are suitable at floor level. The fans and motor do not come in

contact with the fumes. The air at high velocity is blown by fan, is discharged through a venture, and this creates a low pressure region in the exhaust duct. This low pressure induces a flow of air from the fume cupboard. The fan and motor have a much longer life than in centrifugal system, but its efficiency is lower than the positive system, hence to obtain the same effect, a fan of greater output capacity is required. The system is also noisier than the centrifugal system. the fumes may be extracted either by a central extract system, where a single fan is situated at a convenient position or an individual extraction system, where each fume cupboard or a small group of adjacent fume cupboards are provided with individual fans.

LIGHTING IN THE LABORATORY

Purpose of lighting

Proper lighting is required in the lab because much of the work done in the lab is more visually exacting than the work done in the classroom. It is provided by both natural

and artificial lighting, a luminance of 500 lux is recommended. This can be achieved by recommending both the natural lighting supplanted by directed and localized artificial lighting. Lighting in the lab must be sufficient so that the workers can be able to see easily and comfortably without strain. itprovides an agreeable working environment, it assists the workers in the various operations which they perform.

Artificial lighting

This may be provided by either permanently installed lights or by using lamps with luminaries on the work benches. For intricate work such as dissection, higher levels of lighting are obtained by using either tungsten filament lamp or lamps fitted with miniature fluorescent tubes having a lower heat output.

Since there are many types of fluorescent tubes, it is important to ensure that the lamps chosen produces light that blends with the available daylight. This will enable colour and colour changes such as those in titration, to be

perceived without difficulties. Lamps mounted on luminaries, which are fitted with directional control devices, such as prismatic panels or louvers can prevent excessive glare. The incandescent types of lighting, usually the tungsten filament lamps, have been replaced by fluorescent discharge tubes, the reason being that:

- The fluorescent tubes give a more diffused light
- Operating cost is much lower
- They are nearer to daylight

Incandescent sources are usually shielded to avoid glare. Frosted light bulbs helps to reduce glare, glare is a strong light from a source that cause eye discomfort.

Tungsten particles are emitted from the lamp filament; hence the glass tube darkens with age, causing less light to be emitted by the bulb. Incandescence sources produces light composed of all wavelength of visible spectrum though the light is predominantly yellow.

Lighting efficiency

The amount of illumination from a particular lighting design depends on the following factors;

- Illuminating power of the source i.e wattage of the lumps used
- Efficiency of the fitting
- Distribution of light from fitting
- Depreciation
- Size of the lab
- Colour of the ceiling, walls and furnishing
- Height of the fitting

Illuminating power of the source

This is usually indicated by the manufacturer e.g. 20w, 40w etc

The rating output maybe reduced by the type of shade or masking device used with it, if any. Some form of control may be necessary to reduce glare or direct light

The light from the source

It is controlled by reflecting or a transmitting a medium. The degree of control is determined by the reflectance, transmission or absorption factors of material used. Perfect mirror surfaces reflect light regularly, other surfaces e.g. porcelain enamel produce diffused reflection i.e. mixed reflections, while other surfaces e.g. ribbed glass may produce scattered reflections. Light is transmitted regularly in clear glass, while translucent glass produce diffused transmission; hence the choice of material used to control light is very important. All these factors determine the efficiency of a light fitting

To avoid depreciation in illumination of a light fitting the choice and place of fitting must allow cleaning and servicing, depreciation may occur due to;

- ageing of labs
- dust on the fitting
- difference between the recommended and the actual voltage used

For full efficiency, the walls and the ceilings must be cleaned regularly and repainted.

The number and position of light source depends on the size of the lab, the amount of reflected light reaching any position in the lab depends on the overall size of the lab.

Distribution of light from a fitting

Depending on the way they distribute light from the source, fitting may be classified into 5 types.

S/NO	**Type**	**% light in upward direction**	**% light in downward direction**
1	direct	0-10	100-90
2	Semi-direct	10-40	90-60
3	General diffusing	40-60	60-40
4	Semi-indirect	60-90	40-10

5	indirect	90-100	10-0

Direct lighting

Is used where good lighting is required on working plane, it tend to produce shadows and a dark ceiling effect, this effect can be minimized if the furniture and the floor is of reflective nature.

Indirect lighting

There is little shadow effects that is experienced but the ceilings and upper side of the walls should be of light colour with no glare.

Diffused

Shadows may be avoided by using diffused lighting. It also gives an even illumination. It tent to produce a glare hence it is not recommended for visual tasks and prolonged eye work. The walls and ceilings must have high reflective values.

Semi-direct and semi-indirect

A skillful use of direct and indirect lighting will combine the characteristics of the two types of lighting already mentioned above.

Renovation of a building into a lab

Drainage

A proper sewerage and drainage system should be installed; lab waste water should drain into the local authority sewage system or into a soak pit. Waste water should never be allowed to the ground outside the lab or run into open drains for this will contaminate the environment and cause infection to both plants and animals. Bottle traps, catch pots, should be filled and the sink to prevent the backflow of gases into the lab from the sewage system.

Lighting

Both natural and artificial lighting should be installed. Size of the windows, lab orientation and the type of artificial lighting system design should be considered.

Service

This includes water, gas, electricity and compressed air.

Water

The sources of water includes

- Rain water
- Piped water
- Well water
- Stream

The type of water used in the lab includes

- deionized water
- distilled water
- tap water

This type is used for various purposes in the lab i.e. cleaning apparatus and preparations of reagents.

Gas

The mode of gas supply includes:

- Piped gas
- Boiled gas

Piped gas is supplied/ distributed to various points on the bench surface from the gas cylinder, preferably from an outside store. Bottled gas is supplied to special burners from a disposable container i.e the containers can be re-filled.

Electricity

They should be adequate electric socket distributed to various points e.g on the benches for practical work and equipment such as balances and microscopes and on the walls for equipments such as refrigerators.

Types of electricity

Alternating currents

Direct current

This A.C and D.C may be supplied in the either variable or stabilized form by various voltage supply instruments. The electric outlets should be isolated from wet areas and water sources

TOPIC 2

LABORATORY SAFETY

Objectives

- Describe sources of dangers in the lab
- Explain prevention of danger in the lab
- Explain safety design features in the lab
- Describe the aspects of essential good housekeeping in lab
- Explain the role of supervisor in laboratory safety

SAFETY IN THE LAB

ACCIDENTS

An accident is unexpected occurrence or injuries to the lab personnel or danger to properties

Results of accident

Causes of injuries

- Disrupt working
- Cause loss of equipment, supplies and records
- Cause damage to the adjacent building and environment
- Cause contamination of reagents

Assessing the risk

- Identifying the common cause of accidents
- Deciding the next cause of action
- Evaluation of the hazard

- Deciding on the safety regulation and awareness needed to minimize the risk and prevent the accidents from occurring.
- Basing on the findings of the risk assessment, written safety measures to be followed should be put in place.
- All the lab personnel should be trained on the how to apply the safety measures in place of work.

Laboratory hazards and sources of danger

- Fire hazards
- Radiation hazards
- Chemical hazards
- Physical hazards
- Biological hazards

FIRE HAZARD

Fire is heat and light evolved during a chemical reaction called combustion. It relights in the presence of oxygen from air and flammable substance.

Causes and sources of fire

Significant fire risk exist in the lab due to

- Frequent use of matches and open fires in close proximity to highly flammable chemicals and reagents
- Overheating of poorly maintained electrical equipment, overloading of electrical circuits due to inadequate ventilation
- worn out gas tubing, pipes and electrical cables
- ignorance of safety rules in the lab i.e
- failure to understand how fire are caused and spread
- failure to follow safety precautions
- lacking knowledge on how to use firefighting equipment
- not knowing the kind of first aid measures to undertake in case of fire accidents
- inadequate storage and disposal methods
- loose clothing when working with naked flames

- poor design of the lab
- inadequate temperature controls

A significant fire risk exist in a lab due to the frequent use of matches and open flames in close proximity to highly flammable chemicals and reagent acetone ,diethyl ether, methanol, methylated spirit, acid alcohol and stains that are alcohol based.

Fire may also be caused by overheating in poorly maintained electrical equipment, overloading of electrical circuits, use of adapters or overheating of electrical motors due to inadequate ventilation

Gas tubing or electrical cables that are worn out or too long

Injury, damage and loss caused by fire can be minimized when the laboratory staff:

- Conduct proper storage of chemicals
- Understand how fires re caused and spread

- Reduces the risk of fire by following fire safety regulations at all times
- Understand what to do once there is a fire outbreak in the lab.
- Understand how to use the firefighting equipment
- Understand how to administer first aid for burns

INFLAMMABLE CHEMICALS

Handling

Solvents with low boiling points e.g. carbon disulphide and ether are the most dangerous, the degree of danger increases as the boiling point of the solvents becomes lower. At the flash points the vapours are given off which can form explosive mixture with air. Handling of bulk quantities should be carried out in fireproof rooms. In areas where the nature of work is that flammable vapours, dust or gases is produced, avoid naked flame, smoking and use of matches. Display warning notices, possible sources of ignition e.g. electric switches, fuse boxes,

sparkling tools and lamps should be well guarded or excluded from the area.

Vapour-tight light fittings should be installed

Use in the lab

Heating

The best method of heating low boiling point solvents is by steam, heating mantle can be used but it is risky in case the heating vessel fractures, the content might seep through to the heating element and catch fire.

Boiling chips

these are small insoluble porous stones carbonates and silicon carbide, they have pores inside which provides cavities both to trap air and to provide spaces where bubbles of solvent vapour can form. These bubbles ensure even boiling and prevent bumping and boiling chips when the solvent is hot, because it can cause the solvent to boil over violently. If you forget to add the chip before you begin, you cool the solution before adding one to prevent loss of the solution. Boiling chips are also used once,

since the pores in the stones become filled with liquid on cooling. the chips prevent large bubbles from forming or bumping, leaving a uniform smooth boil. bumpingis a violent boiling that can lift the entire volume of liquid on one luge bubble and this may result in liquid being thrown out of the boiling flask resulting to hazard.

Heating blocks have an advantage over naked flame since its temperature can be maintained at lower level than the ignition temp of the liquid. For medium boiling point liquid electric water baths can be used

Distillation and extraction

For distillation and extraction of solvent, erect the apparatus on the sand bath i.e on the metal tray containing a layer of sand. Use a ground glass stoppers instead of cork or rubber bungs, which might deteriorate and leak in hot vapours. Do not fill the distillation vessel to more than half of their capacity. Fill the vessel when it is cool. To prevent bumping, bumping stones should be added to the solvent. The stones should never be added when the

solvent is still hot, since it may be superheated and addition of bumping stones would cause a sudden ebullition.

Disposal

It is very dangerous to dispose inflammable solvent by pouring them into a sink, this is because some solvent are toxic while others may cause explosion hazards e.g. carbon disulphide in the presence of oxygen forms an explosive mixture readily in a flame, shock or catalytic agents such as rust which may be present in drains. To dispose spread the solvents in a suitable quantity over a wide area on a waste ground and then allowed to evaporate. The solvent may also be burnt in small quantities in open metal trays in a disposal area. An experienced person should carry out the disposal, other people should be prevented from entering the area until is safe to do so. Materials such as filter papers and solid residues from flasks, if soaked in inflammable solvents must never be deposited in rubbish bins in the lab.

Storage

Bulk quantities of inflammable material should be stored in a fire proof store built of non-flammable materials. The store should be situated at a safe distance from the main laboratory. The store may be constructed of brick and must have a heavy fire proof door. The store should be well ventilated including ventilation at or near floor level because vapours of highly flammable liquids are heavier than air. The floor should be sunken or the sill raised so that in case of fire the content of the store may be retained and the flaming liquid are not likely to be run out and spread the fire to the neighbouring buildings.

Light switches should be fixed outside the store. Vapour proof light fittings should be installed; an automatic fire control method using a piped dry chemical system may be installed. Keep only small quantities of flammable chemicals and reagents on the lab benches and shelves. it should not be more than 500ml.

Cause and prevention of fire

Occasionally the fire brigade personnel should be invited to visit the lab to assess to fire risks and to familiarize them with the layout of the building. Hazardous materials should not be stored unnecessarily in the lab. All hazardous operations should be carried out in specific locations, if fire proof rooms are not available, use of fire-proof partitions should be considered. They are used to prevent the spread of fire.

Sprinkler systems should be installed in suitable locations. Fire prevention also depends on good lab-keeping; this involves tidiness in the lab and stores, inspection and maintenance of the lab and the efficiency of firefighting equipment. Lab staff should know their function or what to do in an event of fire. A good warning system should be installed, spilled solvents should be wiped out immediately, inflammable liquids should not be stored in domestic refrigerator, should not store flammable and

oxidizing chemicals together. One should ensure that bottles and dispensing containers of flammable liquids are tightly closed after use. Before the bottle of a flammable liquid, make sure there is no open flame within 2 meters, when using ether or acetone allow a distance of 3m

Firefighting equipment

Hand-size and large-size fire extinguishers should be installed in the labs; large fire extinguishers should be installed in the corridors. The position, number and the size of extinguishers depends on the size and type of the lab. One fire extinguisher should be positioned at each end of the lab at an area where fire risk is not high. A water hose can be installed at a central point where its length should reach the ends of the lab. Regular fire drills should be held, regularly check the equipment and refill the extinguishers. Safety showers should be installed above the exits in chemical labs, the showers should give a cascade of water and can be used by a person whose clothes are on fire or if a fire or if a person has been

splashed with acid or any other corrosive chemical. Fire blankets should be placed at various points around the lab for quick local action

Classes of fire

Before any fire can be start or be sustained, there must be a source of fuel, a support medium, usually oxygen and sufficient heat to bring the fuel to a temperature at which combustion can be maintained. If any one or more of the three factors is removed, the fire will go out.

Fire risks are classified according to the nature of material that is burning, it is essential to use the appropriate type of fire extinguisher.

S/NO	CLASS OF FIRE	EXTINGUISHER
1	**CLASS A** Ordinary combustible fires e.g. paper Wood or fabric	Water form hose, CO_2 expelled, soda acid
2	**CLASS B**	CO_2 expelled

	Flammable liquid fires e.g. oil, fats Organic solvent	BCF(vaporizing liquid), Foam, dry powder Fire blanket
3	**CLASS C** Electrical fires: caused by electrical Appliance or machinery	CO_2 expelled BCF
4	**CLASS D** Metal fires e.g. aluminium, magnesium or pottasium	Dry Sand Dry powder

FIRE EXTINGUISHERS AND THEIR USE

Water extinguishers

It is suitable for class A fire risks, they are intended to use only on ordinary combustible materials. They may also be

used on flammable liquids which are soluble in water, must not be used on electrical fires, on flammable solvents immiscible in water or on sodium or potassium fires. It functions with cooling effect of water

Soda acid extinguishers

The cylinder is red in colour, consists of a metal cylinder containing a solution of $NaHCO_2$, inside the cylinder and below the plunger is a vessel containing H_2SO_4 acid. When the plunger is struck, the vessel releases the acid which then mixes with the carbonate solution; the gas that is produced creates pressure which causes the liquid to be forced out from the jet. The jet may be directed to a fire from a distance of up to 30 feet.

CO_2 extinguisher

It is the universal fire extinguishers because it can be used to put all types of fire. It has three properties which make it ideal as a fire extinguisher

- It is denser than air

- It does not support combustion
- It does not burn
- It is not poisonous

Foam extinguishers

The cylinder is red with a cream band suitable for class B fire risks, this fires involves flammable liquids. It should not be used in electrical fires as foam is an electrical conductor. The foam is contained in a metal cylinder; it is ejected when pressure from a CO_2 high pressure cartridge below the striking knob is released. The small bubbles of CO_2 which constitute the foam blankets out the flame

BCF (Bromochlorodifluromethane) extinguisher

The cylinder is red with a green band or colour code; it is suitable for class B and C fire riks. It is known as high vaporizing liquid fire extinguisher, may be used on flammable liquid and electrical fires. They should not be used on confined places.

Advantage

It does not produce toxic flames when the liquid comes into contact with fire

The low boiling point and rapid vapourisation makes it an excellent medium for fire fighting

Carbon dioxide extinguishers

Is red in colour with a black band, it is suitable for class B and C fires. It can be used for electrical fires and fires involving materials that are immiscible with water, it can be used on a person whose clothes have caught fire.

It consists of a metal cylinder containing CO_2. The cylinder size ranges from 22.7 kg to 1.3 kg. For large cylinder, CO2 is released by a screw valve, while from small cylinder by a trigger action. The gas extinguishes the fire by blanket action. It is preferred in the lab because of its clean action which is important where expensive equipment is involved. The discharge from the cylinder can be stopped any time and if the cylinder is not fully emptied, it can be re-used again.

Dry chemical extinguisher

The cylinder is red in colour with a blue band, are suitable for class B, C and D fires. It can also be used on electrical and flammable liquid fires as well as fires involving metals. It consists of a metal cylinder filled with a dry powder. The powder is mono-ammonium phosphate, which is;

- non-hydroscopic
- non-conducting
- non-toxic

The powder is released when the CO2 cartridge situated inside the cylinder is caused to release its gas pressure, after use the cylinder can be refilled.

Asbestos Blanket

This is not recommended for bench fires as they are heavy and may damage the apparatus and hence spread the fire. It may be used to smother fires which may occur in large wide-mouthed vessels.

Water

Adequate supply of pressurized water is essential. This is suitable for ordinary combustible materials; it may also be used on flammable materials which are soluble in water.

CHEMICAL HAZARDS

They include those caused by;

Explosive chemicals due to, poor storage and handling of volatile and inflammable chemicals, fuming chemicals, gas cylinder and fire extinguishers

Corrosive chemicals like acids and bases

Poisonous chemicals that is inhaled, swallowed or absorbed

Dangers from explosion

Explosion in the lab may occur due to various reasons;

- Improper disposal of pressurized vessels
- Improper handling liquid air
- Improper handling of gasous mixtures e.g. oxygen and hydrogen

- Improper of flammable solvents
- Improper handling of explosive chemicals

To prevent explosion there should be proper handling and disposal of the above chemicals

Handling of explosives

Buildings where special risks exist due to handling and storage of explosive, should be spaced in such a way that each building is at a safe distance from each other, protective walls or mounds of earth may separate the buildings. Ideally, the buildings where lab tests' involving the handling of explosives is carried out should be of single storey and fire proofed.

The building should be well ventilated and should have wooden floors and benches, electrical fittings should be spark proof, other facilities should include a fume cupboard with a good draught, enough protective clothing. The normal services of gas, electricity and water should be provided including steam. Bulk inflammable

solvents and explosives samples must be kept in special stores situated away from the main building.

When handling explosives they must be subjected to friction or shock, for this reason smooth bottles of good quality closed with a soft rubber stopper are necessary.

Explosives due to inflammable solvents

Volatile inflammable chemicals give off inflammable vapours, when the concentration reaches a certain limit and mixes in right proportion with air their ignition will cause combustion which moves a high speed and with great violence, the sudden expansion which accompanies the combustion constitutes an explosions generally occur when the vapour concentration is low e.g. an empty in inflammable solvent container due to accumulation of air and vapour mixture in them, can be dangerous than when full.

Explosion due to liquid air

Materials such as cotton wool burn explosively if contaminated with liquid air. Liquid air also forms

explosive mixtures with reducing agents, and is dangerous in the presence of hydrocarbons. Good traps should be used when liquid oxygen is being used as a coolant and it is much safer to use liquid nitrogen.

Explosion due to dust

Dust from combustible substances can, if is dense enough and when mixed with air, ignite and explode violently. This is due to its rapid combustion and expansion. Avoid formation of explosive, irritant or toxic dust; this can be done by enclosing source and exhausting the dust locally. Keep the exhaust system clean and regularly test its efficiency. In areas where is not possible to prevent dust formation, all likely source of ignition must be excluded. For personal protection use gas mask or respirators, some operations need to be conducted in an inert atmosphere while other wet methods of grinding may be possible in order to avoid the formation of dust.

Explosion due to gases

Many gases are explosive when mixed oxygen or air, pieces of apparatus used to contain or transport such gases should be made safe after use by filling them with water or by blowing air through them.

Hydrogen

The gas explodes when mixed with oxygen, therefore precautions must be taken when using hydrogen in the lab e.g. when a jet of hydrogen is to be ignited, it must first be sampled to see that all the air has been expelled from the gas producing apparatus, hydrogen is a light gas that easily diffuses through small apertures into lines and vessels to form explosive mixtures.

Fuel gas

It forms extremely dangerous mixtures with air. if a leak is detected, open all windows and doors immediately.

Explosions due to chemicals

Many chemicals used in the lab are explosive in nature or form explosive compounds, care must be taken when

working with the following chemicals in the lab: conc acids, conc H_2O_2 and perchloric acids

Peroxides

They can be very dangerous even in storage, hydrogen peroxide may decompose explosively especially when in contact with dust and fine metals, it is safe to store when diluted, and in cool condition, it causes white blisters, if it comes in contact with skin.

Ether peroxides

They are formed by oxidation of diethyl ether, isopropyl ether and higher ether especially in the presence of UV rays. For this reason, ether should be stored over a spiral of bright copper, active carbon or aluminium oxide or in an atmosphere of nitrogen, which prevents the formation of peroxides. Keep peroxides wrapped in black paper, brown bottles are not suitable. The oxidation of ether proceed very fast when the bottle is partially filled and the liquid surface is in contact with air.

Perchloric acid

If the solution comes in contact with a strong dehydrating agent, the anhydrous perchloric acid formed is explosive, if anhydrous acid, which is a volatile colourless liquid, is prepared, it may explode after standing for a few days. If drops are allowed to dry on woodwork, brickwork or fabric this chemical will explode or catch fire on impact. A drop of acid in contact with charcoal will explode; organic matter should never come in contact with perchloric acid or with a solution of the acid. Special fume cupboard are necessary to wash perchloric acid vapours or accumulation of dust or residues in the ducts of fume chamber in which perchloric acid is used may lead to an explosion.

Precautions taken with explosives material

There is always an element of risks involved when performing experiments involving the use of chemicals substances and gases.

- The experiment may be best conducted in a specially protected area, in a fume cupboard or in open air.

- Obtain permission before conducting a hazardous experiment
- Experiment involving volatile solvents should not be carried out in the presence of flames
- If the behaviour of a substance is in doubt under the conditions in which is to be used, first use a small quantity.
- This should be heated in a water bath and not on an open flame.
- Wear protective clothing
- When using glassware for pressure or vacuum work, the correct thickness and shape of the vessel should be used
- The apparatus should also be shielded by appropriate guard or safety screen.

PRESSURE VESSEL

Autoclaves

They are best placed behind a solid wall which provides complete protection for the operator. The autoclave should have an efficient safety valve and regulator, the working of the valve and the regulator must be checked regularly. The safety valve should be set at a pressure not exceeding three third of the test pressure. When choosing a pressure vessel, the temp and the pressure must be considered in determining whether the vessel is suitable for the conditions it must withstand. The material making the vessel must be must be suitable for use at working temperature. After use immediately clean the vessel and check all working parts.

DANGERS IN STORAGE

Planning chemical stores

A well-designed store minimizes hazards associated with storage of chemicals, liquid reagents and gas cylinders. The store must be:

- Well ventilated

- Spacious to allow good clearance in the aisles
- Situated on ground floor
- Have the fire proof door that opens to the outside
- Moderate and even temperature should be maintained
- An outside opening door allows direct access to the open air in an emergency
- It also allows a convenient and safe delivery of packages
- Separate rooms are needed for safe storage of acids, ammonia and gas cylinders
- There must be adequate safety measures i.e. adequate fire extinguishers, protective clothing and vapour proof tight fittings
- There must be a good supply of sand shovel and an all-purpose respirator
- Sprinkler system is recommended if the materials are safe when water is used

GENERAL PRECAUTIONS FOR STORES

Smoking

Smoking in stores should be prohibited

Unauthorized persons should not be admitted and they should not be allowed to dispense or carry stores material.

Shelving

Shelving must be strong and should be able to withstand the weight of materials stored on them. Care must be taken to ensure that accidents arising from leakages or spillage of any material are prevented; hence a beading that protrudes above the front edge of the shelving is fixed Use of chairs and stool for reaching materials on the shelves should not be allowed, a pair of non-slip steps or a ladder should be provided. Heavy items should be stored on the lower shelves.

Trolleys and carriers

They are good for safe transportation of materials, safe hand carriers for Winchester bottle and other bottles are necessary.

Inflammable materials

It should be kept in a separate inflammable store, wood wool from unpacked box and other packing materials should be taken outside to prevent the accumulation of combustible material in the store

Acid stores

The floor should be made of cement and allowed to slope towards a drain in one corner. Shelves are best constructed by inert material such as precast slabs, made with acid resistant cement.

The shelves should not extent too high up the walls. A supply of water for washing the floor in case of spillage or for emergency use in case of personal contamination must be available.

A large container of soda ash or $NAHCO_3$ should be kept ready for use. An eye wash bottle to irrigate the eyes is also necessary. Safety siphons and carbonyl tilters must be kept in the stores for dispensing acids and other dangerous liquids. The store should have a strong ventilating fan.

Ammonium stores

Where large quantities of ammonia are used, a separate store is recommended. Its construction should be similar to that of acid store.

STORAGE OF CHEMICALS

Hazardous Combinations

Avoid hazardous combination of chemicals during storage to reduce the risks of fire, explosion and fumes. Strong oxidizing agents and oxidiziable materials should not be kept close together. Chemicals liable to react vigorously with oxidizing agents, must be stored apart e.g. HNO_3 acid and hydrocarbons.

Sodium which is kept in closed containers under naphtha and white phosphorus, which is stored under water, should be separated. This is because the chemicals are dangerous and resemble each other in appearance and the media in which they are stored are dangerous to one another.

Volatile liquids

Volatile liquids such as ether and nitric acid exert pressure during storage hence should be kept in a cool place away from direct sunlight, hot water pipes, radiators and other sources of heat. The containers with volatile liquids should never be completely filled and open with care. It is advisable to wear goggles. Never store inflammable liquids on the open shelving, empty inflammable liquid containers must be covered securely or may be kept filled with water

Chemical containers

Bottles containing dangerous substance e.g. Bromide must not be kept on high shelves. Any bottle containing chemicals that can give off toxic fumes or highly objectionable odours, if broken, should be store in a safe place. Chemicals such as Phosphorus pentoxide and Sodium peroxide should be kept tightly sealed and when opened should be rewaxed around the stopper after use. When the spillage of substance may result in dangerous

conditions, it may be kept in a shelf inside a large inert container which will contain in the event of breakage.

Labeling of Containers

All containers should be labeled before filling; containers must only be filled with substance detailed on the label.

DANGER FROM DISPOSAL OF CHEMICALS

Unwanted chemical usually accumulate in the lab due to:

- deterioration of labels
- through contaminations
- as residues

Such chemicals may be of known or unknown character hence their disposal maybe pose an element of danger. If any doubt exists concerning the handling of chemical during disposal, someone with specialized knowledge of chemicals should be consulted.

To accurately assess the degree of danger involved in the disposal of chemicals, a good knowledge of their properties is required. If the nature of the chemicals is

unknown, extra care is needed and very small amounts of the substance should be tested before disposal is attempted. if the substance is a solid the following may suggest the best method of disposal:

- Appearance
- Odour
- Inflammability

In case is a liquid the following are important indication:

- Miscibility
- Inflammability
- Volatility
- Odour

DANGERS OF POISONOUS CHEMICALS

A poison is any substance which when taken alters the normal functions of the body

Types of poisons

Toxic chemicals; this includes heavy metals, lead. Arsenic, antimony, herbicides, acaricides and pesticides

Carcinogenic chemicals (cancer causing chemicals) these chemicals are capable of inducing cancer, they cause tumors in tissues, and they include acetone, benzene, formalin, benzyl chlorides chlorophenols and mercury.

Corrosive chemicals they corrode the skin on contact e.g. Acids and Bases

Precautions

- Avoid body contact with all chemical
- When handling the chemicals use protective clothing e.g. lab coats, hand gloves and goggles
- When pouring and diluting the chemicals always use the fume chamber
- Use trolleys, Baskets for carrying spillable materials
- Methodical transfer of liquids by use of funnels, pipettes and burettes

- Good housekeeping e.g. pouring of liquids, rinsing of apparatus
- Flash out chemicals from sinks using copious amounts of water

Hazards associated with the transport, storage and handling of chemicals can be minimized if the lab workers know:

- Which chemicals are hazardous
- How to handle them
- How to store them properly

In general, keep chemicals out of direct sunlight and prevent their overheating in the lab as this can cause:

- Decomposition of chemicals
- Explosion
- Fire
- Formation of toxic fumes

Label the chemicals or reagents clearly

Before storing or using the chemicals the worker must read the safety and risks phrases written on the label and understand.

The hazard symbol used

Chemicals can be classified into six classes, depending on the nature of the danger associated with a given material

CLASS I: Explosives and unstable substances

CLASS II: Oxidizing

CLASS III: Flammable substance

CLASS IV: Toxic and Harmful

CLASS V: Corrosive and Irritating

CLASS VI: Radioactive material

signs diagram

DANGERS FROM GAS CYLINDERS

Storage

The storage room should be unheated, the room should be protected from extreme heat, cold and direct sunlight. Smoking and use of naked lights should be prohibited in the store room.

Light fittings should be vapour proof type; light switch should be positioned outside the room. The best position for the store should be close to an outside exit. Separate room for empty and full cylinder is advisable. Cylinders containing poisonous gases must be stored in an outside store and must be protected from direct sunlight.
Cylinders must be stored in upright position and secured to the walls with their protective metal caps in place.
Acetylene cylinders must always be stored in upright and be kept separate from oxygen cylinders, damaged cylinders must be returned to the supplier with a note giving the details of the nature of the damage. Display warning notices on the doors of rooms where cylinders containing flammable gases are stored
Store rooms should be well ventilated at the top and at or near floor level. Protect the cylinders from corrosion and rusting conditions.

Handling

Fix securely the gas cylinder using a chain onto the wall or on a solid bench to avoid it being dislodged. Always turn off the main high pressure valve when the equipment is not in use.

Use a trolley to support gas cylinders when they are being transported with caps in place. Gas cylinders must never be banged together, rolled, dragged or dropped, they must be transported singly with the valve closed and all fittings and regulators detached. Poisonous gas cylinders should always be lifted by two people; it is always dangerous for one person to attempt to carry gas cylinders as this might result to serious internal injuries.

Do not handle oxygen cylinders valves with greasy hands, glove or rags since these will burn fiercely in oxygen if ignited by a spark

Suspected leaks should be tested outside using soapy water. A cylinder should never be emptied completely, it is best left with slight positive pressure and the valve

closed to prevent diffusion of air into the cylinder, this is important especially with flammable gas cylinders.

Valves and Fittings

Use the correct pressure regulators according to the gas contained in the cylinder, regulators are usually painted the same colour as the cylinder for which they are suitable, or the name the gas is marked on the. The regulators should not be hammered tight in the valve, hand pressure and the current key is sufficient. Valves should be turned on slowly; a sudden release of pressure is dangerous and may damage the pressure regulator. Do not over tighten the valve when shutting off the gas and use hand pressure only. Over tightening will damage the valve spindle. Never lubricate valves and fittings of the cylinders, keep the valve threads free from dirt, grit, water, oil and grease. Oil and grease must never come in contact with oxygen and acetylene valves since they

ignite violently and may cause an explosion. Oxygen valves should not be handled with greasy hands, greasy rags or when wearing greasy or oily clothes.

Cylinders, valves, pressure reducers and gauges for combustible gases e.g. hydrogen and ethyne have outlets and fittings screwed with the left hand and thread. Those for non-combustible gases e.g. oxygen and nitrogen are screwed with a right hand thread.

Cylinders in the lab

They must never be laid in the lab floor; it should be secured in a stand or chained to a bench. Disconnect the cylinder from the apparatus or plant with which they were being used after use or when the lab is to be closed

Acetylene cylinders

With copper, silver or copper alloys which contain more than 70% copper, acetylene may form explosive compounds, never use copper pipes or joints with this gas. The cylinders may become hot due to backfire from faulty equipment or other accidental heating. If this happens

close the valve and take the cylinder outside into open air and cool it with water. Open the valve fully while cooling

S/NO	GAS	CYLINDER COLOUR	SHOULDER COLOUR

the cylinder as you allow its contents to escape.

Chlorine cylinders

They are fitted with special needle valves, which corrode and become jammed and in some cases the needle breaks off hence chlorine cylinders should not be stored for a long periods. It is advisable to return them to the suppliers even when they still contain gas rather than risk the possibility of having a stuck valve.

COLOUR CODE FOR CYLINDERS

1	**Acetylene**	**Maroon**	**-**
2	**Air**	**Grey**	**-**
3	**Argon**	**Blue**	**-**
4	**Ammonia**	**Black**	**Yellow/ Red**
5	**Carbon dioxide**	**Black**	**-**
6	**Carbon monoxide**	**Red**	**Yellow**
7	**Chlorine**	**Yellow**	**-**
8	**Coal gas**	**Red**	**-**
9	**Helium**	**Brown**	**-**
10	**Hydrogen**	**Red**	**-**
11	**Methane**	**Red**	**-**
12	**Nitrogen**	**Grey**	**-**
13	**Oxygen**	**Black**	**-**
14	**Sulphur dioxide**	**Green**	**Yellow**
MEDICAL			

1	**Air**	**Grey**	**White**
2	**Carbon dioxide**	**Grey**	**-**
3	**Helium**	**Brown**	**-**
4	**Nitrogen**	**Grey**	**Black**
5	**Nitrogen oxide**	**Blue**	**-**
6	**Oxygen**	**Black**	**White**

The content of a gas cylinder are denoted by the colour of the cylinder

DANGER FROM RADIATIONS

Lab technicians may be exposed to harmful ionizing radiations from radioisotopes or from x-rays produced by certain types of equipment. Lab technicians should keep themselves updated with current safety measure to ensure maximum safety in the lab and overcome any possible harmful effects.

Types of Radiations

These forms of radiation associated with disintegration of radioactive isotopes are

- Alpha
- Beta
- Gamma

They differ in their penetrating and ionizing powers

ALPHA PARTICLE

- They are helium nuclei He^{2+}
- They are positively charged
- Have little penetrating power
- Have greater ionizing power

BETA PARTICLE

- They are positively charged particles
- They are electrons in nature
- Have a moderate power of ionization
- Have moderate penetrating power
- They are given off by most disintegrating radioactive isotopes

X-RAYS AND GAMMA RAYS

- They are electromagnetic waves. Gamma rays have a shorter wave than x-rays
- Gamma rays have a greater penetrating power than x-rays
- X-rays are emitted by radiographic, fluoroscopic and similar equipment

Mode of entry into the body

Radiation may enter the body through

- Penetration through the skin
- Ingestion
- Inhalation inform of gas and dust
- Through cuts in the skin

Alpha particles cannot penetrate the skin but are dangerous if inhaled or ingested, similarly beta and gamma emitting substances are dangerous if taken into the body or when one is exposed to them. Gamma rays

are more dangerous since they are more difficult to screen than the less penetrating beta particles.

Hazards due to radiations may be prevented by providing:

- adequate shielding
- special methods of ventilations
- clean and efficient methods of working
- proper storage of radioactive materials
- use of protective clothing

Measurement of radiations

In labs where radioactive material is handled, frequent measurements of radiations to which occupants are exposed are necessary. Monitoring instruments are used to determine the dose received by an individual over a period of time, the systematic measurements of radiations in the lab including the level of contamination.

Film badges

They are used to measure the dose of radiations received by the worker over a period of time. The badge consists of

a photographic film enclosed in a small holder. It is worn on an unscreened position on the lab coat. If hands are receiving more radiations than the rest of the body badges of similar type are worn on the wrist or as a ring on the finger. The sensitivity of the badge varies with the type and sensitivity of the film used in it. At regular periods the badge is replaced with a new one. The exposed films are processed and the results recorded, in this way a complete record of the dose of the radiations received by the individual is maintained

Pocket dosimeters

They are in the form of ionizing chamber; it is about the same size with a fountain pen. It has a small scale from which the number of dose units may be read i.e. it is direct reading dosimeter

Monitors

There are various types of monitors. They are used to measure radioactive contaminations in working areas and in the surrounding inactive areas.

They may be used as portable or fixed instruments for monitoring working conditions and lab operations. The monitors consist of a detector unit such as the ionization chamber, a Geiger-muller tube or scintillation counter. These units are used together with a power supply and a counting rate meter. The detectors may be in the form of a probe head which is attached to the measuring instrument by a flexible cable. Probe unit vary in design depending on the nature of radiation they are required to detect.

Stationary Monitors

They are used in fixed positions to measure contamination on the hands and on the feet of workers leaving the active areas. They are also used to monitor the whole building and in this case may be incorporated into the building alarm system. Stationary monitors may be used for continuous monitoring of the atmosphere and for

monitoring the liquid flow such as waste water and in this case, it may be connected to the alarm system.

Measurements of contamination

Smear test (Swipe Assay)

It is used to assess the level of contamination on the lab surfaces, the air is drawn through the filtering medium, and this is then monitored by a cavity unit.

Protection against radiation

Alpha particles

Their range in the air is about 25cm; hence there is no possibility of them penetrating through the skin hence there is no need for special shielding. For perfect safety rubber gloves and a light mask to cover the nose or the mouth should be worn. The active material should be as far as possible, handle the material behind a glass screen.

Beta particles

They have a much longer range of several meters and can penetrate the skin tissue. They may be stopped by a shielding material such as glass, aluminium or Perspex.

Gamma rays and X-rays

They have a greater penetrating power; the shielding used is made of lead or concrete. The lead shields are usually made of interlocking lead bricks. The shield is made in such a way that the radiations cannot escape at any place where manipulating rods pass through them. Further protection may be achieved by led impregnated apparel e.g. gloves. Concrete shields should be much thicker than lead brick shield, mirrors and periscopes are used for observation purpose

SAFETY PRECAUTIONS

When working with radioactive material in the lab:

- Observe normal lab rule i.e. no drinking or eating in the lab
- Always wear a lab coat and other protective clothing, if possible, a lab coat should be set aside specifically for this purpose and monitored regularly.

- Thoroughly wash your hands with soap and water after leaving the working areas until no significant activity remains. Use disposable towels to dry your hands.
- Mouth operations must never be allowed e.g. licking labels
- Keep a set of glassware exclusively for work with radioactive materials.
- Label all radioactive materials clearly with an appropriate warning signs
- Part of the lab should be set aside for work with radioactive materials
- If possible confine work with radioactive material to a set of large plastic trays lined with proper towels
- Work should never be undertaken by anyone with a cut, abrasions or any other open wounds
- Use fume cupboards especially if the experiments will give rise to fumes or sprays

- Glassblowing should never be allowed in the active areas
- If small accidental spills occur wipe them out from the bench top using a paper towel, cotton wool or any other adsorbent material held in tongs and then place the material used in the radioactive waste bin.
- Containers of radioactive material should be opened in the fume cupboard or in a dry box.
- Use tongs to hold the containers when they are being opened and not hands.

DECONTAMINATION

Apparatus

Decontaminate all apparatus and tools after use; the method of cleaning depends on the nature of equipment or apparatus. Glassware may be cleaned by normal cleaning agents e.g. chromic acid and detergents may be used on

tools ,Some items may be difficult to decontaminate using cleaning agents and may be kept in special containers until the contamination has decayed.

Label these containers clearly, with the contents and the date which the radioactive will have decayed to safe level.

When accidental spillage or release of radioactive powders or aerosols to the atmosphere occurs employ emergency procedures, followed by rigorous decontamination of the area. If an inhalation hazard occurs, the room should be evacuated, person involved should remove all contaminated clothing, they should wash thoroughly all contaminated parts of the body until no activity remains. They should be monitored before being allowed to leave the lab. The general safety procedures include:

- Informing the safety officer
- Warning the person in the vicinity
- Taking steps to avoid the spread of contamination

- Seal off the area and display notices prohibiting entry into the area, if the area cannot be effectively decontaminated.

Personal decontamination

Use of soap and water is usually sufficient to decontaminate the skin, if the eyes are affected, immediately irrigate with water. Give special attention to finger nails, a soft brush may be used for obstinate contamination.

Working areas

Use soap and water to decontaminate large surface areas e.g. bench tops. For obstinate contamination the surface may have to be removed by solvents paint removers.

Disposal of radioactive waste

For normal lab waste material, provide a pedal operated waste bin. The bin should be lined with waxed paper or plastic bags mark the bin as radioactive waste. Disposal methods of waste material are determined by the nature and degree of toxicity of the material concerned.

Solid waste

Bags containing solid waste should be tied at the neck. If the material has a short half- life, the bags may be stored until the activity reaches a safe level. The material can then be disposed through the normal refuse channels. Material with a long half- life are placed in safe storage until a competent authority gives permission for them to be disposed at sea in special containers or by other means. Animal carcasses are incinerated provided care is taken in respect to the gases and ash produced.

Liquid waste

Liquid waste involving radioactive material should not be disposed down the sink. Radioactive solutions with short half- life may be kept in safe storage until the activity has dropped to safe level; with permission from environmental agencies this may then be disposed into sewers. The disposal is usually accompanied by dilution

with large quantities of water or by addition of inactive carriers. Small quantities of liquid can be kept in stoppered plastic bottles, which are then placed inside large and strong containers, which can retain the contents in case the bottle breaks. Large quantities of liquid can be kept in special tanks until the activity has decayed.

Gases

Labs ventilating systems should be that airborne effluents are discharged well clear of all buildings.

Storage of radioactive sources

High activity sources should be stored in special store room preferably outside store. The store should be adequately shielded and protected from fire. The store room should be adequately ventilated, if gases and vapour are likely to be evolved from the solid materials, mechanical ventilation to the outside is necessary. The room should be monitored regularly to assess the inside and outside radiations which should not exceed certain levels. Glass vessels containing active materials should be

stoppered with cork, polythene or rubber stoppers and not glass or screw on stoppers. Solutions that are thermally unstable and contain radioactive material should be stored in vented containers. All the stored sources should be fully labeled, and records kept of their purchase, issue and receipt should be kept. Sources of low activity may be kept in special containers that are shielded.

Radiation exposure

It is a measure of ionization produced in air by X-rays and Gamma rays. The unit of exposure is Roentgen; acute radiation exposure is an exposure of a short duration to intense ionizing radiation, usually occurring due to an accidental spill of radioactive material.

Exposure of the whole body to approximately 10,000 rad causes neurological and cardiovascular breakdown and can be fatal within 24 hours. A dose of about 500- 1200 rad destroys the gastrointestinal mucosa, produces bloody

diarrhea and may cause death in several days. A dose of about 200- 500 rads destroys blood producing organs and may cause death in few weeks.

Emergency procedures

For a person who has received external body radiations through exposure to radioactive material or internal radiation contamination by inhaling or ingesting radioactive material:

- Should be treated by cleaning and surgical isolation to protect other parts of the body
- Should be given first aid treatment similar to a person that has been exposed to chemical poison
- Body waste should be collected and checked for radioactive levels
- If the victim has also suffered a wound, care must be taken to avoid gross-contamination of exposed surfaces

- Apart from taking special precautions to control the spread of radiation effects, give the victim any life-saving emergency treatment needed
- Any person handling the patient should wear surgical gowns, caps and gloves.

First aid

- Check the person breathing and pulse
- Start CPR, if necessary
- Remove the person clothing and place them in a sealed containers, this stops further contamination
- Vigorously wash the body with soap and water
- Dry the body and wrap with a soft clean blanket
- Call for emergency medical help or take the person to the hospital
- Symptoms of radiation exposure
- Bleeding from nose gums, mouth and rectum
- Dehydration

- blestering,skin burns and inflammation of exposed parts
- Vomiting blood

DANGER FROM GLASS

This may occur when;

- Cutting glass tube or rod while not using the proper method
- Heating glass, glassware that is to be used at high temperature or heat sterilized is made of pyrex or other heat resistant glass
- Carrying glass e.g. Winchesters
- Bending glass tube or rod without using a cork borer
- Using cracked glass or glassware with wrong shape and thickness for pressure and vacuum work
- Inserting glass tube or rod through rubber bung
- Handling broken or chipped glassware

Cutting glass tube and rod

To cut small diameter glass tubing or rod into a shorter lengths

First mark it with a glass knife or triangular file

Place the thumbs one each side of the mark and close to it

Then pull the glass slightly towards its ends and at the same time break it away from your body in one motion, the hand should be protected with a piece of cloth.

Flame polish the cut ends before using them in apparatus

NB This method is suitable and is risky with glass tubes with more than 15mm bore

Cutting glass sheet

Safe and successful cutting of glass sheet is achieved through practice. A sharp tool is essential and a diamond glass cutter is the best. Cutting is done on a level surface e.g. a good bench top or the table. Lay the glass sheet on the table and measure out the position of the cut.

Hold a straight edge steadily against the stops in line with the pencil marks; draw a light scratch using the diamond cutter across the surface of the glass once.

Never try to deepen the cut by retracing the original scratch mark as this will result to ragged edge and failure to cut the glass. Note that new glass cuts well than old glass.

With both thumbs one on each side of the scratch, break the glass.

Bending glass tube

The bend should be well rounded in order that the tube retains its original diameter. Flat or distorted bends should not be used. They should be discarded. Good bends assists the function of the apparatus and also prevents the accidents from occurring when the apparatus is being assembled. Flame polishes the sharp ends of the glass tubing.

Heating glass

When glass is heated, stresses and strains occur; the amount of stress and strain depends on the composition and thickness of the glass. The glass can only withstand a limited thermal or physical shock before it cracks. When heating liquids, heat resistant glass should be used, it should also be used when heat is likely to be evolved when diluting or dissolving a substance. These operations should never be carried out in non- resistant glass vessels e.g. Winchester bottles

Carrying glass

To avoid accidents when glassware is being transported, lab floors should be non-slippery and sensible shoes should be worn.

The path should be free from obstruction and spilled liquid should be wiped out immediately. Winchester bottle should not be carried by the neck or cradled in arms. Use carriers and trolleys to transport Winchester.

Issue of glassware

Never use damaged glassware. It should be discarded and placed in a metallic bin, if the damaged glassware can be repaired place it in the repairable glassware box to await repairs

boring corks and rubber bung to make glass tubing

Corks and bungs should be held by their sides between forefinger and thumb and bored on a piece of timber. Bore from then arrow end by rotating the borer in one direction. When boring a hole in the cork, the bore used should have a fractionally smaller diameter than that of the glass tubing to be inserted sothat no undue force is exerted when inserting the tube.

First lubricate the cork borer with glycerol teepol or soft soap to assist the operation

diagram

Inserting a glass tubing

After boring a hole as shown above, select and lubricate the next largest cork borer and slide it over the first until it has passed through the bung. Withdraw the smaller cork

borer and slide the glass tube into the position. Consider the amount of tube length required on the either side of the cork, and then withdraw the cork borer.

Alternatively, a special tool consisting of steel tube set in a handle can be used. The tube is filled with a bullet nosecap. The nosecap is removed when the tool has been pushed through the rubber bung. The glass tube is then inserted through the hollow steel tube, which is then withdrawn leaving the glass tube.

Removing a stuck glass tube

Rubber bungs which are in contact with glass tube for a long time get stuck to the glass. A safe way to remove the bung is by either to cut it off or use a cork borer or the special steel tool. Select a cork borer which is slightly larger than the outside diameter of the glass tube.

Lubricate the borer with glycerin. Insert the borer into the bung using the glass tube as a guide. Withdraw the glass tube, and then remove the borer from the bung.

If the steel tool is to be used to free adhering glass tubing, the nosecap is removed before inserting the tool; same procedure is used as with the cork borer.

Glassware from vacuum or pressure work

Under pressure or vacuum conditions, glassware which is only scratched can be very dangerous. The glassware to be used for this work should be thick walled and should be protected by a wire mesh guard. Goggles or screens should be used during the experiment as a safety precaution.

Cork and bung used must fit very well and must not protrude too far into the neck of the vessels. After evacuation of the glass vessels, air must be admitted back into the glass vessel slowly, especially if organic solvents are involved. When glassware containing volatile substance is shaken, the pressure which builds up must be released from time to time.

Other dangers

Round bottomed glass vessels should always stand on cork ring support. Glass tubing stored in racks should not protrude beyond the ends of the racks

In gen dangers from glass can be prevented by

- Proper handling
- Flame polishing
- Proper of glass
- Use of cork borer
- Use of wireless guards goggles sand screens

Dangers from general lab operations

Acids

When diluting conc acids pour acids into water and not water into acids

Rubber gloves and goggles should be worn

Sometimes stoppers in conc acid bottles get stuck, to deal with this problem, wear protective clothing. Place the bottle in a preumatic trough, which may be placed in a larger sink and then cover with a stopper and the neck of

the bottle with a cloth. Gently tap the stopper and the neck of the bottle; if this method fails it may be necessary to cut the neck of the bottle. This can be done by marking the bottle around the middle of the neck with a file. A point of the glass is then applied to the file mark.

When pouring the acid, the attention of the operator should not be distracted, after pouring the bottle should be flashed on the outside with water. Any vessels which gas contained an acid should be rinsed out with plenty of water immediately and be left to be washed later. Never place con acids and alkalis adjacent to each other on the shelves.

Acid slash to the skin should be flush immediately with a lot of water and afterwards a solution of $NAHCO_3$ should be applied. Acid splash on the bench must be wiped out immediately. When acid is being discarded, run plenty of water into the sink.

Ampoules

Care should be taken when sealed ampoules containing dangerous or low boiling point liquids are opened. It is recommended that the ampoules should be cooled in water.

If necessary, they should be progressively cooled to lower the temp by using the water, ice salt or solid carbon dioxide and solvent

Sodium

Keep a limited amount of sodium in laboratory reagent bottles. These should be cut into small pieces, the larger pieces or quantities should be kept in the lab store. Regularly inspect the bottles to ensure that sodium is covered with naphtha. Remove every trace of sodium before the bottles are put out for washing, old sodium is disposed of by adding it carefully in small quantities to alcohol.

Pipetting

Poisonous, corrosives or volatile liquids should never be mouth pipetted. A rubber bulb pipette or a safety pipette

should be used. Rubber bulb pipette or automatic pipettor are recommended for all liquids and are more hygienic. Pipettes should never be laid down with the ends protruding beyond the edge of the bench.

Sulphurated hydrogen

Is an extremely dangerous gas, it forms an explosive mixture with air and has a characteristic odour of a rotten egg, when the concentration of the gas is high one loses the sense of smell.

This gas must always be used in a fume cupboard. Should large quantities of this escape in the lab the room must be vacated and entry prohibited until the gas is dispersed. When the conc is diminished and it is safe to enter the room with a breathing apparatus or a respirator.

Picric acid

Is a fairly strong acid, it must be stored under water, if allowed to dry it can become explosive. This can occur if the chemical is left to dry in pipes without being flashed

away with adequate amount of water. Picric acid is also explosive when in contact with ammonia and metals.

Diethyl ether

Is a colourless, highly flammable and volatile liquid, its vapours forms explosive mixtures with air, when exposed to air and sunlight, ether absorbs oxygen to form peroxides, which explodes when heated.

Potassium chlorate

It is used in making safety matches and fireworks; it forms explosive mixtures with carbon, phosphorus, sulphur, powdered metal and organic substances.

Furniture

Lab furniture whether wooden or metallic must be of high quality, its surface must be non-absorbent; benches must be of correct height depending on the work to be done on them. Benches should have enough sinks for easy access by any person in case of an emergency. Shelves above the benches should not be too high, the shelves should have a beading fixed on their front edge to prevent the bottles

from being knocked off easily. Bench service control should be positioned in the bench in such a way that is not necessary to reach over the bench.

Service pipes should be painted with the appropriate colour for easy identification.. There should be enough bins for the lab waste and the bins should be appropriately labeled with the type of waste.

BIOLOGICAL HAZARDS

Biological materials that may cause hazards includes

- Microbes i.e bacteria fungi virus and protozoa
- Poisonous plants i.e. Datura stramonium
- Poisonous animals i.e. spiders snakes

Microbial hazards

Are likely to occur if appropriate measures are not taken during microbiological work,these precautions will protect both the laboratory worker and the animals from being infected. Precaution against infection includes one

must wear the lab coat when working with microorganism and should be cleaned regularly.

Dirty clothing should be placed in a special bag and not left in the cupboard or on laboratory bench. Before washing they should be soaked in 1% domestic bleach.

Protective clothing must be left within the working area and never be taken home or worn in room where refreshments are taken.

All hand to mouth operations e.g. moistening labels with the tongue must be prohibited, smoking, and eating in the lab must be forbidden.

All exposed cuts should be protected with a water proof adhesive dressing. Refrigerators used for microbiological cultures should never be used to store food. Cultures spilled on the benches should be swabbed with 1% sodium Oxochlorate solution. Plastic containers with disinfectant should be placed in the lab for storing contaminated items.

Wash the hands and arms with soap and water after handling specimens, wash hands in 0.1% hypochlorite solution after handling body fluids.

Wear closed shoes and do not walk bare foot. Animals should be removed where microbiological work is being carried out.

Habit such as chewing gum, applying cosmetics, biting nails or placing pens in the mouth should be avoided.

Poisonous plants

The range of toxic plants material is very wide; the following is a list of some toxic species of plant material

S/NO	**COMMON NAME**	**BOTANICAL NAME**	**POISONOUS PRODUCTS**
1	Daffodil	*Narcissus. spp*	Bulbs
2	Toad stool	*Ricinuscommunis*	Seeds
3	Thorn apple	*Amanita muscaris*	All

4	Wild arum	*Datura stramonium*	All
5	Poinsettia	*Arum maculatum*	Leaves & flowers
6	Hyacinth	*Hyacinthus spp*	Bulbs

Use of impervious material and easily cleaned materials for construction of floors, walls and ceilings, adequate wash rooms and change rooms for use by lab staff. ultraviolet air locks and door barriers. Most important way of combating infection is the use of correct working techniques by lab staff i.e. the staff should be well instructed and use the correct lab procedures when working with infectious materials. Special warning should be given concerning bacteriological hazards likely to be encountered. Correct handling techniques for animals reduce the risk of infection. This includes

- Cleanliness
- Use of protective clothing

- Thoroughly washing after handling animals

Bites and scratches from the animals are dangerous such wounds should be reported and proper treatment given immediately. All wounds in the skin should be covered before work with animals is undertaken, other lab precautions should be observed.

In biological labs diseases may be transmitted from man to animals or from animals to man. Diseases may be transmitted from man to animals that from appearance are apparently quite healthy, for this reason:

- Unauthorized person should not be allowed in animal houses
- Special precautions should be taken by lab staff.

Lab staff may be immunized by protective vaccination.

Infection organism may be transmitted to susceptible host.

- Respiratory process
- Excretions from intestinal or urinary tracts i.e. feacal matter or urine

- Discharge from open sores
- Shedding of skin or hairs

Primary methods used to prevent the spread of disease involves

Confinement of the infection at its source e.g use of safety cabinets or closed ventilation systems

Confinement of infectious materials by other local means

Secondary methods used involve good laboratory design e.g.

complete isolation of infection

TOPIC THREE

FIRST AID

This is the first and immediate treatment given to a casualty before been taken to the hospital.

Patient: This is somebody who has been admitted to the hospital to receive medical aid.

Casualty: A victim of accident or a certain illness whose health before the accident or illness occurred.

Scope of First Aid

This is in four parts:

Assessment of the situation

Look at the type and nature of the accident and decide quickly and methodically what should be done i.e. prioritize your operation and decide which should come first so as not endanger the casualty i.e. ensure safety of the casualty and yourself.

Guard against any further injury or minimize any further damage to the victim.

In an event of electrocution switch off the main switch.

Diagnosis

You are supposed to know what is wrong with the victim or sudden illness. This aided by:

History of the case

This is a report furnished by the conscious casualty or the person present when the accident or injury occurred.

Symptoms

These are details of the casualty sensations gathered from

him/her when conscious.

Signs

These are details obtained by complete examination of the casualty using your senses to the maximization e.g. feeling, smelling or hearing.

Check the following:

The pulse rate

The temperature (too high or too low)

Rate of breathing

Treatment

This should be immediate and appropriate e.g. start artificial respiration or give drinks like water, salt water.

Disposal

This is the process of releasing the victim after the first aid treatment and can be either:

To his or her house to rest

The nearest medical clinic

To the dispensary

To the hospital

All this depends on the nature of the accident and the extent of the recovery.

If the situation is so serious one can dispose the victim to the hospital by an ambulance.

First Aid

First Aid is the temporary and immediate treatment given to a person who is influenced or suddenly becomes ill using facilities or materials available at the time before regular medical help is imparted.

Objectives

To preserve life

To prevent further injury and deterioration of the

condition

To make the victim as comfortable as possible to conserve strength

To put the injured person under professional medical care at the earliest.

Shock

Shock is a syndrome that results from a decrease in effective circulating blood volume or fluid in the body as a result of injury or illness.

It can vary from faintness to complete collapse.

Effects of shock

Early loss of consciousness that mainly involves the nervous system and that may be fatal.

Progressive loss of blood from active circulation which may lead to failing heart output and insufficient oxygen to cells that is vital for survival.

Sustained lowered blood pressure which may lead to liver and kidney failure.

Causes of shock

Severe or extensive injuries

Severe pain, heart attack

Loss of blood

Severe burns

Electric shock

Exposure to extreme heat and cold

Allergic reaction

Bites or strings of poisonous snakes or insects

Gas poisoning

Poison taken internally

Emotional stress fright

Signs and symptoms of shock

Signs

Casualty is anxious and restless.

Weakness, fainting or giddiness and disorientation

Shallow rapid and gasping breath

Nausea, vomiting or extreme thirst

Skin becomes pale and clammy sweating may develop.

Symptoms

Pulse rate increases but becomes weaker.

Blood pressure falls.

Pupils are dilated.

Restless eyes

Shaking and trembling of arms and legs.

Unconsciousness may develop.

Treatment

Immediately reassure and comfort the casualty.

Body positioning for shock

If the casualty condition allows, lay the casualty down on the back on a blanket keep the head low and turned on one side. To maintain blood supply to the brain and to lessen the dangers of vomiting e.g. stomach contents entering windpipe and causing asphyxia, raise legs unless you expect fracture normally the lower extremities should be elevated unless they are well splintered.

If there is any indication of head injuries the head should be raised slightly to reduce the pressure on the brain.

The feet may also be elevated. The head should not be

elevated if there is mucus in the throat.

If there is any breathing difficulties, the victim may be more comfortable with the head and shoulders raised that is in a semi sitting position.

If the victim is unconscious, she should be placed on her side in coma position.

If circumstances indicate the individual should be left in the position found.

Keep the casualty warm. Cover the casualty with a blanket.

Loosen any tight clothing to help the circulation and assist breathing.

Search for and if possible, treat the cause of the shock, stop bleeding immobilize fractures.

Check breathing rate, pulse and level of consciousness.

If breathing and heart beat stop then establish an airway; begin resuscitation immediately.

Keep patient in recovery position.

Remove to hospital immediately. Transport as stretcher

case maintaining the treatment position.

Do not:

Apply hot water bottle. This will increase the blood flow to the vessels of the skin and take it away from the vital organs.

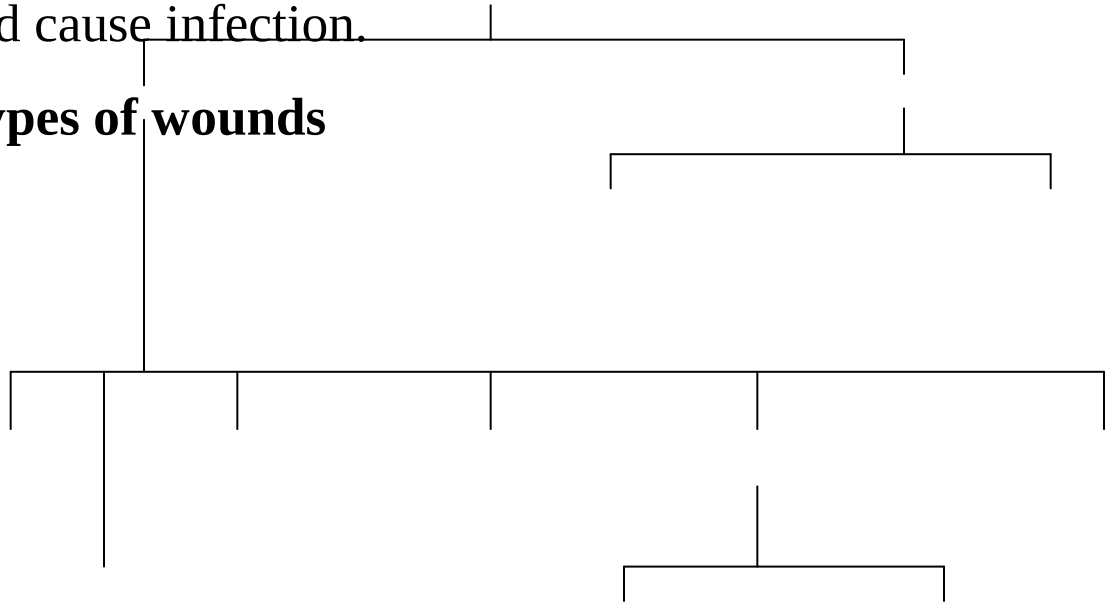
Move the casualty unnecessarily. This will increase shock.

Give the casualty anything by mouth. It will prevent or delay the administration of anaesthetic.

Wounds

A wound is an abnormal break in the skin or other tissues which allow blood to escape external wounds are complicated by the fact that the germs can enter the tissue and cause infection.

Types of wounds



Open wounds

Open wounds allow blood to escape from the body, skin is broken.

Closed wounds

Closed wounds allow blood to escape from the circulatory system but not from the body, skin is not broken.

Bruises or contusion

In this closed wound, the soft tissues beneath the skin are damaged but the skin is not broken. They are marked by local pain and swelling if small blood vessels beneath the skin are broken the victim the will also exhibit ecchymasis (black or blue colouring) if large vessels have been torn beneath the bruised area hematoma develops.

Internal bleeding

In this, the blood is lost from circulatory system but not from the body. Blood collects at one of the cavities and remains concealed. It may reveal by a flow of blood form

one or more of the various opening such as mouth, nose, ear or rectum.

Incised wound

Incised wounds are sharp even cuts that tend to bleed freely because the blood vessels and tissues have been severed. They are caused by sharp objects like knife, razor blade or broken glass.

Lacerated wound

A laceration is a cut inflicted by a sharp uneven instrument such as broken glass bottle that produces jagged incision through the skin surface and underlying structures.

Laceration may also cause significant bleeding skin and tissue may be partly or completely torn away. A laceration may contain foreign matter that lead to infection.

Punctured wound

A punctured wound is caused by stab from the pointed object such as nail, knife, bullet or sword.

Each object puncturing the body will tear through the skin and proceed in a straight line damaging all tissues in its path.

Abrasion

An abrasion is a superficial wound caused by rubbing or scrapping in which part of the skin surface has been lost.

General Emergency care for open wounds

Control bleeding.

Lay the victim quiet.

Cover the wound with gauze and apply pressure.

Elevate the limb.

If necessary apply tourniquet piece of fabric etc. that is tied tightly around an arm or leg to stop a wound from bleeding.

Treat for shock.

Immobilize the part and keep the victim quiet.

Prevent further contamination by applying dressing and bandage.

Do not remove impacted objects. The object should be stabilized with bulky dressings.

Preserve evulsed parts. Torn off part should be saved and flaps of skin may be folded back to their normal position before bandaging.

Do not try to replace protruding organs. Protruding eyeballs or protruding intestines should be covered as they are and no attempt should be made to replace them in their normal positions with a body cavity. The covering for intestines should be kept moist.

Controlling bleeding

Prevent further contamination all open wounds will already be contaminated but a dressing and bandage will prevent further contamination.

Do not remove impacted objects. They may be cut if necessary to move the victim but should remain in place until the victim receives hospital care. The objects should be stabilized with bulky dressing.

Do not try to replace protruding organs.

Immobilize the part and keep the victim quiet.

Preserve avulsed parts torn off parts should saved and flaps of skin may be folded back to their normal position before bandaging.

Wound with foreign body

Foreign bodies

Carefully remove any small foreign bodies from the surface of a wound if they can be wiped off easily with a swab or rinsed off with cold water.

If the victim has a large foreign body embedded in the skin, never to attempt to remove it. It may be plugging the wound therefore restricting bleeding moreover, the surrounding tissues may be inured further if it is pulled out.

Treatment

To control bleeding apply direct pressure by squeezing the edges of the wound together alongside the foreign body.

Gently place a piece of gauge over and or around the

foreign body. Place a ring pad or crescent shape pads of cotton wool or similar material around the wound. If possible, build up the padding until it is high enough to prevent pressure on the object.

Secure with a diagonally applied bandage. Make sure bandage is not over the foreign body.

Elevate the injured part and immobilize as far as possible.

Infected wounds

All open wounds will be contaminated by germs which enter either from the cause of injury, from air, from first aider's breath or finger.

Any wound which has not begun to heal properly after about 48 hours may be infected because of dirt, dead tissue; foreign bodies or bacteria may be present.

Infection may further spread and cause dander to life.

Signs and symptoms

Increasing pain and soreness in the wound

Increased swelling and redness of wound and surrounding parts with a feeling of heat.

Pus may ooze from the wound.

Fever, sweating, thirst, shivering lethargy

Swelling and tenderness of glands

Management

Remove the soiled dressing by picking it up at the corners. Do not touch other positions.

Wash your hands with soap and water.

Remove the swabs from the wrapping or container.

Moisten the swab with antiseptic solution.

Remove dirt, dried blood and foreign matter using the swab.

Apply bandage to keep the dressing in place.

Special wounds

Wounds to the palm of the hand

Such wounds may bleed profusely and can be accompanied by fractures. If the wound is deep the nerves and tendons in the hand may be damaged.

Signs and symptoms

Pain on the site of the wound

Profuse bleeding

Loss of sensation and movement in the fingers and hand of the underlying nerves and tendons are severed.

Treatment

Control bleeding. Place sterile dressing or gauze and a clean pad over the wound and apply direct pressure. You can use any clean cloth or tissue.

Ask casualty to maintain pressure first by clenching fist over dressing or pad. If it is not possible the victim should grasp the fist of the injured hand with the other hand.

Elevate the injured limb.

Bandage the fist firmly. Tie off tightly across the knuckle to maintain pressure.

Support the arm in an elevation string.

Abdominal wounds

A deep wound of the abdominal walls is serious because it will involve external bleeding.

Underlying organs may have been punctured or lacerated.

Severe internal bleeding and infection

Part of the intestines may be protruding from the wound.

Symptoms and signs

General abdominal pain

Bleeding and associated wounds in the abdominal area

Part of the intestines may be visible in protruding from the wound.

Vomiting

Symptoms and signs of shock

General treatment

Control any bleeding by carefully squeezing the edges of wound together.

Place the victim in half sitting position with knees bent up to prevent the wound gaping and reduce strain on the injured area. Support the shoulders and knees.

Apply a dressing to the wound and secure with a bandage or adhesive strapping.

If breathing and heart stop begin resuscitation immediately.

Treat shock.

Look for evidence of internal bleeding.

If vomiting occurs support the abdomen by pressing gently on the cloth or dressing to prevent protrusion of the intestines.

Shift the victim to hospital immediately. Transport as a stretcher case maintaining the treatment position.

INJURIES

Head injuries

Direct blows to head may cause scalp wounds or bruising and may be accompanied by skull fractures.

Head injuries leads to consciousness may be lost concussion and compression may occur.

Concussion

In this condition, the temporary disturbance of the brain occurs.

It occurs from blow to the head; fall from the height or to the feet or blow to the jar.

Symptoms and signs

Brief or partial loss of consciousness

Breathing may be shallow.

Face may be pale.

Skin may be cold and damp.

Rapid and weak pulse

Nausea and vomiting

On recovering consciousness he may not remember any

events just before or after the incident.

Treatment

Stop bleeding from scalp wounds.

Treat shock.

Manage as a case of unconsciousness.

Check breathing, pulse, level of responsiveness watch for signs of compression.

Shift him to hospital.

Burns and scalds

Burns are the injuries that results from dry heat like:

Fire, flame, piece of hot metal, sun, contact with wire carrying high tension electric current, lightening and friction

Scalds are the injuries caused by moist heat like:

Boiling water, steam, oil and hot liquids

Types of burns

Chemical burns

Acid and alkali may cause burns when they come in contact with the skin.

Electric burns

Electrical currents and lightening heat and burnt skin and underlying tissues

Radiation burns

Sun rays and light reflected from bright surfaces can damage the skin and eyes, overdose of x-rays may cause burns.

Cold burns

Contact with liquid oxygen and liquid nitrogen can cause cold burns.

Dangers of burns

Infection: There is a big risk of infection with burns because skin is damaged and there is no protection against the germs.

Shock: Shock develops because serum leaks out of the

circulatory system into burnt area.

Classification of burns

Area:-Burns are classified on the basis of area. Any burn of over 30% irrespective of depth degree should be hospitalised.

Severity of burns

Types of burns

Light burns – This is a burn where there is no general disturbance to the victim.

First degree burns: - Causes the skin to become red and swells.

Second degree burns: - Causes swelling to open or tear and release some fluid.

Third degree burns: - Involves the distortion of the superficial layer of skin.

Symptoms and signs of burns and scalds

Severe pain in and around the injured area if burn is superficial, the area may be numb if the burn is deep

Redness and swelling of the area

Blisters (they are thin bubbles which form on skin damaged by heat. They are caused by tissue fluid leaking into the burnt area just under the surface of the skin.

Grey charred skin around severe burn.

How to help a person whose clothes have caught fire

Put out the flame by any means available use water to quench the flames, water also cools the burnt area causing less damage to occur.

Do not allow the person to run about. This only fans the fire and allows it to spread.

Hold a rug blanket coat in front of you while approaching a man whose clothing has caught fire.

Lay him down quickly on the ground and wrap tightly with any thick piece of cloth or coat. This starves the flames of oxygen and puts them out.

Do not roll the victim along the ground as this can cause burning of previously unharmed areas.

If the clothes in front of the body have caught fire lay him

on his back and vice versa.

How to rescue persons from sites of fire

In rescuing a person from a room which has caught fire speed and clear thinking are required.

Remember, clean air is at ground level so crawl along the floor to pull out a person who is lying unconscious or is disabled.

Have a wet handkerchief round your face when you rescue.

If there is carbon monoxide in the room these precautions do not protect the rescuer from carbon monoxide poisoning where there is a fire in a closed room there is always some amount of Carbon monoxide therefore quick action is all important.

When there is fire in a room in which the doors and windows are closed do not open the doors and windows to let air in, the rush of air will increase the fire and it will burn more intensely.

Treatment of minor burns and scalds

Reassure the victim place the injured part under slowly running cold water or immerse it in cold water for ten minutes longer if the pain persists.
Gently remove any rings, watches, shoes and other constricting clothing from the injured part before it starts to swell.
Press the area with clean sterile material.
Give plenty of fluids orally.
Do not use adhesive dressing.
Do not apply cotton wool.
Do not break blister, remove any loose skin or otherwise interfere with injured area.

Treatment of serious burns and scalds

Lay the victim down and make comfortable.
Gently remove any rings, watches or constricting clothing from the injured area before it starts to swell.
Cover the burnt area with a sterile dressing and apply bandages.

For facial burning make a mask from a clean dry sterile material cut holes for nose, mouth and eyes.

Immobilize badly burnt limb.

Treat shock.

If breathing and heart stop begin resuscitation immediately.

If the victim is unconscious but breathing normally place in the recovery position.

If the victim is conscious, give sips of cold water at frequent intervals to replace lost fluid.

Do not apply lotions or ointments to injury.

Do not break blisters, remove any loose skin or otherwise interfere with injured area.

Burns in Mouth and throat

They occur after drinking hot liquids or swallowing corrosive, they can close the airway.

Symptoms and signs

Severe pain in the injured area

Damage skin around the mouth

Difficulty in breathing

Unconsciousness

Symptoms and signs of shock

Treatment

Reassure the victim.

If the victim is conscious, give sips of cold water at frequent intervals.

Remove any constricting clothing or jewellery from around the neck and chest.

If breathing and heart beat stops begin resuscitation immediately.

If the victim is unconsciousness but breathing normally place in recovery position.

Treat shock.

Shift him to hospital immediately.

Chemical burn

Strong corrosive chemicals cause chemical burns, when they come in contact with the skin.

Symptoms and signs

Slinging of the skin

Skin may appear stained or reddened

Blistering and peeling may develop.

Alkali burns

Irrigate the affected area with plenty of water then treat with 5% ammonium chloride and finally with 2% boric acid solution.

Phosphorous burns

Apply 10% of sodium sulphate or immediately immerse the wound in water and sock in 2% solution of sodium carbonate then treat with $CuSo_4$ and followed by Na_2CO_3 solution victim must be taken to hospital.

Phenol burns

Wash or flash with plenty of water as for acids.

Bromine burns

Wash the bromine traces with plenty of water then treat the area with 5% sodium thiosulphate solution for 15 minutes.

Hydrochloric acid burns

Irrigate all affected area with water then wash with sodium hydrogen carbonate $NaHCO_3$.

General treatment

Flood the affected area with slowly running cold water for ten minutes to prevent further damage to burnt tissue.

Gently remove any contaminated clothing while flooding the injured area.

Continue treatment for severe burns.

Chemical burns in the eye

Corrosive chemicals can easily enter the eye and rapidly damage its surface causing severe scarring and even blindness.

Treatment

Hold the affected side of the victim face under gently running cold water so that water drains away from the face.

Check that both surfaces of the eye lids have been well irrigated. If the eyelids are closed, gently open the eyes.

Lightly dress the eye with sterile eye pad.

Treatment for slight thermal heat burns

Wash or irrigate the wound with plenty of warm water or centrimide solution (a disinfectant).

Bath the area with solution of sodium bicarbonate finally cover the wound in sterile bandage. Take the victim to the hospital.

POISONING

Definition: Are harmful substances which when taken in sufficient doses may kill a person.

Poison may be consumed:

Accidentally (by mistake or by ignorance)

For suicidal purposes

Intentionally for killing enemies

Methods of entry of poison in the body

Swallowing (ingestion)

For liquid and solid poison through the mouth

Inhalation: Taken in gaseous form.

Absorption: Through the skin e.g. body cream, acid and base.

Infection: This is from snakes, bees and wasps.

Classification of poisons

Corrosive poison

Destroys the tissues they come in contact with i.e. they corrode the tissues e.g. strong acids and bases.

Irritant poisons

They cause the stomach and the intestines to be irritated and inflamed e.g. antimony compounds and phosphorous compounds.

Nerve poisons

These are absorbed in the blood system and attack the nervous system e.g. opium, steroid and nicotine.

Recognition of symptoms of poisoning

Corrosion poisoning

The lips are stained

The tongue, lips become swollen.

The victim vomits and suffocation may occur.

Sometimes the victim may be under shock.

Irritant poison:

Diarrhoea

Shock

Nausea

Nerve poison

Causes the victim to become drowsy or sleepy, the pupil of the eye becomes contracted and the face becomes flashed.

Treatment of poisonous gases

Specific poisons by individual gaseous poison poisoning by ammonia.

Procedure:

Give an antidote to the victim.

If the victim is unconscious let him inhale the fumes of acetic acid (antidote). If the eyes are affected then irrigate them with plenty of water or use ice pack to cool them thoroughly.

Generally treatment should be applied in case of ammonia poisoning even if the victim is unconscious.

Always take the victim to hospital if necessary.

Hydrogen sulphide H_2S

Apply general treatment i.e. take the victim to where there is fresh air and administer artificial respiration.

Keep the victim warm and quiet.

Follow by applying the mixture of O_2 and carbon dioxide hydrogen sulphide is highly poisonous irrigate the eyes with plenty of water, finally give a coffee as a stimulant and take the victim to the hospital.

Swallowed antimony compound

Apply general treatment.

Give 4g of tannic acid in 250ml of water or give a universal genetic antidote or white of an egg.

Take the victim to the hospital.

Cyanide compounds

Apply general treatment.

Give 1% of sodium disulphate (emetic).

If vomiting, start then assist the victim to vomit.

Give strong tea or coffee as a stimulant.

Administer artificial respiration.

Mercury compounds

Apply general treatment.

Given an emetic

Give the victim large quantity of water.

Give him the egg white and take him to hospital.

Chloroform

Apply general treatment.

Re-apply artificial respiration.

Give plenty of oxygen and take victim to hospital.

Barium compound

Apply general treatment.

Administer 60g of MgSo in a half litre of warm water.

Give an acetic emetic.

Swallowed acids

Give plenty of water.

Give warm water 5-7% acetic acid or give 0.5g of citric acid in a quarter litre of water.

Do not induce vomiting.

If milk or water is not available then olive oil, butter white of an egg and bailey water can be given.

Shift casualty to the hospital.

Lead poisoning

Apply general treatment.

Give a solution of sodium/magnesium sulphite in warm water as an emetic.

Repeat the emetic unlit the person victim.

Terms used in poisoning

Emetic: A substance administered to a victim of poisoning to induce vomiting and get rid of poison from the stomach examples; soapsuds, mislaid and salty water.

Mustard: Take one spoonful and add to a glass of warm water. A quarter of this solution is given to the victim followed by a glass of warm water.
This is repeated at an interval of a minute. The mustard has been used.

Salty water

Two table spoonful of salt are dissolved in warm water in a glass and administered to the victim. This is repeated at one minute interval until five glasses full have been given.

Soapsuds A piece of soap is shaken in a glass of warm water then a quarter of this is given to the victim. This is by a glass of warm water and the treatment is repeated at intervals of one minute until all the soapsuds is used up.

Antidote

It makes the casualty not to be affected. A substance given to a victim of poisoning to render the poison harmless or to reduce the absorption of the poison e.g. magnesium for strong acids, lemon juice for strong bases.

Resuscitation techniques

Techniques undertaken to revive a victim who has difficulty in breathing, the following basic measures should be checked first.

Airway

Open the airway.

Position the victim on his/her back.

Find out if the victim is conscious if yes arouse him/her shaking response to pain

Check breathing

Place your ear above casualty's mouth and look along the chest and abdomen.

Hear and feel the breath.

See movements along the chest and abdomen.

Open the airway

Clear any debris of his/her mouth and throat. This can include broken teeth, vomit, mucus or foreign matter that got into the mouth during injury.

Airway is opened by two methods:

Head tilted

Place the palm of one hand on the victim's forehead.

Apply firm, background pressure.

Lifting the victim's head backward as far as possible

Jaw thrust

This is used when a cervical or spinal injury is suspected.

After mandible is displaced forward support the head carefully without tilting it backward.

Restore breathing

Mouth to mouth (kiss of life)

This is the simplest method used. It can be used anywhere by any person and no equipment is required.

Procedure

Lay the victim on the back and clear any debris from the mouth and throat.

Tilt the head backwards until fully treated.

Stand firmly until one leg is ahead of the other or the left hand side of the victim.

Kneel close to the victim's head.

Pinch the nose of the victim using the fore finger of the

right hand and then tighten your lips over the victim's mouth and blow through his mouth.

When the chest of the victim is seen to rise remove your mouth to allow the chest to relax.

Repeat this method at the rate of 12-20 times per minute until the victim gains breathing. This method may also be applied by mouth to nose technique. This is only applied when the victim's mouth has been injured.

Holger Nelson method

Employed when the victim is suffering from facial injury

Procedure

Lay the victim on the stomach with arms bench onto the chest head turned on one side.

Remove any obstruction from the airway then kneel on one knee near the victim's head.

Stretch out the victim's fore arms and place the arms and the finger below the shoulder plate and press hard at the rate of see once then twice and at the 3rd time lift the victim up and lower him down while pressing the fifth

and sixth time.

Repeat until the victim gains breathing or consciousness.

Sylvester method

Lay the victim on his back.

Place folded clothing beneath his shoulders.

Clean the victim’s throat or mouth if necessary and then turn the victim on one side.

Kneel behind the casualty’s head and grab the wrist of the victim and cross over the lower part of the chest probing the body forward.

Press down on the victim’s chest then release the pressure and draw the victim’s arms backward and then outward as far as possible. Repeat the same procedure 12 times per minute take the victim to hospital.

Summary of first Aider skills

Control the scene of accident.

Gain access to the patient.

Evaluate the scene in term of safety and possible cause of accident.

Gather information from the patient and by stander.

Determine vital signs (pulse breathing skin temperature).

Determine diagnostic signs and relate those to possible injuries or sudden illness that require emergency care.

Perform the necessary ABC's of emergency care:

Open airway

Breathing (provide artificial ventilation).

Circulation (pulse lesness)

Bleeding control

Diagnosis and care of shock

Diagnosis and care for soft tissues and internal injuries including basic dressing and banding techniques.

Diagnosis and care of open and closed fractures, sprains and strains

Detect and care for poisoning.

Golden rules of First Aid

Do first things quickly, quietly and without panic.

Reassure the casualty and his relatives.

Symptomatically:

Look for the following

Is there a failure of breathing? If yes start artificial respiration.

Is there any failure of circulation? If yes start external cardiac massage.

Is there severe bleeding. If yes stop bleeding by pressing o the pressure points, press firmly on the bleeding area with a clean pad and keep on pressing the bleeding area for at least a few minutes.

Avoid handling the casualty unnecessarily.

Arrange for the safe removal of the casualty to the care of a doctor or hospital as soon as possible.

KIT FOR FIRST AIDER

Triangular bandages

Rotter type bandages

Dressing/gauze pads

Adhesive tape

Bandage sheats

Eye protector

Stick for tourniquet

Blanket.

Pillow.

Upper extremely sprint set

Lower extremely sprint set

Asphyxia

Asphyxia is a condition in which the lungs do not get sufficient supply of air for breathing. If this continues for some minutes breathing and heart action stop and death occurs.

Causes

Conditions affecting the air passage

Spasm

Food going down the wrong way

Irritant gases getting into the air passage

Obstruction

Tongue falling back in unconscious patient swelling of

tissue of the throat as a result of scalds (boiling water) injury, infection, burn, corrosives.

Compression

Tying a rope or scarf tightly around the neck causing strangulation

Compression of the chest

Injury to the lungs

Conditions preventing the use of oxygen in the body e.g. carbon monoxide poisoning; cyanide **POISONING.**

Symptoms and signs

Difficulty in breathing.The rate and depth of breathing increases.

Noisy breathing.

Veins of the neck become swollen.

Face, lips, nails finger and toes turn blue.

Pulse gets faster and flexible.

Froth may appear at mouth and nostrils.

Confusion.

Unconsciousness

Fits may occur

Breathing may stop

Treatment

Remove the cause of asphyxia and open the airway.

If the casualty is not breathing begin artificial ventilation or mouth to mouth respiration immediately.

When breathing the pulse return, place the casualty in recovery positioning.

Check breathing rate, pulse and level of consciousness at ten minutes interval.

Send casualty to hospital.

FRACTURES

A fracture is the partial or complete breakage of periostenum (bone).

Causes of fracture

Direct force

A bone can be fractured directly at the point where the force of blow applied.

Indirect force

The bone breaks away from the spot of application of force e.g. fracture of collarbone after a fall on the outstretched hand.

Force of muscular tendon

Violent contraction of a group of muscles may pull process of bone away from the point where the muscle is attached i.e. fracture of knee cap after a powerful high muscle jerk.

Types of fracture

Simple (closed) fracture. In this fracture the skin surface around the damaged bone is not broken.

Compound (open) fracture: when the wound leads from this surface of the skin to the fracture or a broken bone and penetrates the surface of the skin causing extensive blood loss and infection.

Complicated closed or open fractures are said to be complicated when there is associated injury i.e. injury to blood vessels or nerve.

Symptoms and signs

Pain at the near site of injury which increases by movement

Difficulty in movement

Swelling of the area and discolouration

Deformity

Tenderness

Treatment

Treat difficulty in breathing, bleeding and unconsciousness before the fracture.

Treat all fracture in the position in which the casualty is found unless there is immediate danger to life.

Immobilize and support the fractured limb using bandages or splints. This should be done on both sides of fracture above and below the fracture site. This can be done using bandages: usually it is enough to use the other **** limb or the body of the patient as the splint. The upper limb can be supported by the body the lower limb by other limb, but do not apply bandage over the area of fracture. The bandage should be fairly firm so that there is no movement of the fractured ends but not too tight to prevent circulation of blood in the affected area. Always place padding material between the ankles and knees and other hollow if they have to be tied together so that when limbs are bound together they are comfortable and steady. Using splints (when available and necessary expertise is there). A splinter is rigid pieces of wood or plastic material or metal applied to a fractured limb to support it and to prevent movement of the broken bone. They should be long enough so that the joints above or below the fractured bones can be made immobile.

Raise the injured part after immobilising it to minimize discomfort and swelling rolled up blankets can be used.
Treat for shock.

Bleeding or haemorrhage

Haemorrhage is the flow of blood from artery, vein or capillary.

Types of haemorrhage

There are three different types of haemorrhage or bleeding:

Arterial bleeding

Blood is bright red in colour.

It spurts at each contraction.

Its flow is pulsative.

Venous bleeding

Blood is dark red in colour.

It does not spurt

Steady flow.

Capillary bleeding

Blood is red in colour.

It does not spurt.

Slow but even flow.

Effects of haemorrhage

The loss of blood cells causes lack of oxygen to the body system.

A decrease in blood volume causes a decrease in blood pressure.

The heart pumping rate increases to compensate for reduced blood pressure.

The force of the heart beat is reduced since there is less blood to pump.

Diagnosis

External bleeding

Evidence of major external blood loss

Symptoms and signs of shock

Casualty complains of thirst.

Blurring of vision, fainting and giddiness.

Face and lips become pale.

Skin feels cold and damp.

Pulse becomes faster but weaker.

Restlessness.

Breathing becomes shallower (air hung).

Management

Place the victim in such a position that he/she will be least affected by loss of blood.

Lie the victim down and elevate the legs in a semi-flexed position. This prevents aggravation of spinal injury or breathing impairment.

Control the breathing.

Maintain airway.

Prevent the loss of body heat by putting blankets under and over the victim.

Victim should be kept at rest as movement will increase heat action which causes the blood to flow faster and perhaps interfere with clot formation or dislodge a clot already formed.

Contents of First Aid box

The first Aid boxes situated in the various laboratories should be easily removable from the walls. They should have the following minimum contents:

Acetic acid

250ml

Adhesive plaster (strip) dressing 65mm x 90 cm

1 boxBandage 25mm3Bandages 50mm3Bandages 75mm3Bandages, triangular (90.5cm side)2Centrimide solution 10%250mlCotton wool (sterile 12.5g pts)3Gauze (75 x 90 cm)1pktLaboratory first aid manual1Lint 12.5g pkt1Magnesium sulphate crystals250gMilk of magnesia (liquid)100mlSafety pins (assorted)12Sal volatile30mlScissors blunt 125mm1Teaspoon (stainless steel)1Sodium chloride crystals250gTourniquet (rubber bandage type)1Tumbler (unbreakable)1Wound dressings (sterilized medium)3Wound dressings (sterilized) small3Wound dressings (sterilized) large3Universal

antidote, dry powder (need only to be provided in chemical lab)30g

It provides for the careful treatment of shock causes and serves as a rest room for people before they are dispatched to hospital.

The room should be ideally situated on a ground floor and close to an outside exit. This facilitates the removal of stretcher casualty to the ambulance. The room should be quiet and capable of being heated and ventilated without droughts.

The walls and floor should be constructed of a hard impervious material and all corners should be rounded to allow for washing and disinfection.

Electrical sockets should be provided for boiling water and for the use of a steriliser.

Good natural and artificial lighting are necessary.

Equipment for first aid room

The following are includes:

Sink with hot and cold water.

Examination couch with rubber sheet.

Table for dressing table

Smooth top desk

Chairs

Blankets

Pail for dirty dressing

Instrument cabinet

Medicine cabinet

Sterilizer

Oxygen cylinder and administering apparatus

Self-contained breathing apparatus

Accident report book

The windows should be filled with blinds. The smaller items or equipment should include:

Bowls, Kidneys, Dishes, towels, jugs, medicine, glasses and jars for lotion

TOPIC 4

LABORATORY WARE

Objectives

- Classify laboratory ware
- Explain properties and uses of laboratory ware
- Describe the methods of cleaning laboratory ware
- Describe methods of storage of laboratory ware
- Explain the effects of reagents on laboratory ware

Classification of laboratory ware

Laboratory ware can be classified according to the material making them as follows

- **Glassware**
- **Plastic ware**
- **Platinum ware**
- **Ceramic ware**

Types of glass

Soda lime- silica glass (soda glass)

It the most common of all the glasses, It is used in large quantities for plate and sheet glass, containers and lump bulbs, it consist of

Silica SiO_2 70%

Soda NaO 15%

Lime CaO 10%

Sometimes magnesium MgO and alumina (Al_2O_3) is added to improve the chemical resistance

Borosilicate glass Pyrex

Consist of

- Silica
- Basate
- Alumina
- It has a low coefficient of thermal expansion, about a third that of soda lime glassware, industrial piping, high temp thermometers, large telescopic mirrors, electronic tubes of high wattage.

Alumino silicate glass resistance

Consist of

- Silica SiO_2 5-60%
- Alumina Al_2O_3 20-40%
- Lime CaO 5-50%
- Borate B_2O_3 0-10%

It has a low coefficient of thermal expansion, it is resistant to chemicals and can be used at high temperatures than borosilicate glass.it is also much harder to fabricate, aluminosilicate glass without any boron is especially resistant to alkalis.

NB Nearly all laboratory glassware is made from borosilicate glass,aluminosilicate glass or a glass called aluminoborosilicate which contains roughly equal amounts of the alumina and borate, thus aluminosilicate glass is used for high temperature application or alkali resistance but has slightly greater thermal expansion.

Platinum ware

Physical and chemical property

Platinum is not affected by atmospheric exposure, even in sulphur bearing industrial atmosphere

It remains bright and does not exhibit an oxide film when heated.it can work to fine wire and into the thin sheet.

It is not attacked at room temperature by any single acid and alkali or aqueous of simple salts and inorganic material, but it is easily dissolved by hot AQUA REGIA.

This solution is made by mixing one part of nitric acid to 3 parts of hydrochloric acid

It is also known as chloroazotic acid or chloronitrous acid or nitrohydrochloric acid or nitromanatic acid.

Although platinum is resistant to hydrogen chloride at high temperature it reacts with chlorine at about 5000c

It is resistant to sulphurous gases, mercury, fused sulphates, chlorides, carbonates and molten gases

Uses

In glass industry, platinum is used at high temperature to contain, stir and convey molten glass other high temperature applications include thermocouples and resistant thermometers for temperature measurements.

Properties of glass

Glass varies widely in tits composition but essentially it consists of a mixture of silicate which has not crystallized out on cooling from molten state. It is made by melting together silica sand with CaCO3 or CaO and sodium or potassium salts usually the sulphates and carbonates

$SiO_2 + CaCO_3 \rightarrow CaSiO_3 + CO_2$

$SiO_2 + KSO_4 \rightarrow K_2SiO_3 + SO_3$

Common glass, soda glass, has the approximate composition $NaSiO_3.CaSi_3.4SiO_2$. The physical property of glass depends on the proportions of the various silicates present.

General cleaning procedure for glassware and plastic ware

Laboratory ware should be kept clean and ready for use at all times. In general the superficial dirt on burettes' and pipettes and similar items can be cleaned by

- By washing in detergent
- Rinsing thoroughly with several applications of water
- Rinsing thoroughly with distilled water
- Drying preferably in an oven

NB Care should be taken during rinsing not to leave a film of detergent on the cleaned glassware.

To protect the hands rubber gloves should be worn.

Burettes and pipettes and similar pieces of glass can be cleaned using a cleaning solution.

Preparation of cleaning solution

Sodium or potassium dichromate 30gms

Con sulphuric acid 900ml

Distilled water **100ml**

Dissolve 30gms of powdered sodium or potassium dichromate in 100ml of water, and then add 900ml of concsulphuric acid to the solution of dichromate add a few ml of acid at a time and stir. Allow the resulting solution to cool and then decant the solution through a funnel containing the glasswool into a pyrex bottle with a glass stopper. For cleaning soda glass HNO_3 acid is used in place of sulphuric acid.

Cleaning a burette

The cleaning solution is placed in the burette for some time and then return to the plastic bottle.

Rinse the burette thoroughly with tap water, check whether water clings to the sides walls of the burette in droplets, if it clings in form of droplets the burette is not clean and the procedure is repeated.

After establishing that the inside surface is clean, rinse the burette with distilled water

If the burette is to used immediately, rinse it with several small portions of the liquid to be measured and fill it with this liquid.

The same procedure should be used to clean pipettes

Heavily contaminated lab ware

These may be obstinate dirt which may not be removed by general cleaning method. This can be done by a suitable cleaning powder and a brush.

Tri-sodium phosphate solution together with a little pumice powder is efficient cleaning mixture.it may be necessary to use a solvent such as acetone or a caustic solution to remove the adhering substances.

After washing the glass must be thoroughly rinsed in clean water. The glass is then left in an inverted position to drain and dry.

Small items such as test tubes may be dried in an oven at a temperature of about 100^0c while large items of glass may be dried in a drying cupboard. If the apparatus which has been washed is required immediately for use, it may

be flushed out with methylated spirit followed by ether; it is finally dried on an electric oven.

Glassware which is grossly contaminated may need special cleaning treatment before cleaning by the general method

Oil and grease

This can generally be removed by shaking with warm detergent solution. It may require one to use some scouring material e.g. paper or sawdust the material is then washed out with water, it is then washed with conc HCL acid and finally with distilled water.

Silicon grease

It is more difficult to remove. First rinse the glass with paraffin or suitable hydrocarbon solvent, then cleaned with a warm solution of chromic acid. Alternatively, after the hydrocarbon has been used the glass ware may be cleaned with a warm solution of one of the following

- 5gms of Sodium Perborate in 100ml of 10% sodium hydroxide solution

- 10gms NaOH and 5gms borax dissolved in 100ml of water
- 10 - 15ml of 50% KOH solution in 100ml industrial methylated spirit
- Soak in fuming Sulphuric acid
- Clean with Carbon Tetrachloride
- Use a hot detergent such as teepol 10 parts, water 4 parts, paraffin 45 parts, heat the mixture to boil and use while hot.

Tar: use benzene or any other suitable solvent followed by cleaning with an abrasive powder.

Carbon: it is difficult to remove. Soaking in caustic soda NaOH solution is usually effective.

When the carbon is very obstinate, heat a small quantity of chromic acid in the vessel, obstinate carbon can also be remove by using a steam heated acid cleaning bath. One

can also use a mixture of 2 parts tri-sodium phosphate, to one part sodium oleate in 16 parts of water

Heat a few grams of sodium Sulphate in the flask, over a Bunsen flame. This is a method helps to loosen the carbon deposit.

Stains

This is cleaned using saturated solution of ferrous sulphate in dilute H_2SO_4. Permanent stains may be removed by sulphurous acid. Iron stains are removed by hydrochloric acid diluted with an equal volume of water.

Other hard deposit

It is easy to remove them if their nature is known.

Deposits of chalk which adhere to the walls of glass vessel after boiling can be removed by dilute HCL.

If the deposits adhere firmly to the walls of the vessels, a scouring agent together with a cleaning agent e.g. sand, glass beads, lead shots e.t.c but sand scratches the glassware. If the nature of deposit is not known and does

not respond to the normal washing methods, chromic acid mixture should be used

A cold solution called universal reagent for cleaning glassware consist of a mixture

- 5 % hydrochloric acid
- 33 % nitric acid
- 2 % teepol
- 60 % water

It is effective for grease, carbon and mercury contamination

Prolonged treatment should be avoided; the reagent should not be used to clean volumetric glassware.

DEACON 75 Cleaning concentrate

This may be used in place of chromic acid. It is non-foaming surface active agent

It is non-corrosive non-toxic. It can be rinsed off the material being cleaned without leaving traces of the detergent.

Cleaning volumetric apparatus

Volumetric glass should be cleaned and free from all greases, hydrofluoric mixtures and strong solutions should not be used. For accurate work clean with chromic cleaning solution.

Fill the apparatus with the cleaning solution and leave it to stand for about 12 hours before rinsing and drying in an oven, pipettes should stand in a tall plastic measuring cylinder.

Volumetric glassware should not be heated or cleaned in hot water since a glass takes a long time to contract to its original form resulting in errors in measurements.

Cleaning and greasing stopcorks

First clean them thoroughly and then rinse in ether to prevent them from binding or freezing and then rinse them slightly by indirect heat.

Then smear some grease down one side of the keys and then re-insert the key in the barrier and rotate until the grease forms an even film.

To prevent the keys from sticking when strong alkaline are used, the keys should be cleaned and the ground surface rubbed with graphite pencil until completely blackened, the key is then greased in the normal way.

Suitable lubricants for stopcock keys are;

- Pure Vaseline
- A mixture of Vaseline and resin cerate
- A mixture containing 1 part of beewax to 3parts pure Vaseline
- Grease consisting of 1 part of soft rubber, black, added in small pieces to a mixture
- Heated to 140-1500c and stirred continuously until thoroughly mixed.

Sintered glass

It is a glass mesh used for filtration

It can be used instead of filter paper

It is preferred to filter

Advantages

It is permanent

Porosity of sintered glass is labeled by integers from 0 - 5where 0 has a pore size of 160- 250 um and is considered a course filtration whereby fine the fluids will pass through it quickly together with some fine solid particles.

To prolong the life of sintered glassware

- They should not be heated above 200^0c
- Clean any deposits on the face of the sinter immediately after use
- Strong solution of alkalis and acids fluoride solution should not be filtered.
- The correct working pressure should not be exceeded e.g. for large discs the max pressure differential is 380mmHg and for discs below 40mm, 600mmHg.

- Care should be taken when drying crucible before placing them on the oven or autoclaves
- First the oven and the autoclave should be cool and the temperature then raised. The temperature should then be allowed to fall almost to room temperature before the crucibles are removed.

Cleaning

New sintered glassware should be:

- Washed with distilled water before being used
- Pass through HCL acid
- Then washed again with distilled water

After use, the cleaning of sintered glass may not be easy, it requires vigorous cleaning.

If the crucible has been used for gavimetric analysis, use a dilute solution of di-sodium salt of E.D.T.A. This removes many precipitates that may be present.

If the crucible becomes discoloured and difficult to clean, other methods may be used, e.g. boil the crucible or other

sinters in aguaregiain a large beaker, in a fume cupboard, and then wash the glass ware in distilled water.

Microscopes slides

New slides:

- Wash in hot water containing a small quantity of detergent
- Rinse thoroughly and soak in a dichromate cleaning solution for several hours
- Rinse in tap water then rinse again in distilled water
- Then store them under 95% alcohol in a covered dish until required for use

Old slides

- Soak in xylol to effect separation
- Then soak in alcohol for several days
- Then clean as for new slides

Syringes

- Rinse immediately after use to remove blood

- To remove paraffin oil, wash the syringe in chloroform, then in alcohol and then ether
- Draw air with the syringe and expel it
- Repeat until the plunger is free in the barrel
- Plug ends of the syringe with non – absorbent cotton wool and put on the cap
- Sterilize by heating for one hour in an oven at 160^{o}c
- Allow it to cool in the oven

Silica ware

Remove light stains by fusing sodium bisulphate in the vessel

Pour off the molten salt and wash in water

Badly contaminated apparatus should be treated with the following solution;

- Hydrofluoric acid 40 % 2 parts by volume
- Nitric acid conc 7 parts by volume
- Water 7 parts by volume

Immerse the vessel in or fill them with the above solution and soak in for 30 minutes depending on the degree of contamination

Then wash in tap water then distilled water

Finally dry on a clean glass cloth.

NB Whenever hydrofluoric acid is being used, protect the hands by the use of a barrier cream and rubber gloves.

Eye shields should also be worn

Main glassware cleaning agents are

- Water both tapwater distilled or deionized
- Commercial products e.g. teepol or specialized laboratory detergents such as decon, quadralene, RBS-2S, Haemosol and pyro-neg
- Chromic acid
- Organic solvent propane (acetone) tetra chloromethane, which are not recommended for general use but are required in some cases to dissolve grease and other organic substances

- Alkalis such as 5% aqueous solution of sodium or potassium hydroxide
- 1% potassium manganite solution
- Alcohol sodium solution is mainly used for removal of grease and other oily matter from glass ware and plastic ware. The preparations include
- NaOH pellets 120gms
- Distilled water 120ml
- 95% alcohol 1 litre

Chemical for cleaning microscope lenses and slides

95% alcohol

It removes most dust, oil and film from the lenses.

One drop of **ammonia** or a filter paper moistened with ammonia: this removes blood stains and other aluminous matter

Xylene: removes paraffin wax, oily matter and balsam.

Selection of appropriate cleaning method

Most glass ware in normal laboratory use may be cleaned by washing in water containing a little teepol or other detergent.

It should then be rinsed well in running tap water and finally be washed with a little distilled water and/or small amount of acetone and then placed in the cabinet to dry.

If the stains do not respond to normal treatment, immerse the glass ware in a solution of oxidizing agent such as chromic acid or 1% potassium hydroxide or nitric acid.

Volumetric flask can be filled with the solution and left overnight.

Small items or pieces of glassware e.g. slides may be placed in a bowl of solution or in case of pipettes in a tall plastic measuring cylinder.

Any brown stains remaining after treatment with potassium manganate vii solution is removed by using a little con HCL acid.

Traces of grease or oil may be removed by rinsing with a small amount of acetone. Care should be taken as the

solvent is highly flammable. Carbon may be removed by using hot chromic acid.

Heavy deposits of tar, resins, gum, oil and other organic residues may be removed by using specialized laboratory reagent e.g. decons

In general solution of alkalis NaOH or KOH should not be used to clean volumetric glassware. When cleaning with alkalis, it is necessary to check if the alkali is completely eliminated after rinsing. This is done by autoclaving the glassware in distilled water. It is then cooled and the ph of the water measured, if the ph continues to be consistently high, the material is discarded.

Cleaning using detergents

Detergents are available in liquid or powder form. The cleaning action of a detergent is due to its ability to reduce the surface tension of water molecules.

Advantages

- The cleansing action is not affected by temp of the water.
- They are equally efficient in alkaline as well as acidic water i.e. they are not affected by hardness of water.
- They have a coagulative action on proteins hence making cleaning easier

Disadvantage

They have a hemolytic effect on red blood cells hence care should be taken when dealing with hematological work.

Cleaning of ceramic ware

The following are used to clean ceramics

- Strong acids e.g. HNO_3 acid
- Hot water
- Detergents

Use hot water and a detergent to clean ceramic ware, if the stains are strong and obstinate use a strong acid that ionizes completely e.g.HNO_3, this acid is preferred as a cleaning agent as all nitric compounds are soluble

After removal of the stains clean in hot soapy water, then rinse in clean water and then rinse in clean water followed by distilled water and dry.

Cleaning of platinum ware

The agent used is chlorine free hydrochloric acid; the cleaning agent is prepared as follows

Heat rock salts in con sulphuric acid to 300^0c

$2NaCL + H_2SO_4 \rightarrow Na_2SO_4 + 2HCL$

The hydrogen chloride gas collected and dissolved in distilled water to give hydrochloric acid which is free of CL_2

DIAGRAM.

The gas is dissolved using a funnel by a downward delivery method. It dissolves very fast

General cleaning method

- Preliminary cleaning can be carried out using a nylon brush and appropriate scouring powder
- Then wash in a detergent solution for 10 min
- Immerse in cold water and agitate for 10 min
- Immerse in Cl_2 free HCL (500ml HCL acid with water to 1 litre) for 5 min
- Wash in tap water
- Rinse in distilled water
- Dry in a dust free air

Care when cleaning of platinum ware

At high temperatures platinum forms alloys with metal such as arsenic, antimony, bismuth, zinc, lead and tin, therefore it should never be heated in contact with these metals or with their oxides or with any of their salts

Phosphates and sulphides should never be heated in platinum vessels.

Halogen and halogen compounds also attacks platinum especially free chlorine.

When platinum is being heated, the base of the vessel should be above the blue cone of the flame otherwise the metal becomes brittle.

Platinum must not be heated in contact with other metal, use pipeplay triangles to support platinum vessel when heating. Platinum vessels can also be used to support platinum crucibles.

Stained platinum ware

Platinum crucible that are slightly soiled or stained can be cleaned using sodium Carbonate or borax by fusing the salts in the crucibles

If the stains are obstinate potassium bisulphate can be used but this slightly attacks the metal

Heat the cleaning agent until it melts, gently tilt the vessels to bring the molten cleaning agent into contact with the whole of the interior surface of the vessel, use the platinum-tipped tongs to tilt the vessels, then pour the contents of the vessel on a piece of iron, boil the water in the crucible to remove any remaining salt.

Finally, immerse the vessel in concentrated HCL and heat, then rinse in tap water and dry

Sodium amalgam can also be used to clean platinum.

Effects of reagents on laboratory ware

Acids

Pure silica glass is not attacked by water and will resist most acids except hydrofluoric acid and hot phosphoric acid which dissolves the glass.

Alkalis

Sodium hydroxides attacks glass, hence clogging burettes and pipettes outlets and also sticks the glass stoppers to glass bottle necks

Pure silica glass is attacked by alkaline solutions, thus soda glass contains the seeds of their own chemical destruction, when these glasses are exposed to water, the water dissolves the sodium ions out of the glass surface to form sodium hydroxide. This in turn attacks the silica in the glass. For resistance to alkali attack, boric acid and aluminiumoxidesare used insteadof soda and lime to produce aluminoborosilicate glass which is used for laboratory and industrial glasses and for packing delicate pharmaceuticals.

Organic solvents

Ether and benzene attacks or distorts plastic ware.

Do not use rubber stoppers or plastic containers for storing ether, iodine or xylene. These chemicals attacks glass and plastics, iodine is also photosensitive.

Storage of laboratory ware

The following should be considered when storing laboratory ware:

- Labeling
- Position of storage
- Method of storage

Glass is stored according to its type and size

Store each of the laboratories separately in the drawer or locker, separate the glass ware from the plastic ware, different sizes of laboratory ware should be stored separately. Store the 500ml beakers separately from the 250 ml beakers even if they are in the same locker, store each type of volumetric flask separately from beakers.

The lockers or the drawers should be labeled appropriately with the type and size of the items. This makes it easy in the retrieval of the item when required. Laboratory ware are best stored at the level not beyond shoulders height. All flasks should be stored in the same

locker but separately according to size flat bottomed vessels should stand upright, while round bottomed flask should be stored in a bin with a high front.

Glassware that includes specimen tubes, petri dishes, microscopes slides are best kept in the shelf trays.

Burettes require a long padded drawer. Glass taps in separating funnels should be prevented from sticking by means of a piece of tissue paper placed between the tap and the barrel or by greasing. Thermometers should be placed in their cases and stored according to type and range.

Glass tube and rods are best stored horizontally e.g. in a plastic guttering. Large diameter tubing should be plugged at the end to keep out dust. Should soda and Pyrex tubing become accidentally mixed, it is very difficult to separate them by visual examination. They may be identified by:

Apply a little aqueous solution of phenolphthalein on a piece of porous plate and allowed to dry out. Wet the end

of the glass tubing and draw it across the plate. Soda glass produces a red lime while Pyrex, the indicator shows no change.

Immerse part of the tubing in a glass walled vessel containing trichloroethylene and look through the vessel wall, Pyrex tubing will be almost invisible while soda glass tubing is easily seen.

TOPIC 5

INSTALLATION OF LABORATORY EQUIPMENT

Objectives

Explain the effect of vibration in the installation of equipment and how to overcome it.

Explain the consideration in the installation of;

- Balances
- Mercury barometer
- Galvanometer
- Glass blowing equipment
- Heavy equipment
- Laboratory still
- Spectrographic equipment

Each type of lab has its own special problems connected to installation of equipment. This may be overcome during laboratory design. Problems may arise in later years especially of space as new items are purchased as department expands

The effects of such conditions such as humidity, temperature, and the effects of sunlight, dust, draughts, noise and vibrations must be considered. The placement of equipment must also be related to position of the lab service outlet.

Vibrations

The mounting of precision equipment is determined by the effects of vibration. The amount of vibration present in a building is normally associated with its location. Vibration source may be due to:

- Machinery
- Passing traffic
- Underground trains
- Movement of people near the equipment

It is important to investigate and if possible remove the source of vibrations.

Balances

In considering the ideal conditions for the housing and mounting of balances one should pay attention to the balance room itself and how the balance is supported.

Balances room

This should be situated near the people that use it. If the room is to be shared between several labs, it should be at central position. The room should not be situated on the outside wall. Direct sunlight rays should not enter the room.

The room should be well away from sources of vibrations such as heavy machinery or human traffic.

For highly sensitive beam balances e.g. a periodic beam balances, which is able to weigh to within 0.002g, 2mg, a reserved location or balance room is essential. This balance room requires adequate shielding from draughts. The atmosphere must be free from corrosive material including excessive moisture and warmth.

The balance must rest on a vibration free bench. If a beam balance is kept in a balance case, the atmosphere within the case should be kept dry by means of a suitable desiccant e.g. calcium oxide or self-indicating silica gel.

Balance room doors and other neighbouring doors should be fitted with springs to avoid vibrations when they are

slammed, draught should be avoided hence there should be only one door opening into the room. The room should be ventilated by other means other than windows

Air conditioner is the best method of ventilating the room since it will maintain constant humidity and temperature which are necessary for very accurate balances. A constant temperature is very important and tubular heaters fitted with a thermostat may be used, but they do create undesirable air disturbances due to convection.

Recommended humidity is 50% and a temp of 25^0C. Dust can be minimized by making the balance room easy to clean. The floor should not be swept but cleaned.

The wall should be labeled to the floor to prevent the accumulation of dust.

Balance support

The main problem to overcome in the balance room is that of vibration, vibrations make it impossible to read a balance accurately; they also shorten the balance life by excessive wear on the knife edges.

Various types of balance support have been suggested with the aim of isolating vibrations

Method 1

Holes are made in the floor of the balance room. These holes should penetrate the foundation

The holes are filled with concrete but a paper like material is placed between the concrete and floor of the building to create a 1.3- 2.5 cm space. When the concrete has set the paper material is removed and the space filled with a bituminious material. Above the concrete foundation brick material are erected.

On top of these pillars a 1.3 cm thick concrete is placed and on its top a 3.8 cm layer of cork is placed, finally a heavy slab of polished slate is laid on the cork.

Diagram.

The brick piers are built on their own foundation, a 13 mm layer of cork is interposed between the two pieces of lead sheet on top of the brick piers

The pier supports a slate top 63 mm thick. A small space is left between the back of the balance bench top and the wall of the building to avoid transmitted vibrations.

Mercury barometer

In addition to the method for the installation of barometers, the methods of transporting and moving this instrument should be considered.

Fortin barometer

It is used to illustrate changes in air pressure with different weather conditions. It is very expensive and delicate; it is more accurate for barometric height measurement than with simple barometer it should be placed in a lockable hardwood case as a way of protecting it.

Factors to consider during installation

Room or site

The barometer should hang in a position which is free of vibrations and where there is little traffic. The base of the instrument should be 0.75m from floor level.

The room must be well lit and direct sunlight should be avoided. Room temperature should remain fairly constant. The room should have no corrosive fumes. Local sources of heat may upset the working of the barometer; hence it should be placed away from radiations and hot water pipes.

Hanging position

It should be fixed in a vertical position, the blackboard of the barometer should be firmly fived to the wall, and a plumber line is used to ensure that the instrument is in a vertical position the top of the mercury column should be at a convenient height for observation approximately 150 cm above the floor level.

Transportation

It should be packed in a wooden case. The top of the case should be secured with screws; the blackboard of the barometer should be screwed to the inside of the case. When unpacking the barometer, the cistern must be kept in a raised position while the box is being unscrewed.

Before instillation the barometer must be carried upside down i.e. with the cistern uppermost to avoid possible damage to the cistern.

GLASS BLOWING EQUIPMENT

The following should be considered before the setting up of the glass blowing equipment

Glass blowing equipment

- Benches
- Burners
- Lathes
- Ovens
- Room

To assist in the ventilation and to allow heat, water vapour and gases given out by burners to escape, glass blowing room should have high ceilings, the ventilators should be placed high up, and the room should be free from droughts especially at working levels.

Acoustic tiles may be used in on walls and ceiling of the room in order that the noise from burners is reduced to a minimum.

Adequate daylight should be provided but direct sunlight should be avoided the window should be arranged in the such a way that glassblower does not face them directly, rather the light should be enter either from behind him or at right angles to him

Artificially lighting is required and fluorescent lighting is best, the overall intensity of illumination in the room should not be too high because it will mask the blowpipe flame.

Walls should be painted green or some other suitable colour that makes the burner flame to be seen easily.

There should be fume chamber designed to allow the use of hydrofluoric acid. Metal rubbish boxes with raised off the floor by short legs are required to allow the hot pieces of glass to be discarded without the possibility of fire or damage to the floor. Wood blocks are suitable for floor

since they are hard enough to prevent the pieces of glasses trodden in and do not burn easily.

Adequate electrical socket should be provided to provide power for machines such as grills cutters and grinders.

There should be enough supply of oxygen from cylinders and compressed air is necessary.

Benches

The design of glass blowing bench is important. It should be 1m high, not less than 1.8m long and 0.8m wide. The bench top should be covered with hard black cement-asbestos composition.

It should have a raised ledge around its edges to prevent the glass from rolling off. There should be a clear working space, preferable on three sides of the bench to allow manipulation of long length of glass tubing.

Control for various services e.g. fuel gas, oxygen, compressed air or vacuum may be placed on a rail under the front edge of the bench for easier operations

BURNERS

Gas burners used should be suitable for the type of fuel gas to be used. Butane and similar gases require burners with special jets.

LANTHES

Glassblowing lathes rotate at low speeds hence they do no vibrate. They do not require rigid fixing. They are best placed on the feet and to the floor. It should be protected from draughts and should not be near doors or windows.

A vacuum point close to the lathe may be necessary for vacuum chucks and for operations involving the shrinking of glass.

Should have an all-round accessibility and enough space should be left at the ends so that long tubes may project through mandrel.

OVENS

Ovens for glass annealing should be level and firm so that hot glass items are not distorted by gravity effects

Ovens should stand on feet of large area on a firm floor.
A three phase electricity supply is required for the oven and should be insulated to prevent heat losses.
For convenience, the oven should be positioned as near as possible to the glassblowing bench.

HEAVY EQUIPMENT INSTALLATION

The following should be considered during installation

- Space
- Concrete blocks

- Three phase electrical supply
- Water supply

Space

Problem of positioning of large heavy equipment may arise in the lab hence sufficient space for installation should be during laboratory design.

Because of vibrations and noise and heavy moving equipment need to be installed in rooms separate from the lab and in some cases away from the lab. Liquid air plant is used for high vacuum and low-temp work.

The equipment should be situated outside the building outside the laboratory. It must be close to an existing electrical and water supply. The room should be well ventilated with a temperature of about 200c. The room should have a solid cement floor; the building should be fire proof.

A three phase electrical supply and water supply are required. A drainage system for water effluent is also required. The machines should be mounted on a concrete

block to which is fastened by means of its base baseplate. The bolts are first fixed into the block when the block is being cast.

The size of the block varies with the weight of the machine being installed.

Laboratory stills

The still is very heavy equipment hence; they are fixed to the lab walls using bolts. A still boils tap water and condenses the vapour as distilled water; heat energy to boil water is supplied by burning gas or by electric heater element.

It should be mounted in a room where the damp atmosphere created will not have harmful effects on the other apparatus.

It should be fixed so that the top of still is 2.1m above the floor level this position allows the distilled water container to be supported on a wooden stand directly beneath it.

The electrical supply socket should be set high on the wall. This keeps the electric cables to the stills as short as possible. The socket itself should have a red indicator lamp. A cold water supply should be situated on same level with the still inlet valve so that they connect close to the still is also kept short. There should be a drainage system for the still overflow.

SPECTROGRAPHIC EQUIPMENT

The following should be considered during the installation

- Room
- Strong benches
- Electrical supply

Room

The room which can be partially or completely darkened is needed. Modern spectrographic equipment can be operated in rooms which are not completely darkened, but some way of reducing light from window is necessary.

The finishing of the ceilings, walls and floor should be such that they are easy to clean, and there should be no ledges or projections on which the dust can accumulate. The room should be dry and free from fumes and well-ventilated without causing draughts. The substances likely to produce fumes should not be kept in the room. Sufficient electrical outlets for both A.C and D.C should be provided at suitable positions and away from water outlets.

Benches

They should be strongly constructed as other items of spectrographic equipment are heavy; other furniture includes desk for calculations and other written work, a filling cabinet for recorded data and book shelves. There should be drawer for electrodes, photographic plates and other small items and wall shelves for samples and reagents.

Darkroom

A photographic darkroom adjacent to and directly accessible from the lab is required for development of plates.

TOPIC 6

GLASS BLOWING

Objectives

- **State the various types of glass**
- **Explain the glassblowing technology**
- **Explain the characteristic of a given type of glass**
- **Make simple glass apparatus**

- **Describe the use and maintenance of a given glassblowing tool and equipment**

Historical background

The glass articles were being made by pouring molten glass in successive layers over a core, until sufficient thickness and rigidity had been attained in the product, which was a cup-shaped vessel. This pouring technique was used until around 200 B.C when simple tools were developed, e.g. the blowpipe that revolutionized the glass working.

The glassblowing was first accomplished in Babylon and later by Romans.

It was performed using an Iron tube, several feet long, with a mouthpiece on one end and a fixture for holding the molten glass on the other.

A blob of molten glass in the initial required shape and viscosity was attached to the end of the iron tube, and then blown into shape by an artisan, either freely in the air

or onto a mold cavity, other simple tools were used to add the stem and/or base to the object.

The art of glassblowing is still practiced to date.

Tools and equipment of glassblowing technology

Bunsen burner

This includes flame spreader and fish-tail; they provide heat or flame to the glass being acted on.

Annealing oven or lehr

Used for annealing newly made glass items or products

Diamond glass-cutter

Used to cut glass tubes, rods and plates or sheets the glasses should have a diameter of 15mm or less.

Cane

Is a cross-section of glass made by pulling and stretching molten glass from both ends.

Cold-working

Any work, grinding, surfacing or drilling that is done on the glass

That has been finished after annealing process is completed.

Jack

A tool shaped like a huge tweezers used to manipulate hot glass.

Lear/lehr

A gigantic oven that is computer controlled used to relieve stress from glass during annealing process.

Marver

A flat steel plate or slab that is used for shaping of molten glass on the end of blowpipe by a rolling action

Necking

Reducing an end of blown glass to form a bottle neck

Parison

The first small bubble of molten glass at the end of the of blowpipe

Sodium flare

Is the bright light that is given off due to the reaction of O_2 which flame and the sodium of glass in a kiln. This flare can damage the workers eyes

Lathe

Used to cut glass tubes whose diameter is more 15mm

Flaring tool and carbon rod

Is used for widening the diameter of one end of glass tube

Triangular file

Used to cut tubes whose diameter is 10mm and below

Carbon plate and asbestos plate

Used for flattening and smothering hot glass items

Goggles

Used when working and looking directly at the glass being heated.

Requirements for glassblowing room

The walls should be painted green or some other suitable colour, which enables the burner flame to be seen easily
The room should have a high ceiling; this will assist in ventilation and allows heat, water vapour and gases produced by burners to escape.
The ventilators should be placed high up.
Enough light should be available but direct sunlight rays into the room should be avoided
The windows should be arranged such that the glassblower does not face them directly.
Light through the windows in relation to the operator should enter from behind or at right angle
Overall illumination intensity in the room should not be too high, as it will mask the burner flame.
A fume chamber should be designed and fitted in the room to permit the use of hydrofluoric acid.
Artificial light is required and fluorescent lighting is best.
A metallic rubbish box raised off the floor level is necessary to allow hot pieces of glass be discarded easily.

The floor should be of wooden blocks

Adequate electrical socket should be provided for drills cutters and grinders.

Enough supply of fuel gas a supply of O_2 cylinders and compressed air is necessary.

GLASS

It is an inorganic product of fusion that has cooled into a rigid condition without crystallization.

It is an amorphous solid having a structure of a liquid. All glasses contain at least 50% silica, also known as a glass former. The composition and properties except their strength can be altered by the addition of oxides of Aluminum, Calcium,Sodium,Barium ,Boron, Magnesium, Titanium, Lithium, Lead and potassium.

Depending on their function, these oxides are known as intermediate or modifiers

Glasses are generally resistant to chemical attack. They are ranked according to corrosion by acid, alkalis or water.

Silica is the best glass former, it transforms into a solid state upon cooling from the liquid i.e.it does not crystallize upon solidification.
The additional ingredients are contained in a solid solution with SiO2 and each has a function

Acting as a flux, promoting fusion during e.g. Na_2CO_2, Lime & Borax
Increasing fluidity in the molten glass for processing e.g. Na_2CO_3
Reducing thermal expansion in the final product e.g.borax
Retarding devitrification i.e tendency to of molten glass to crystallize from glassy state on cooling
Improving the chemical resistance against attack by acids, alkali and water e.g boric oxide B_2O_3
Adding colour to glass
Altering the refractive index for optical appreciation in lenses e.g addition of boric oxide

Causes of devitrification in glasses

Devitrification is commonly known as devit. It is caused by:

- Holding the glass at high temperature for too long which causes nucleation of crystals
- The presence of foreign residues e.g. dust on the surface of glass
- High lime content
- Slow cooling of hot glass

Techniques of avoiding devitrification

- Cleaning of glass surface of dust or unwanted residues
- Allowing rapid cooling once the glass reaches the desired temperature, until the temperature reaches the annealing temperature
- Apply the devit spray to the surface of glass before firing

To remove devit on the surface of glass

- Apply the devit spray and refire the glass item

- Sand blasting the glass surface
- Soaking the glass in acid bath
- Polish the surface to a pumice stone
- Use a rotary brush to brush the glass surface

Bloom

This is the formation of oxides during the heating of glass. This oxide includes Sodium or Calcium carbonates. The oxides may be formed of the glass surface and can be removed by wiping out, hence referred to as temporal bloom. The oxides maybe formed within the glass material and cannot be removed hence referred to as permanent bloom.

TYPES OF GLASSES

This includes:

- Soft glass
- Hard glass

This classification is based on the thermal property rather than mechanical property, a soft glass softens at a lower temperature than a hard glass e.g. soda-lime and lead alkali are soft glasses while borosilicate is a hard glass. Laboratory glass is usually made from hard glass.

Categories of glasses

- Soda-lime glass
- Lead- alkali
- Borosilicate
- Aluminosilicate
- 98% silica glass
- Fused silica glass

Glasses can also be classified as coloured,opaque,optical,photochromatic and photosensitive

Soda-lime glass

It constitutes 98% of all manufactured glass. It is used for containers of all kinds, it melts at relatively low

temperature, they are sufficiently viscous, that they do not devitrify and yet they are not too viscous to be workable at reasonable temperature.

Addition of high content of alumina and lime and reducing the alkali (soda) content produces a glass with high melting temperature and one which is more chemically resistant.

Lead alkali

It contains 18-40% lead II oxide, is made by substituting lead oxide with CaO in glass.

The glass is used for optical work because of high refractive index and dispersion of light

This glass is also good for shielding from nuclear radiation and X-rays.

They are used to make light bulbs neon signs tubing e.t.c

Addition of lead oxide to glass raises its refractive index and lowers its working temperature and viscosity

The high atomic number of lead also raises the density of the material

Lead glasses also have high electrical resistance twice that of soda-lime glass, hence leadcontent glass is frequently used in light fixtures.

Borosilicate glass

This glass has the following properties;

- A low coefficient of thermal expansion
- High resistance to shock
- Excellent chemical resistance
- High electrical resistance

The borosilicate glass is used in;

- For laboratory ware
- High tension insulators
- Telescopic lenses
- Disposal of radioactive material

The laboratory ware is classified into three main types

- Soda glass
- Borosilicate glass
- Resistant glass or aluminosilicate glass

Fused silica glass

It is made by high temperature pyrosis (thermal decomposition or melting) of silicon tetrachloride or fusion of pure sand which consists of quartz crystals.

This glass has low expansion i.e a near zero coefficient of expansion and has a high softening temperature which gives it a high thermal resistance. This allows it to be used beyond the temperature ranges of other glasses.

The glass is also very transparent to ultraviolet radiation than any other glass material.

Application

- UV-quality quartz glass component
- High temperature applications
- Quartz glass cover slips
- UV measurement technology
- Quartz glass microscope slides
- Space technology

RAW MATERIAL, PREPARATION & MELTING OF GLASS

The major component in all glasses in silica which is obtained from quartz in sand. The sand is washed and classified; washing removes impurities such as clay and other minerals that would cause colouring of the glass. Classification of sand means grouping the sand according to the grain size. The most appropriate particle size for glass making is in the the range of 0.1-0.6mm.

The other component such as soda, lime aluminum oxide potash K2O and minerals are added in the correct proportion to achieve the desired composition.

Mixing is usually done in batches; in amounts that are in compatible with capacity of the melting furnace Recycled glass is usually added to the mixture. This facilitates the melting. The batch for starting materials to be melted is known as charge and the method of it into the furnace is termed as charging the furnace.

Glass furnaces can be categorized into four types.

Pot furnaces

This is a ceramic pot of limited capacity in which melting occurs by heating the walls of the pot.

Day tank

These are large capacity a vessel, hence heating is done by burning the fuels above the charge.

Continuous tank furnace

These are long furnaces in which raw material are feed in at one end and melted as they move at the other end, where the molten glass is drawn out to make glass articles.

Electric furnace

There are varies designs for a wide range of production rates. It is an emission free method of melting glass. It has the lowest CO_2 emission on site.

Glass melting is usually carried out at temperatures of between 1500^0c- 1600^0c.

The melting cycle for typical charge takes about 24-48 hours. This is the time required for all the sand grains to

become clear liquid and the molten glass to be refined and cooled to the appropriate temperature for working.
Molten glass appear as a red-hot viscous syrup, since the shaping operations follows immediately the melting cycles, the temperature at which the glass is tapped from the furnace depends on the viscosity required for the subsequent processes.

Glass products

Soda-lime glass (window glass)

Is made by mixing soda (Na_2O), lime (CaO), with silica (SiO_2) as the major ingredients.
The mixing of ingredients is done in such a way in order to achieve a balance between avoiding crystallization during cooling and achieving chemical durability of the final product.
Magnesia is added to reduce devitrification.

Container glass

The proportion of lime and soda differ from that of window glass. Lime improves fluidity but it increases devitrification but since cooling is rapid today, this effect is not as important as in olden day when processing techniques during cooling was slower.

Reducing soda increases chemical stability and reduces solubility of the containers glass.

Light bulb glass

Is high in soda and lower in lime, it contains small amounts of MgO and alumina Al_2O_3

Laboratory glassware

This includes flasks, beakers, glass tubing e.t.c the glass must be resistant to chemical attack and thermal shock. Glass that is high in silica is suitable because of its low thermal expansion. This product is very insoluble in water and acids.

The addition of boric acid (B_2 O_3) hence borosilicate glass produces a glass with low coefficient of thermal expansion.

Further addition of alumina hence aluminoborosilicate glass reduces further the coefficient of thermal expansion and chemical resistance.

Processes used in glass making

Blowing process is used to make hollow thin walled glass items such as bottles and flasks. Blown air expands a hollow gob of heated glass against the walls of the mold. The molds are usually coated with a parting agent such as oil or emulsion, to prevent the glass from sticking to the mold.

Pressing

A glob of molten glass is placed into mold and pressed into shape with the use of a plunger.

After being pressed the solidifying glass acquires the shape of the plunger-mold cavity

The products are relatively flat e.g dishes. The products have a higher dimensional accuracy than those obtained by blowing

Centrifugal casting or spinning

Here the centrifugal force pushes the molten glass against the wall of the mold where it solidifies forming a funnel shaped components e.g T.V picture tubes and computer monitors. A gob of molten glass is dropped onto a conical mold made of steel. The mold is rotated so that the centrifugal force causes the glass to flow upwards and spread itself on the mold surface.

Sagging process

It is used to make shallow dish-shaped glass parts e.gsunglases lenses and telescopic mirrors.

A sheet of glass is placed over a mold and heated; the glass sags by its own weight and takes the shape of a mold.

Heat treatment and finishing

Glass products have undesirable internal stresses after forming which reduces their strength. Strain and stress are internal tensions that occur within the glass material. Annealing is done to relieve these stresses.

Annealing is done in an annealing oven called LEHR. A lehr consists of a heated chamber in which the rate of cooling can be controlled.

Depending on the size, thickness and type of glass, annealing time vary from a few minutes to as long as ten months, as in the case of the 600 mm telescopic lens

Annealing involves heating the glass to elevated temperatures and holding it to a certain period to eliminate the stress and temperature gradient, then cooling the glass to suppress stress formation, followed by a more rapid cooling to room temperature. The common annealing temperature is around 5000c.

The length of time the product is held at the temperature as well as cooling and heating rates during the cycles depends on the thickness of glass. The rule is that; there required annealing time varies with the square of the thickness.

N/B annealing involves two operations

- Holding the glass above a certain critical temperature long enough to reduce internal strain by plastic flow, to less than a pre-determined maximum
- Cooling the glass to room temperature slowly enough to hold the strain below this temperature

Tempered glass

Thermal tempering

A beneficial stress pattern can be developed in glass products by a heat treatment known as tempering. The insulating material is known as tempered glass. The process involves heating the glass to a temperature above the annealing temperature and into the plastic range, followed by quenching the surface with air jets. When the surface cools, they contract and harden, while in the interior is still plastic and compliant.

As the internal glass slowly cools it contracts, thus pulling the hard surfaces in compression. This tempered glass is more resistant to scratching and breaking.

This is because of the compressive stresses on its surface. The compressive surface stresses improve or increases the strength of the glass.

The application of this tempered glass include safety glasses, all glass doors e.t.c

When tempered glass fails, it does so by shattering into numerous small fragments, which are less likely to cut someone, than annealed window glass.

Chemical tempering

In this process the glass is heated in a bath of molten KNO_3, K_3SO_3 or $NaNO_3$, depending on the type of glass. Ion exchange takes place with the larger atoms replacing the smaller ones in the glass surface.

As results, compressive stresses are developed on the surface. This condition is similar to that created by forcing a wedge between the two bricks on the wall.

The time required for chemical tempering is about 1hour, longer than that for thermal tempering. It may be done at various temperatures.

FINISHING

All types of annealed glass must undergo certain finishing operations, which though relatively simple, are very important.

This includes; cleaning, cutting, drilling, grinding, sandblasting and polishing, although all these are not required for every glass object, one or more is necessary.

- Shapes edges and corners can be smothered by grinding. This effects is done to glass tops e.g. for desks benches and shelves.
- Fire polishing is done to glass edges. This method rounds the edges by localized softening and by surface tension. It is done by holding torch or flame against the sharps edges.
- In continuous glass working processes in which glass plate and tubes are produced, the continuous sections must be cut into smaller section or pieces.

- Decorative and surface processes are performed in certain glassware products this includes mechanical cutting and polishing operations. Sandblasting, chemical etching with hydrofluoric acid combined with other chemicals and coating e.g. coating a glass plate with aluminium or silver to produce mirrors.

Cutting glass tube and rods

For a diameter less than 10mm, a notch at 90oc to the length of the tube is made using a glass cutter e.g. a triangular file or the hack-saw

Place the glass tubing or the rod on a flat bench and make the scratch where you want to cut.

Roll the tube on the bench while scoring around it.

Protects your hands with a cloth, the scored tube can then be broken by applying pressure behind the nick on the opposite side of the tubing with the thumbs at the same time exerting an outward pull.

With small diameter tubing, is not necessary to score all the way round. A nick on one side will do. If long lengths are to be cut, make sure that the far ends do not knock over apparatus.

When cutting a short piece from a long length, it is safe to hold the long end under the armpit for greater control as the two pieces separate.

Glass tubing of over 10mm in diameter is not easy to cut by scoring and pulling. Large diameter glass tubes are best cut by scoring all round with a glass knife then broken by any of the following methods:

- A resistance wire is fastened around the scratch and the wire is electrically heated with a PD of 12- 24 volts. The heat causes the glass to break along the scoreline. If the glass is so thick, more than one application of the heated wire may be necessary.

- The glass tubing is gently warmed at the scratch, and then a drop of cold water from a teat pipette is released onto the warm scratch area. Abrupt contraction of glass causes the glass to break along the scratch.
- The scratch is touched at various places with a hot glass rod. The heat from the glass rod is enough to initiate a local crack. This is done for large diameter glass tubing. Repeated procedure of this produces a clean crack which runs around the scoreline.
- Note that for any clean cut to occur, the scratch should be done once along the uniform path, not at several places. This can best be achieved by holding the glass tubing or rod firmly on the bench close to the mark. The cutter is then rested on the block of wood and the glass is then rotated around it.

Cutting a measuring cylinder

The following methods are used;

Make a scratch round the item that you want to cut, and then fill the glass with engine oil up to the mark (scoreline) a red hot rod is then plunged at the surface of the oil, the glass cuts cleanly at the oil level.

Clump the resistance wire loop round the cylinder or the bottle at the scratch level; adjust the length of the wire so that it fits with about 1/16th of an inch gap between the terminals to prevent a short circuit, turn on the current for about 20 sec then shut it off and quickly immerse the bottle in cold water, the sudden chilling should crack the bottle cleanly.

Drilling a hole through a glass plate

A hole can be cut through glass with an abrasive drill, but not with an ordinary drill use a short length of brass or copper tubing of same outside diameter as the diameter of the desired hole, cut a slot on one end of the of the metal drill with a hack saw about 1/6th inch deep to make it easier to keep the abrasive cutting.

Insert the drill into the drilling machine and set it to the slowest speed. Place a soft board pad under the glass and place clay around the area where the hole is to be made, in this clay, put silicon carbide grit and about 5ml of water.

Use enough pressure to keep the drill cutting, but too much pressure will crack the glass. Feed the drill with abrasive grit with a small paint brush. Patience is needed as glass cuts slowly.

FIRE POLISHING

A freshly cut tube or glass sometimes has jagged edges and this must be removed. First hold the tube in the left hand and hold a piece of wire gauze with the right hand. Sharply strike the gauze across the edges of the tube. This will remove the sharp pieces of glass.

Hold the tube in the hot blue part of a Bunsen burner while rotating it in the fingers all the time until it becomes very hot.

This will smoothen the edges of the cut part of the tube or rod and prevent it from being too sharp to cut fingers.

Glass bending

Using a Bunsen burner fitted with a flame spreader or a fish tail burner, adjust it to give a blue non-luminous flame. Holding the tube or rod in both hands in the flame, rotate it constantly slowly using the thumb and the fingers. It is important that the tube rotates just over 180o on each rolling in order to heat the glass evenly. After a while the tube will be hot enough to bend under its own weight. Remove it from the flame and allow it to bend itself to the desired angle. Do not bend it or force it into position for this will cause the tube to fold and not bend in a smooth curve. When the tube has bend sufficiently anneal it by holding it in a luminous flame until it is coated with soot, this reduces the internal strain in the glass.

If the bend is to be greater than 90o, the tube will tend to be flatten at the vertex of the bend this is prevented by rolling the bend along the heated part of the tube several times before the glass cools down.
When making a U-tube, allow it to hang down vertically and roll the bend by raising and lowering each arm alternatively.

Making a hole on a boiling tube

Clamp the boiling tube horizontally then fit a stopper in the in the mouth of the tube firmly such that there is no air that passes either inside or outwards. Heat continuously at the point where you want to make a hole with the top of the blue flame
The principle is the fact that when the trapped air is heated, it will expand and tries to escape, and this is through the weak heated part of the tube which melts.
A hole will just blow off the burner through the point where it is being heated.

Sealing tubes

Draw out the tube slowly until the waist is of smaller diameter, then reheat the narrow portion very strongly while rotating the tube in the fingers. This will separate the two portions of tubing and seal the ends at the same time. Blow gently into the tube while it is still soft, this will remove any lump at the end of the tube. If the tube shows any tendency to bend at the sealed end, it should be softened again and then rotated slowly in a vertical position away from the flame until it hardens.

Making bulbs in tubing

If a bulb is to be made at the middle of the length of the tubing, seal or plug one end of the tube first.

If the bulb is to be made at the end of the tube, seal the tube as described above, then soften 2cm of the sealed end. Remove the tube from the flame and then blow the bulb with a quick but gentle puff.

If a layer bulb is required, heat the next 2cm of the tubing and puff it out, then still rotating the tube, reheat the waist

and blow gently with the tubing held vertically and rotate until a spherical bulb is formed.

Making a hole in glass tubing

Plug or seal one end of the tube.

Use a blowpipe with the Bunsen burner or a needle flame from a propane blazing torch to heat a small spot on the wall of the tube. When the glass is soft, blow firmly to produce a thin-walled bubble of glass, break-off the bubble with a tool.

Re-heat the edges to smoothen the hole, remove the plug or cut the sealed end.

Making a T-Joint

Make a hole as described above, seal or plug both ends of the tube heat the two pieces of glass to be joined until both are soft as you rotate them continuously. Bring them together, and then gently blow into the open tube to straighten and clear the joint. Anneal in the Smokey flame

Sealing wires into tubing

If nichrome or platinum is placed in capillary tubing and the end heated, the joint made will be very weak. The correct method is to draw out a piece of tubing slightly, and then insert a wire with a small collar of tubing. Heat the collar and the tube to form a bed and this will join the wire to the tube, always use pyrex tubing.

Making a glass stirring rod

Cut a suitable length of glass rod, heat one end strongly until soft, press this end vertically onto a flat metal surface or a tile to produce a head, then heat about 1cm of the other end until very soft. Lay the softened end on a tile and press the end flat with a file to form the stirring blade. Anneal the end in a luminous flame until covered with soot.

Annealing using a Bunsen burner

The glass must be allowed to cool slowly to remove tension brought about by the process of heating or bending. This should be carried out in the LEHR but in practice it can be done by turning the air supply to the burner flame down, until the flame is luminous i.e. no blue flame, and then move the bend or heated area and about 4 cm of tubing, either side of the heated area, through the flame until carbon soot begin to deposit on the tube. Then place the sheet of asbestos or ceramic tile to cool.

TOPIC 7

WATER AND LABORATORY WASTE DISPOSAL

Objectives

- **Identify sources of water**
- **Describe methods of water treatment for laboratory use**
- **Describe methods of lab waste disposal**

Sources of water

- Rain water
- Stream water
- Borehole water
- Piped water

Protection of water supply

The first step in providing pure water is protect the source of supply e.g. against sewage pollution. Boreholes should be located at considerable distance from septic tanks cowsheds and other pollution. They should be carefully constructed to prevent seepage of surface water. They should also be closed with concrete cover.

Large water sheds from which water is collected into ponds, streams or reservoirs should be carefully inspected. The water sheds are usually fenced off to exclude all sources of pollution.

Treatment Methods

- Steps in water treatment
- Course screening

- Coagulation
- Flocculation
- Sedimentation
- Filtration
- Chlorination
- Ph adjustment

SEDIMENTATION

Purification of water by sedimentation is done as water flows slowly or stands in a reservoir. It is made more efficient by adding alum or Iron salts. The hydroxides produced form a precipitate which traps the microorganism and other suspended particle in the water and this settles rapidly. Sedimentation does not sterilize

polluted water but greatly reduces its microbial population. Sedimentation is often considered as the first step towards water purification.

FILTRATION

It is an effective means of removing microorganism and other suspended matter from water. Two types of sand filters are used in large scale filtration of water.

diagram

The water filters through the filter slowly, the bacteria, algae and protozoa are caught in the surface layers of the fine sand, these microorganisms forms a gelatinous mass onto which other microorganism and suspended particles adsorb. The efficiency of the filters gradually decreases and eventually the surface layer of the sand must be cleaned. Large filter beds are required because the rate of filtration is slow.

Rapid sand filters

diagram

It operates about 40 times faster than the slow sand filter, it consists of sand, gravel and rock, the coagulant such as alum or ferrous sulphate is added to water before filtration. The water first passes through a settling tank in which most of the precipitate settles out, the reminder being removed by the filter. A rapid sand filter soon becomes clogged and must be cleaned. This is done by forcing water backwards through the bed of gravel and sand. These filters are usually operated on batteries, such that some may be in operation while others are being cleaned.

NB Properly constructed and operated sand filters remove 90-99% of the microorganism and most of the suspended particles. Filtration does not sterilize water.

GRAVITY FILTER

When using gravity filter fitted with a ceramic candle filter of about 0.9µm porosity, most bacteria, parasitic, microorganisms suspended particles can be removed from

water and not dissolved. If the supply of water to lab is heavily contaminated ith particle matter, and there is no opportunity for rain water leave the water to stand in a container overnight to allow the larger particles to settle or sediment. Filter the upper layer of water using a gravity filter. It is however preferable to use rain water in the gravity filter because it will contain less dissolved chemical and matter.

CHLORINATION

This is done by using chlorine in gaseous or powder form. The amount of chlorine added depends on the degree of pollution of the supply and its organic matter content. The water is usually treated to contain 0.1-0.2 ppm of residual chlorine. The residual chlorine is the available chlorine that remains in water 20 minutes after its addition. During these 20 minutes the chlorine combines with organic substances and with bacteria. The more the contamination, the greater its organic content, the more chlorine that must be applied to ensure a safe residual.

The initial sedimentation and filtration of water is therefore very helpful. Chlorine kills the non-sporing gram negative bacteria, but in the concentration used, it does not kill spores or gram positive bacteria. Chlorinated water therefore is not sterile.

DISTILLATION

In distillation the impure water is boiled and the steam produced is condensed on cold surface or condenser. This produces chemically pure distilled water. The water in which non- volatile organic and in-organic materials are removed, distillation does not remove dissolved ionized gases such as Ammonia, Carbon dioxide and chlorine. Distilled water should be colourless clear and odourless, it should be pyrogen free. Pyrogen is a substance that cause fever if transfused in the intravenous fluid, provided that the design of the the still ensures that the water contains only the condensed steam, and the distillate is collected into a clean sterile container, the water will also be pyrogen free.

Water feeding the still should not be heavily contaminated, most expensive models of water still is capable of producing highly purified water for research and specialist lab work i.e. grade 1 and 2 water quality.

DEIONIZATION

In deionization, impure water is passed through anion and cation exchange resins to provide ion free water. Deionized water has a low electrical conductivity, near a ph of 7 and is free from water soluble salts but is not pyrogen free or sterile. The cations present in water such as Ca^{2+}, Na^{+}e.t.c are exchanged by cations resins R-H, which in turn releases hydrogen ions, H^{+}

$R\text{-}H + Na^{+} \rightarrow R\text{-}Na + H^{+}$

Anion impurities such as SO_4^{2-} , CL^{-} are exchanged by the anion resins (R-OH), which in turn releases hydroxyl ion (OH^{-}) ions. The hydrogen ions (H^{+}) then combines with the hydroxyl ions (OH^{-}) to give ion free water.

$R\text{-}OH + CL^{-} \rightarrow R\text{-}CL + OH^{-}$

Water of the grade of analytical work and for making reagents can be made by deionizing water that has been previously filtered. It is cost effective to deionize water that has first been filtered, use of unfiltered water will lead to rapid contamination and exhaustion of resins. The life of resins can be maximized if soft filtered ram water is used especially in areas where the natural water is hard. Filtered water can easily and economically be deionized in the lab by passing water through a lab by passing water through a lab- made deionizer column using mixed bed colour change deionizer resin.

This type of resins contains both cation and anion resins and indicator that changes colour as the resins become exhausted.

diagram

GRADES OF WATER

S/NO	GRADES	Resistivity	TOC	Bacteria	Application
1	Type 1+	18.2	5	1	Trace metal detection
2	Type 1	18	10	10	HPLC Immunocytochemistry Mammalian cell culture Plant Tissue culture
3	Type 2	10	50	10	General lab application
4	Type 2	1	50	100	Used to produce

					type 1 Electrochemistry Radioimmunoassay
5	Type 3	0.05	200	1000	Autoclaves Cleaning glassware

Achieving the correct water quality depends on the selecting the correct purification technology and a system design that accurately measures and monitors the contaminants, Producing pure water is one thing but validating the quality, storing water and maintenance are also key to ensuring that you have the quality of water you need. Different levels of quality are required for a vast range of applications; hence different grades of water

must be purified and used for the required procedures and applications as shown in the above table.

Grades of water

Grade 3

It is the lowest grade of lab water. It is recommended for

Glassware rinsing

Heating baths

To feed type I lab water system

Grade 2 water

Used for general lab applications e.g. preparations of reagents for chemical analysis or synthesis

Grade 1 water

Used for critical lab applications e.g.

Production of reagents for molecular biology

Preparation of solutions for electrophoresis and blotting

Lab grade water production methods

Filtration technologies

This includes reverse osmosis, nanofiltration, ultrafiltration, microfiltration and particle filtration. Filtration is the first step in producing type 1 and II water.

UV Radiation

Is used for eliminating bacterial and other microorganism in water

It does not remove particulate matter

It does not produce water with the ph or conductivity levels required for some applications

Other purification methods

Distillation, deionization, filtration and activated carbon absorption.

Quality standards for purified water

The quality of purified water is graded according to the amount of biological matter, dissolved organic matter and inorganic material it contains. ISO specifies water as Grade 1 2 and 3. Water of grade 3 is produced by single distillation, deionization or reverse osmosis. This water is recommended for preparation of reagents and ordinary

laboratory analytical work. Such water should have electrical conductivity at 250c of not more than 5µs/cm.
Water of grade 2 is obtained by redistillation of grade 3 water or deionized or product of reverse osmosis.
Water of grade 1 is obtained by subjecting the grade 2 water to distillation, deionization and then filtering it through a membrane with a pore size of 0.2µm

WASTE DISPOSAL

The routine work in the lab produces considerable quantities of waste materials. This waste material can be categorized as

- Solid waste which may be either wet or dry
- liquid waste
- Gaseous waste

Each of the following waste should be kept in a separate and clearly labeled container before disposal.

- Broken glass

- Wet solid waste e.g. filter paper and cotton wool swabs
- Biological material e.g. plant and animal tissue
- Waste solvents
- Recoverable residue
- Radioactive material

The waste disposal methods include the following:

- Burning
- Diluting and flushing
- Burning and incineration
- Sealed container for radioactive container
- Disposal Specialist
- Detoxification
- Fume cupboard
- Gas traps
- Sterilization

DETOXIFICATION

Small items of reusable equipment e.g. pipette slides spreader etc. should be immersed directly into a basin of a suitable disinfectant. Separate containers, preferably plastic, filled with appropriate disinfectant are needed for syringes, needles, lancets, slides, cover glasses, pipettes, tubes and specimen containers. Each container should be clearly labeled; 2500 ppm chlorine or 5% u/v phenolic disinfectant can be used depending on the type of waste. After disinfection, the small items of equipment should be washed in a hot solution of detergent, rinsed in running water and re-sterilized by autoclaving.

BURRYING

This done in a deep pit or landfill, this prevents the lab waste from becoming a hazard, provided the pit is located at a safe fenced off area. The pit should be at least 4-5m dip and 1-2m deep. The pit should have a strengthened rim and should be kept covered. The pit should not be used for items that do not decompose e.g. plastics, this are best incinerated. It is better for all infectious lab waste is

decontaminated and incinerated it is discarded in a pit. Once a week cover the waste with a layer of quicklime, soil or leaves. The waste should be transported to the pit in closed, strong and leak proof containers. Health centers must not dispose of lab items in urban refuse collection systems.

DILUTING OR FLUSHING

Waste solid chemicals and concentrated water soluble reagents and acids can be disposed of safely by dissolving or diluting in adequate volumes of water and flushing down the drainage system.

If the material is water-immiscible, highly toxic or can react with metal drainage pipes to produce dangerous reactive products e.g. picric acid, mix the chemical with sand and dispose of it in a deep covered waste disposal pit

BURNING AND INCINERATION

Destruction by burning is an effective method of disposing of lab waste, including contaminated disposables e.g. disposable gloves and specimen.

This is done in reusable containers e.g. feacal material, animal carcass etc. The material to be incinerated should be carried to the incineration site in closed, leak-proof and puncture resistant containers. Site the incinerator in a safe well fenced place to prevent the entry of unauthorized persons or animals. Supervise the incineration and bury the ashes as soon as it has cooled off. Care should be taken not to inhale the gases produced during the incineration, wear a dust mask and protective gloves while handling the ashes.

NB Inflammable and volatile solvents may be disposed by spreading them in small quantities over a wide area on the waste ground and allow to burn or evaporate.

DISPOSAL SPECIALIST

Special arrangements need to be made with the appropriate disposal authorities' e.g. public health inspectorate for disposal of radioactive, carcinogens and highly toxic materials. These materials are disposed in

specified areas of the country or at seas in special sealed containers.

FUME CUPBOARDS

It is a container designed to prevent the contamination of the lab by gas or aerosols produced in the lab. Some reagents e.g. ninhydrin are available in aerosols form. Many of the substances used in aerosols are potentially hazardous. To prevention inhalation or skin absorption of these substances, aerosols should be used in the fume cupboard. Experiments involving production or preparation of chlorine, Iodine, hydrogen sulphide gas etc. should be done in the fume chamber.

GAS TRAPS

This includes

Gas absorbents e.g. charcoal or Zeolites

These materials adsorb waste gases then the adsorbent may be buried or disposed of in a waste land.

Gas adsorbents

These are chilled surface onto which the waste gas condenses on. Charcoal has a high capacity of adsorbing gases at very low temps especially when heated with super-heated steam. The adsorbent may then be buried or disposed of in a waste land.

SEALED CONTAINERS

Radioactive waste should be disposed in sealed lead containers if the material is still active. The material is then disposed at sea or specified wasteland of the country with special permission from authority.

STERILIZATION (AUTOCLAVING)

An autoclave is used to decontaminate cultures of other infectious wastes, when performed correctly; autoclaving is the most effective method of decontaminating because it is able to sterilize infectious waste i.e. destroying all bacteria, bacterial spores, viruses, fungi and protozoa

A temperature of 121^0c and holding time of 15 minutes timed from when 121^0c is achieved in the load is used to

sterilize infectious waste before it is disposed in a pit or in a drainage system.

TOPIC 8

PREPARATION AND STORAGE OF CHEMICALS

Objectives

- Describe the requirements of a preparation room.
- Explain a given way of expressing strength of a solution.
- Describe the preparation of a given chemical reagent.
- Describe the preparation of a given biological reagent.
- Explain the precaution taken when storing chemicals.

REQUIREMENTS OF A PREPARATION ROOM

This includes:

- Location
- Services
- Furniture
- Apparatus
- Cleanliness

LOCATION

The preparation area should be located at one end of the laboratory

A large window should be provided to provide adequate illumination in the preparation room is needed.

For a science block, the preparation room should be located between two adjacent labs

In this case it may share the fume cupboards with both labs.

SERVICES

It should be provided with the usual services such as gas main electricity, a large and a small sink each with cold and hot water and disposal facilities.

FURNITURE

This includes stools, benches, shelves, lockers and drawers for the storage of varies items

The top of the bench should be covered with heat resistant material eg asbestos or ceramic tiles

A small workshop bench with a supply of tools will enable simple repairs to be done

A lockable clearly labeled cupboard is required especially for expensive and dangerous materials

APPARATUS

- Water still
- Oven
- Furnaces
- Balances

CLEANLINESS

All areas in the preparation room should be cleaned using appropriate method

- Dusting of machines and apparatus
- Mopping of floors and benches
- Sanding of stained benches
- Polishing of benches and floors
- Waxing of benches

Areas to be cleaned include the floors benches sinks shelves equipment that have collected dust

Suitable rubbish boxes should be available

Special bins should be provided for disposal of cotton waste

The grease or oil spilled on the floor is likely to be make the floor slippery must be wiped up at once

LABORATORY WORKSHOP

The siting and design of a lab workshop should be considered at an early stage in the designing of a science block.

Main functions of a laboratory workshop

Maintenance, repair and construction of apparatus

This requires basic requirement such as a rigid workbench with a vice, lathe, drill, a sharpening wheel and tools

It should be equipped with services such as gas, hot and cold water, a large and small sinks and an electrical socket.

Glass working equipment and a fume cupboard should be provided

Storage of bulk materials

It should have adequate storage facilities such as plastic-gathering to store long glass-tubing and shelves for storage of timber, Perspex and metal

A wall store for sheet materials

Base for technician

Part of the workshop can be arranged as part of an office for the chief technician where he can hold meetings with junior technicians.

It should be supplied with enough furniture, filling cabinets and a noticeboard.

GRADES OF REAGENTS

The laboratory reagents are available in more than one grade of quality:

- Aristar
- Analar

- Pure crystalline
- Technical

ARISTAR

These are reagents in ultrapure grade

They represent the purest grade of reagent that can be available

Reagents of ultra-high purity are unlikely to be used in schools except in special circumstances

Their composition is very specific i.e. 99.9%

ANALAR

This trademark is applied to analytical reagents which conform to the test and purity standards established by analar standards limited.

These reagents are of high degree of purity. A specification is usually given e.g. assay 99.7%

PURE CRYSTALLINE

These reagents are intermediate in purity between the analytical grades and the technical grades. A specification is usually provided e.g. 99%

TECHNICAL GRADE

The composition of technical grade reagent is variable and it is not subject to detailed specification. It is adequate for many purposes in schools but not for analytical work.

In addition to the above grades, a large number of reagents are produced to detailed specification for specialized purposes e.g. chromatography, spectroscopy, clinical analysis, biochemical assay and tissue culture.

Importance of accuracy in volume measurement

Most common error in volumetric determination is associated with the determination of concentration of standard solutions. Standardization value may be incorrect due to;

- The uncertainty in the purity of the primary standards
- Decomposition of solutions on standing

- Improper calibration of volumetric equipment
- Change in temperature

Other common errors are as results of poor laboratory techniques in weighing losses of solutions during titrations or during transfer of solution, dirty burettes or pipettes. These errors can be prevented by careful laboratory techniques; one should keep the number of operations to a minimum to prevent errors.

Ways of expressing strength of solutions

Concentration is the amount of solute present in a given quantity of solution or solvent

Standard solutions

It is a solution whose concentration is known accurately. When a reagent is sold or used as a solution its concentration may be specified in a number of ways:

- Weight per unit volume
- Percentage composition either percentage by weight or percentage by volume

- Molarity
- Formality
- Normality
- Parts per million

Weight per unit volume

The concentration of a solution is expressed in terms of the number of grams of solute per litre of solution e.g. g/l. it can also be given in the number of milligrams of solute per milliliter of solution i.e. mg/l.

Percentage composition

Percentage by weight

If a solution of 1 % is desired, weigh accurately 1gram of solid and add 99 mls of solvent i.e. weigh the solute and

place it in a measuring cylinder, then add the solvent to the mark indicating 100 mls. 3% of hydrogen peroxide means 3g of H_2O_2 per 100g of solution. It is given as 3% w/v solution of H_2O_2.

Percentage by volume

If you wish to dilute start by measuring out of the original solution to the an equal volume in millimeters of the percentage of the new solution needed, then add enough solvent to make this volume equal to the percentage of the solution.

Example 1

To prepare a 50% alcohol solution from a 95% alcohol

Measure out 50ml of 95% alcohol then add 45ml of distilled water to this solution

Example 2

To prepare 7% NaCl solution from a 46% aqueous solution

Measure out 7 mls of the 47% NaCl solution then add 39 ml of distilled water to this amount i.e. $\mathbf{C_1V_1=C_2V_2}$

Where: C_1=conc of standard

C_2= conc of desired

V_1= vol of standard

V_2= vol of desired

VOLUME RATIO

Sometimes a solution of a reagent is given in the numerical ratio of the concentrated reagent e.g. Ammonium hydroxide (1:2) is prepared by mixing one volume of conc Ammonium hydroxide solution with two volumes of water. Generally, this way of expressing concentration is used for reagents not being used as standard solution.

MOLAR METHOD

The molecular mass of an element is the sum total of all the atomic masses of the different elements (atoms) that constitute the molecule.

A molar mass solution is a solution of one mole concentration of the compound in one litre of the solution (i.e. one litre of the solution not the solvent), e.g. 40g of NaOH in 1 litre of the solution gives 1M NaOH solution.

A mole of any substance may be taken to be the same as its molecular mass expressed in grams, to calculate the molecular mass of a substance, write down the chemical formula of its compound, then add up the atomic masses of each atom found in the formula.

If there is more than one atom of certain element, multiply the atomic mass of the element with the number of atoms in the element.

e.g. molecular mass of :

NaCl = 23+ 35.5 = 58.5

H_2SO_4 = (1X2) + 32 + (16X4) = 98

Any molar solution can be diluted to another molarity of a lower concentration by the using the formula

(Vol desired) x (Molarity desired) = (Vol std) x (Molarity std)

EXAMPLE

Assume that 100mls of 0.1m solution is desired but you have a 1 M solution therefore:

(Vol desired) x (Molarity desired) = (Vol std) x (Molarity std)

100ml x 0.1M = Vol of std x 1M

$$\textbf{Vol of Std} = \frac{\textbf{100 x 0.1}}{1}$$

$$= \textbf{10mls}$$

Therefore, this solution can be prepared by measuring out of 10ml of 1M solution and diluting to 100ml using distilled water.

Molarity can also be found using the formula

$$\textbf{M} = \frac{\textbf{Wg}}{\textbf{M.W X VL}}$$

Where M = molarity

Wg = no of gms of solute to be measured

M.W = Molecular mass of solute

VL = Volume in litres of soln

Example

Prepare 500ml, 0.5M NaOH solution from pellet (Na =23, 0 = 16, H = 1)

$$M = \frac{Wg}{M.W \times VL}$$

$$0.5 = \frac{Wg}{40 \times 0.5}$$

Wg = 0.5 x 0.5 x 40 = 10g

Therefore weigh out 10g of NaOH pellets and dissolve up to 500ml using distilled water.

Also, n = M X SL

Where n = no of moles of solute

SL = Vol of solution in litres

M = Molarity

FORMAL SOLUTION

Is a solution made by dissolving the gram formula weight of a solute in one litre of solution.

Formality: formality of solution is the number of gram-formula weight in a litre of solution

A one formal solution is prepared by dissolving one gram formula weight of solution.

To prepare a one formal solution of sodium Hydroxide (1F NaOH)

Dissolve 40gms of NaOH in distilled water to give one litre of solution

NB: Molarity and formality are identical in value

NORMAL SOLUTION

Is a solution prepared by dissolving the grams equivalent weight of solute in 1 litre of solution

A one normal solution is prepared by dissolving one gram equivalent weight of a solute in one litre of solution.

Equivalent weight of any material is the weight which would react with or be produced by the reaction of 8.0gms of 02 or 1.0gm of Hydrogen

Example

To prepare a 1Normal solution of Sodium Hydroxide in one

NaOH = 23.01 +16+1.08 = 40.18 gm equipment weight

Take appropriate 40.18 gms of the solid and dissolve in some distilled water before making it up to one litre.

NB: In a normal solution there is no multiplication with a multiple or a submultiple in any molecular formular as in molar solutions

In cases where there are more than one atom per element, we ignore all the multiples and submultiples in each case.

Examples

Prepare one litre of 1N Sulphuric acid thus

$H_2SO_4 = H_2 = 1X2$

$S = 32X\ 1$

$O_4 = \frac{16\ X\ 4}{98gm/l}$

In this case we take only one gram equivalent weight of acid.i.e. For Hydrogen we take one gram and for oxygen we take 16 gms the mass of one atom of O_2

Therefore, 1litre of 1N H_2SO_4 IS calculated as:

H = 1.0gm

O = 16.00gm

S = 32.06gm

There take 49.06mls of sulphuric acid and make up to one litre with distilled water, however, some solids and liquids have the same amount of grams equivalent weight and molecular mass e.g. NaOH and HCL, hence we use 40gm per litre for preparing a molar solution of NaOH and same amount to prepare a 1N solution of the same salt.

Normality = $\frac{\text{No of gms equivalent of solvent}}{\text{Vol of soln in litres}}$

$N = \frac{Eq}{VL}$

Where: N= Normality

Eq= no of gmsEq of soln

VL= Vol of soln in litres

The gram equivalent of a solute can be determined by dividing the weight of solute to be added by the gram equivalent weight of the solute

i.eEq = wg/gm eqwt

alsoVsX Ns =Vn X Nn

Where: **Vs= vol of std**

Ns = Normality of std

Vn = Vol desired

Nn = Normality

Normality is the only concentration unity that is reaction dependent

Example 1

1M Sulphuric acid is 2N for acid-base reaction because each mole of the acid provides 2 moles of H^+ ions

1M Sulphuric acid is 1N for Sulphate precipitates since 1 mole of the acid provides 1 mole of SO_4^{2-}ions.

Example 2

36.5 gms of HCL acid is 1N solution of HCL acid dissociates completely in water.

1N solution of HCL would also be 1 N for H^+ ion or CL^- ions for acid-base reaction

MOLAL SOLUTION

The molality of a solution is the number of moles of per kilogram of solvent

Note that the mass of the solvent is used and not the mass of the solution, its symbol is m, e.g. the label 6.0m HCL is read as 6.0 molal and represents a solution made by adding to every 60 mol of HCL one kilogram of solvent. Molality is a useful unity in calculation dealing with the freezing and boiling points of solutions, usually expressed as moles per kilogram of solvent (mol kg^{-1})

$$\textbf{Number of moles} = \frac{\textbf{weight of solute (gms)}}{\textbf{Molecular weight}}$$

NEUTRALIZATION

Study the following balanced equation for acid-base neutralization

$2HCL + Na_2CO_3 \rightarrow 2NaCL + CO_2 + H_2O$

Reacting moles

2 moles 1 mol

Reacting vols

$2dm^3$, 1M $1dm^3$, 1M

$V_1X\ M_1 = 2$ V_2XM_2

$\frac{V_1XM_1}{V_2XM_2} = \frac{\text{Moles in (a)}}{\text{Moles in (b)}} = \frac{2}{1}$

Therefore $\frac{\text{Vol of soln(a)x Molarity of soln(a)}}{\text{Vol of soln (b) x Molarity of soln (b)}} = \frac{\text{Moles of soln (a)}}{\text{Moles of soln(b)}}$

Calculate the vol of 0.1M NaOH required to neutralize $20cm^3$ of 0.5m HCL

$HCL + NaOH \rightarrow NaCL + H_2O$

amol b mol

$\frac{Va \times M_a}{V_b \times M_a} = \frac{\text{Moles of soln a}}{\text{Moles of soln b}}$

$\frac{20\ cm \times 0.5}{V_b \times 0.1} = \frac{1}{1}$

Therefore Vb X 0.1= 20 X 0.5

$Vb = \frac{20 \times 0.5}{0.1}$

= 100cm

PARTS PER MILLION PPM

PPM is the number of grams an element or solute in one million mls cm3 of its solution

Thus 1ppm means $1g/10^6$

Therefore 1 PPM = $1g/10^6$mls

But 10^6 = 1000L

Therefore 1PPM =$1X\ 10^{-3}g/l$

OR 1PPM= 0.001g/l

1PPM = 1mg/l.

Thus we can use milligrams per litre or grams per 10^6 mls to express the concentration in parts per million.

Example 1

Prepare 100ppm solution of manganese using potassium permanganate $KMnO_4$

1PPM = 0.001g/l

Therefore 100ppm= 0.001x 100g/l

= 0.1g/l

Thus by dissolving 0.1g of manganate in one litre, you shall have prepared 100 ppm solution

But K= 39X 1

Mn = 55x 1

O= 16x4

158 gram equivalent weight

Therefore 55g of Mn= 158gm of $KMnO_4$

1g of Mn= $\frac{155gm}{55}$ of $KMnO_4$

Therefore 0.1g of Mn = 158x0.1 of $KMnO_4$

= 0.287gm of $KMnO_4$

Thus dissolve 0.287gms of KMnO4 in one litre of the solution by adding distilled water to the mark

Example 2

Prepare 1000 ppm of Calcium metal in $CACO_4$

1PPM = 0.001g/l

Therefore 1000ppm = 0.001 x 1000g/ l

= 1g/l

Thus by dissolving 1gm of Ca in 1 litre we shall have prepared 1000ppm solution

But Ca = 40x 1

C= 12 x 1

O=$\frac{16x\ 3}{100\ gm\ eqwt}$

40gm of Ca = 100gm of $CaCO_3$

Therefore 1g of Ca = $\frac{100g}{40}$ of Ca

Thus dissolve 2.5gm of $CaCO_3$ in a little dil HCL and dilute to 1 litre with distilled water.

NB This stock solution will contain 1 g/litre,of or 1000mg/litre or 1mg/ml which is equal to 100ppm calcium.

Example 3

From the stock solution of 1000ppm, prepare 100cm^3 of 5ppm solution.

Method

Prepare by dilution technique using the formula

$M_1V_1 = M_2V_2$

Where M_1= given the concentration of stock solution

V_1= Vol of the stock soln to be diluted

M_2= Desired conc

V_2= Vol Desired

To prepare 5 ppm preparation

Given M_1= 1000 PPM

V_1=

M_2= 5PPM

V_2= 100ML

Therefore, $M_1V_1 = M_2V_2$

$1000X\ V_1 = 5X100$

$V_1 = \frac{500}{1000}$

$= 0.5$

Thus take 0.5ml of stock and dil to $100cm^3$ mark using deionized water

Example 4

Convert 1ppm of manganite solution to molarity

1ppm= 0.001g/l of Mn

Therefore no of moles per litre = $\frac{0.001}{55}$

$= 1.82x\ 10^{-5}$ moles /litre

$= 1.82x10^{-5}M$

Example 5

Convert 1000ppm of Calcium ions to molarity

1ppm= 0.001g/l

Therefore 1000 ppm = 0.001x1000g/l

= 1g/l

Therefore no of moles/litre = 1/40 moles/litre

= 0.025 moles /litre

= 0.025M

ASSIGNMENT

Convert 0.88mg/ l into ppm

Convert 7.0g/l into ppm

Determination of concentration of stock solution

Example: A5 litre Winchester bottle of H_2SO_4 acid labeled 98% H_2SO_4, density 1.6g/cm and formula mass 98gms was purchased for lab use. Determine the molarity of this stock solution. Density is sometimes indicated as specific gravity or weight per ml at 20^oc and purity as minimum assay of 98%

$$\text{Molarity} = \frac{\%\ \text{Con} \times 100 \times \text{Sp.G}}{100 \times \text{R.M.M}}$$

$$= \frac{98 \times 100 \times 1.6}{100 \times 98}$$

$$= 16\ \text{M}$$

Hence if you want to prepare 500ml 0f 2M solution of H_2SO_4 acid from its concentrated stock solution use the formula

$$M_1V_1 = M_2V_2$$

Therefore 16M x V1 = 2M x 500

$$V1 = \frac{2 \times 500}{16}$$

$$= 62.5cm^3$$

Thus take 62.5cm3 of the stock solution and dilute using distilled water to 500ml mark and you will have prepared 500ml of 2M solution.

When preparing reagents, consider the following points

Reagents bottles must be clearly and adequately labeled:

- With labels which also give a brief details of hazards and first aid procedures
- Date of preparations
- With hazard warning sign

Reagents which are used in large quantities e.g. 2M NaOH, 2M Ammonia may be kept in bottles which have corrosive resistant labels.

Reagents which decompose in light should be kept in tinted bottles, covered with a blank paper or stored in the dark.

Caustic alkalis are best stored in bottles which are sealed by means of a plastic or rubber bung rather than with a ground glass stopper.

Distilled water which has been prepared contains a significant amount of dissolved CO_2 gas

If a reagent is known to deteriorate with storage, large quantities should not be prepared

A freshly prepared reagent should not be added to nearly empty reagent bottle to it up. The bottle should be emptied, washed and rinsed before being filled with the freshly prepared reagent.

Types of reagents

Chemical reagents

- Acids
- Bases
- Indicators

Biological reagents

- Fixatives

- Stains
- Mounting media
- Agar media

STORAGE OF CHEMICALS

Some chemicals may require special consideration during storage

- Fuming chemicals
- Light sensitive chemicals
- Those that require low temperature

It is necessary to separate chemicals which may be dangerous when stored together

Some chemicals tend deteriorate with because is of the hygroscopic nature and for other reasons

A constant check at regular intervals on the conditions of the stock is therefore necessary

The old stock should be used first before the new stock is used. A methodical use should be affected.

This can be achieved by writing the date on each bottle as it is received and place the new stock at the back of the selves.

Regularly inspect the bottles for faded labels and replace them.

Chemicals may be grouped into two main categories, organic and inorganic

If space allows, further subdivision into grades of purity can be done

These will also prevent accidental contamination of expensive chemicals of high purity with those of lesser quality

It will also prevent the use of high grade chemicals in exercise where chemicals of lower purity are suitable

The chemicals are grouped in such a way that is quickly located for issue; it is easier to do this for inorganic chemicals than for organic ones

In-organic chemicals

Arrange them under the name of the metal, the shelves should be labeled accordingly, the prefixes to the name of the chemicals such as tri-, di-, ortho- and meta- are ignored for storage purposes.

Organic chemicals

Store them in alphabetical order

When using this system, prefixes such as O-, M- and P- are disregarded.

Other prefixes such as di- and tri- should be taken into consideration for purpose of alphabetical location

The shelves should be labeled A-Z. Some substances such as Sodium benzoate may be kept with the inorganic or organic chemicals which ever suits the Storeman.

Dangerous poisons should be kept in a strong cupboard under lock and they should be issued on signature only and this must be recorded in a poison book which is kept for this purpose only.

TOPIC 9

CARE OF LABORATORY ANIMALS

Objectives

- **List the common laboratory animals**
- **Describe the breeding procedure of a given animal**
- **Describe various inoculation methods**

- **Explain a post-mortem procedure of a given animal**

Introduction

The importance of laboratory animals in experimental biomedical research is undisputable and the care and handling is a contributing factor to the quality of science resulting from their use. This is true when the animals are used as a source of biological material (cells antibodies and serum) for laboratory use or experimental subjects
An integrated approach to animal programme management is an institutional goal with benefits for researcher, administrators and management alike. Researchers need to obtain valid and reproducible results. The environment where a laboratory animal is housed has an impact on the animals' health and response to experimental manipulation. The following guideline is important when housing the laboratory animals.

COMMON LABORATORY ANIMALS

A number of species of small mammals are available for use in the laboratories of these, only six are recommended, other small mammals such as chinese hamster and spiny mice are not recommended as their breeding is unreliable, they are difficult to handle, it is difficult to obtain stock free of diseases transmissible to man. Wild rodents should never be stocked in the lab for they may be infected with zoonotic diseases.

Rodents

Common name

scientific name

Rat

Rattusrattus

Rattusnorvegicus

Mice

Mus musculus

Hamster

Mesocricetusautratus

Largomorphs

Guinea pig

Carviaporcellus

Rabbit

Oryctolaguscuniculus

USE OF LAB ANIMALS

Small mammals have a very wide variety of use, both in biological and non-biological work. In **research and biology** they are used for;

- Genetics
- Behaviour
- Reproduction and growth
- Anatomy

Toxicology Testing new chemical substances before being used in man or domestic animals e.g. food addictives, colouring and flavoring

Diagnostic work

It can be used for detection of diseases

Bioassay testing

For prophylactic and therapeutic substances before administering them in human or animals in clinical procedures e.g vaccines, drugs

Teaching purpose

Dissecting to study the function and structure of internal organs

The advantages of these small animals is

- They live long
- They are easy to handle
- They can be easily be bred in laboratory conditions
- They can easily be maintained in the laboratory conditions
- They are attractive and add interest to the lab

Requirement for animal house

They should have the following rooms

Have a separate food store

A sterilizing room

A quarantine room

A normal stock room

An infected animal room

When new animals arrive they should be housed in a quarantine room until all danger of possible infection has passed.

The animals are then given a batch number and transferred to the stock room. If they are infected, they are inoculated and moved to the infected animal room.

Separate rooms should be maintained for each stock of animal.

Each cage should be cleaned and labeled with the batch number, date of arrival and any other relevant

information. Infected animals must be clearly labeled with the date and full details of inoculation. Keep a record book for all the inoculations and be sign by the person giving the inoculation.

The animal house should be kept at room temperature between 18^0-26^0c. It should be shielded from direct sunlight, light can be provided by north facing windows or roof lights supplemented with artificial lighting.

It should be well-ventilated and draught proof, the ventilation apertures should be covered with insect proof mesh

The floor should be slightly sloped to the floor drainage grille to help in the drainage.

A supply of cold and hot water is essential

The doors should be fitted with a lock for security reasons. The door entrance should be wide enough to allow a trolley to be pushed in/out. The cages may be stored on adjustable shelving

Any wooden surfaces which may be gnawed should be protected with sheet of metal.

Requirements of animal cages

Size

The size of the cage should be enough to allow free movement of the animal i.e. to prevent congestion. The size depends on the type of animal e.g. rabbit or rats and the number of animals per cage.

Materials

Wood and chipboard can be used, but they should be polished to prevent absorption of moisture.

Wood is liable to gnawing, fungal or weevil attack. Wood is only recommended for large animals e.g. rabbits and guinea pigs

A metallic cage made from aluminium wire mesh is recommended for all animals.

The cage should have:

A good drainage, good security i.e. no animal should be able to escape or allow predators in. they should be made in such a way that animals can easily and safely be removed from the cage.

Sterilized bedding material should be provided. The confinement must be easy to clean and sterilize, ti must be well ventilated, lightened or of correct temperature and humidity.

Beddings

All lab animals require bedding in their living areas. The bedding must be absorbent in order to absorb any moisture and urine from animals. The material adds warmth while some animals will use it as nesting material e.g rats. The materials should be free from moulds mites and any other infectious organism.

Types of beddings

- Wood shavings
- Hay
- Wheat and barley straws
- Saw dust

Bedding for rats

There are several types one can use in the rabbit hutch or cage

Newspaper

But the ink can be harmful if the rabbit ingest too much of it.

Pine shavings and sawdust

Causes liver diseases in rabbits and other small animals, the dust also affects the rabbit’s respiratory system

Shredded cardboards

They are ecofriendly and provide good insulation

They are absorbent

They are a good alternative to newspapers

Straw

It is not very absorbent

It provides good insulation and is good surface of rabbits to sit on

Hay

Provides good insulation hence keeps the rabbits warm

When buying hay make sure it is sweet smelling, not too dusty and has no mould in it.

Cleaning of cages

All cages should be cleaned and disinfected at regular intervals. Faecal pellets and litter contaminated to faeces should be removed frequently to reduce risk of infection. Every 7-10 days the following cleaning procedure should be carried out.

- Scrap and remove all litter and nesting material. Seal the debris in polythene bags and incinerate Remove all animals and place them in a separate cage, but if

possible avoid cleaning cages with newly born young ones.

-
- Scrub the cage with hot water and detergent, then rinse with clean water
- Immerse the cage in a disinfectant e.g 5% Lysol for 15 min.
- Allow the cage to dry thoroughly before adding fresh litter and nesting material
- Re-introduce the animals
- Water bottles should be cleaned and disinfected at the same time as cages.

House sanitary measures

- The animal care and sanitary measures involve the care of physical environment of the lab animals and the surrounding buildings
- The building, equipment used and operational procedures should not be a source of pathogens that will affect the animals.
- The walls, the ceilings and floor of the animal house should be made of materials, which are easy to clean.
- The cleaning material e.g. water, disinfectant e.t.c should be readily available. There should be proper drainage and sewage disposal to maintain sanitary conditions in the animal house.
- Ventilation should be sufficient in order to avoid bad odour.
- Care should be taken to avoid flies and wild rodents in the house. Visitors to the animal house should disinfect their feet at the entrance to avoid introduction of pathogens.

- Special clothing should be provided to the visitors e.g. lab coat, gumboots or caps at the entrance of the animal house.
- Personnel working in the house should always be in clean clothing and shoes.
- In case of death in the house, remove the carcass immediately and clean the whole animal house thoroughly and disinfect it to avoid infection of health animals.
- Pathogens or germs may gain entry into the an animal house through
- Wild rodents and insects, which are potential biological vectors and mechanical carriers of certain diseases

Food and water

Food should be placed in food hoppers and not in open dishes which may become contaminated.

The hoppers should be kept at least half-full to prevent them from being moved and dislodged during feeding Water should be provided in feeding bottles. Check daily to ensure that there is enough water and food even for short holidays or weekends. Water bottles should be fitted with glass pipettes for rabbits and not plastic pipettes which the rabbits may chew.

Clean and disinfect the water bottles frequently. The feed used must be

- Adequate quantity by weight
- Palatable
- Well balanced diet
- Must be of right type for the animal species.

Food pellets provide a well-balanced diet to most animals; however the animals should be given a variety of food.

Pellets

This is ideal for mice rats and hamsters; the pellet is called DIET 41B or DIET F.F.GM

Rabbits do well on DIET SGI white Guinea pigs do well on DIET RPG.

Fresh food

This should be of highest quality, the seeds and grains should not be preheated with insecticides.

Fresh food that is not eaten should be removed at the end of the day. The fresh food should include;

Grains

Barley, millet, oats, hemp and sunflower seeds

Vegetables

Carrots which are suitable for general and repeated use, lettuce, beetroot and cabbage are also suitable when given in small amounts. All vegetable food must be fresh.

Fruits

These must always be fresh, apples, bananas and corn are suitable fruits while stones e.g. peach and plums are suitable for animal growth.

NB: water should be sufficient or given in a clean and correct containers as per the species e.g. water bottle for rodents and containers for rabbits. Check regularly the level of water to determine whether the animals are drinking.

Check for spillage and for blocked drinking nozzles and tubes in bottles.

If all this has been checked and found correct but the water levels remain the same for a period of time, then, this indicates that the animals are sick and hence are not drinking.

HANDLING

Before and after handling the animals, ensure that you wash your hands. Gloves may be worn if the animal is likely to bite. Wear protective overall.

The movements should be slow and purposeful and handled carefully and firmly. The animals may be reassured first rubbed in the in the litter before handling. An animal removed from a cage for inspection should be placed on the table with a rough surface so that it does not slip, a special board may be reserved for this purpose. Handlers should avoid movements or sounds which are likely to stimulate defense or escape reactions in the animal. On no account should an animal be passed from one handler to another directly. It must be placed on a non-slip surface from which it can be picked up.

Main techniques for handling lab animals

Lifting by the tail

Lift the animal by grasping the base of the tail near the rump. This technique may be used with the mice and rats if they are not ferocious. This technique should not be used on animals with furry tails e.g. rabbits and gerbils. The animal should not be held in this way for too long but

should be rested on the other hand or on a suitable surface as soon as possible.

Cupping

It is the most useful single method for handling most rodents species i.e. rats hamsters and mice. The animal is stroked and allowed to run over the hands, it is then lifted, with a scooping motion, by both hands forming a cup. The fingers and the thumbs may be used to restrain the animal. The animal's head should be pointing towards the handler.

Lifting by the scruff of the neck or shoulder and the rump

This technique is used to handle the larger species e.g. large rats, guinea pigs and rabbits. Both hands are used. Control the head with the right hand; grasp the animal around the shoulders with the thumb under the chin, to control the mouth in case of rats, guinea pigs or small rabbits.

For large rabbits hold the scruff of the neck or ears if they are large enough with the right hands, use the lift hand to support the weight of the body and hip region and place it under the rump. The palms of the right hand with or without the fore-arm is used to support the back of the animal, when both hands are in position, lift the animal with a simultaneous motion of both hands.

General handling

Mouse and small rats

Grasp the base of the tail between the thumbs and fore finger. Lift and then transfer the weight of the animal by placing it on the other hand or on a non-slip surface. Restrain movement by holding the base of the tail.

Large rats

Grasp around the shoulders with the thumb under the chin to control the mouth, support the weight of the body with the other hand held under the rump. Adult rats should not

be lifted by the tail as this may cause a circular disruption of the skin of the tail.

Hamsters

Enclose the animal with cupped hands with the animals head facing the handler; restrain the animal by placing the thumb over its back.

Guinea pigs and small rabbits

Grasp around the shoulders with the thumb around the chin, to control the mouth and head, support the weight of the body with the other hand held under the rump. They are easily frightened and dislike sudden movements. Panic due to events outside the cage may results to severe injury to the animal.

Large rabbits

Approach the rabbit from behind, grasp by the scruff of the neck and the ears, with the right hand. Support the weight of the body with the other hand held under the rump.

Handling to ascertain sex

Mouse and rats

Expose the genitalia by lifting the base of the tail. Support the animal on a non-slip table or cage.

Hamster and gerbils

Hold the animals in cupped hand; turn the animal over by rotating the wrists. Support the back with one hand and the head and front of the animal with the other.

Guinea pigs and rabbits

Handle the animal in normal way, and then rest the animals back on the upper right thigh. Apply gently pressure above the and below the urogenital aperture using the thumb and fore-finger of the lift hand placed above the animal hindlegs, in male the penile organ can be extruded by this manipulation

BREEDING PROCEDURES

The breeding of laboratory animals should be carefully controlled. The following code of conduct should be followed.

Only young and healthy animals should be selected for breeding.

An appropriate mating system should be adopted

Care should be taken to ensure that that there is enough space, food, water and resting material for breeding.

Pregnant females and in some cases newly born young should not be handled.

The young one should be weaned at an appropriate time and removed from the mother.

Ensure that the young animals can reach both food and water

Label all the cages with details of the parents, offspring, and date of the birth, keep breeding records in file or card index.

Uncontrolled breeding should not be allowed to take place especially when the young ones cannot be adequately housed or cared for.

REPRODUCTION PATTERNS

MOUSE

Oestrus cycle **4 – 5 days**

Gestation period **19 -21 days**

Weaning age **21 days**

Mating age **6 – 8 weeks**

Litter frequency **8 – 12 yearly**

Litter size **7 – 8 average**

Optimum temp **21^{o}c**

Humidity **60- 65 %**

BREEDING

Although mice may mate at 6 weeks, the usual age in controlled breeding programme is 6-8 weeks. The mating system is monogamous pairs. Introduce the female to male, if fighting occurs, separate them. They may be kept in polygamous trios i.e. one female and two males which may be kept for genetic work. In case they are kept in trios of one female and two females per cage, litter may be expected every 3 to 4 weeks.

The male may not be separated from the cage at birth of the young. The young may be handled shortly after birth.

The young mice may be weaned before the next litter appears. If mice from a single stock are interbred or inbreeding occurs, for 7 to 8 generations, a fall in average litter size may occur.

HAMSTER

Oestrus cycle:	**4- 5 days**
Gestation period	**21- 23 days**
Weaning age	**28 days**
Mating age	**10 – 12 wks**
Litter size	**7**
Optimum temperature	**21^0c**
Humidity	**45-55%**

BREEDING

Signs that mating may occur is similar to that of mice. The animal should be 10 -12 for mating to occur. Mating system is usually carried out in monogamous pairs. Introduce male to the female cage and observe after introduction for signs of fighting, in which case separate.

Females when pregnant should be moved to separate cage with presence of bedding material. The male may not be separated from female at birth of the young. If fighting occurs separate and try again. Separate them after 30 min after mating. Mating should be supervised because the female may attack the male after copulation or if the male is not receptive. The female comes on heat every fortnight usually after sunset.

NB Hamster must be kept in strong cages otherwise they will gnaw their way out, aluminium or zinc cages are good, one made from polypropylene material is an excellent one. Hamsters must be provided with wood to gnaw; otherwise their incisors teeth will overgrow until feeding becomes impossible, for food, commercial pellets should be supplemented with grains. The monogamous pairs can be left together at the birth of the young ones, otherwise separate them after mating. The young ones should not be handled for the first 16-18 days.

GUINEA PIGS

Oestrous cycle	**16 days**
Gestations period	**63 days, but may vary bet 59-72 days**
Weaning age:	**14 – 21 days**
Mating age:	**12 – 20 weeks**
Litter frequency	**3 yearly**
Litter size	**3**
Optimum temp	**21^0c**
Humidity	**45 – 55 %**

BREEDING

Signs that mating is about to occur are that the female sniff other animals and may mount other females. The male chases the female that exhibits lordosis. The mating system consists of monogamous pairs or a harem of one male with up to 12 females, allowing at least 15 square ft

of floor space per animal, the monogamous pairs can be set up at weaning. The females can be introduced to the harem; the male can be removed from the cage from the cage just before birth of the young in case of monogamous pairs. Pregnant females are placed in the separate cages. The young ones may be handled shortly after birth. For food, in additional to commercial pellets, give 60gms of fresh food per day i.e. carrots, cabbage etc.

RABBITS

Oestrous cycle	**ovulation occurs 10 hrs,**
After mating	
Gestation period	**28 – 31**
Weaning age	**6 – 8 wks**
Mating age	**6 – 9 months**
Litter frequency	**4 yearly**
Litter size	**4 average**
Optimum temp	**18^0C**
Humidity	**40 – 45 %**

BREEDING

Signs that mating is about to occur is that the doc, female, flattens he body on the ground and raises her genitals to permit copulation. The male should be caged separately from the female. A 9th month old rabbits should be mated when the female is on heat, introduce the female to the male cage at oestrus, which is indicated by swollen, red, moist vulva. Mating should occur immediately and the female is removed after mating and return her to her cage. As soon as mating is complete, the buck falls backwards due to exhaustion. When mating is accomplished a scream is herd made by the buck or occasionally by the doe. After 24 days the doe is transferred to a large cage with a screened breeding compartment, plenty of nesting material must be provided, the litter should not be disturbed for 10 days to avoid cannibalism. Do not handle the young ones until they are furred at 28 days. The young

one should be weaned when they are 6 – 8 wks old and sexes can be separated into different cages.

GERBILS

Oestrus cycle	**4 – 5 days**
Gestation period	**25 – 28 days**
Weaning age	**3 wks**
Mating age	**7 wks**
Litter frequency	**8 – 12**
Litter size	**5 - 7**
Optimum temp	**21^0c**
Humidity	**50 %**

Signs that mating may occur is that the male stand on the hind feet and drums, chases the female and attempts copulation frequently.

Mating system is done in monogamous pairs; the pairs should be set up shortly after weaning and can then be left together. The male can be left with the female at the time of birth. The young ones can be handled shortly after birth.

Whatever type of cage is used, the floor should be lined with at least 2 cm of sawdust. The sawdust should be changed frequently. Use sterile sawdust since untreated one from local sawmill may be contaminated by faeces of cats, dogs, mice, and rats and can be a source of parasites and bacterial infections. Sterile sawdust prevents development of sores on the feet of animals. Pregnant animals should be given a supply of wood shavings for nesting, for rabbits, hay is the most suitable nesting material.

HUMANE KILLING METHODS

It is referred to as Euthanasia. It is the induction of unconsciousness and death with minimum pain and distress or irritation of the animal. Euthanasia methods must ensure minimum suffering and safety of workers. The criteria that should be considered when deciding on the method of euthanasia include:

- The ability of the method to kill the animal without inflicting pain and distress i.e the method should be fast in putting the animal to unconsciousness.
- The reliability and irreversibility of the method
- The security of the person administering the euthanasia
- Compatibility of the method with the experiment i.e. if the animal tissue is to be examined after death

- Economic consideration and time taken to carry out the procedure, especially if large number of animals is be killed.
- The availability of the chemicals and mechanical aids required
- The danger of drug abuse when using the chemicals

METHODS

The method of **EUTHANASIA** can be divided into two

Physical method

Chemical method

PHYSICAL METHOD

This method causes injury to the CNS. It is a quick death method and only causes slight suffering if done correctly. The method include use of blunt or sharp objects, this include;

- Stunning: A blow to the head to ensure instant death

- Cervical dislocation: Breaking the spinal cord in the neck region instantly
- Shooling in the central nervous system
- Electric shock
- Rapid freezing by immersion in liquid nitrogen
- Pithing, inserting a sharp instrument, needle, into the brain case

CHEMICAL METHODS

Small lab animals can be killed in variety of ways, they can be killed in a variety of ways, there are three methods of chemical killing as follows

Injections

The routes used are intravenous, intramuscular, intraperitoneal, intrathoracic and intracardiac, the chemicals commonly used include are

Barbiturates e.g. overdose of Nembutal

Magnesium sulphate or potassium chloride

Oral route

Used when tablets are available e.g. barbiturates tablets

Inhalations

Use of volatile and poisonous gases or vapours e.g. chloroform, carbon monoxide, carbon dioxide, nitrogen isoflurane, all poisonous gases must be used in the fume chamber.

Diagram

The animal is placed in the chamber and the carbon dioxide cylinder is turned on slowly, the gas will fill the chamber and force the air slowly out through the hole at the top, leave the animal in the chamber for at least 10 minutes, after it is apparently dead to ensure that the death

is certain. A heavy gauge of polythene bag may be used instead of the killing chamber, but it is less satisfactory. Ethoxyethane and trichloromethane are also effective killing agents, but they are highly flammable. Animals may also be killed in the a container e.g. the desiccator or bell jar, the following method is used;

- Put some chloroform or ether on same pad of cotton wool and place it the desiccator.
- Cover the cotton wool with a grid of wire or gauze to prevent the animal from touching the chloroform, as it causes irritation
- Put the animal in the desiccator and leave the lid slightly opened to allow the air to mix with fumes. This causes the animal to sleep. When the animal is asleep close the desiccator completely, Wait for about 10 minutes after their heart has stopped breathing to make sure they are dead

NB The length of time depends on the size of the animal and the type of chemical used.

RECOMMEDED METHODS

MOUSE/MICE

Lethal chamber

Commonly used when a large number of animals are to be killed.

Cervical dislocation

Place the mice on a solid surface and then place a pencil across the back of the neck, with a soft movement, pull back and up with the tail as you push down the pencil. Dislocation of the neck breaks down the spinal cord, causing instant death

Use of barbiturates

This method involves the injection of the animal with chemical barbiturates. This method is often not economical.

RAT

Cervical dislocation

Hold the rat around the its body with your two hands, then bring it sharply down striking the back of the neck against the edge of the bench, sink, or similar hard object.

Lethal chamber

Use of barbiturates

Guinea pigs

Cervical dislocation

Grasp the guinea pig around the neck and bring it sharply down, still holding the neck firmly, thus performing the whip cracking movement, this will break the guinea pig back. This method should be practiced first on a dead animal.

Rabbits

Cervical dislocation

Hold the rabbit by the scruff above the shoulders so that the head hangs downwards. Hit behind the ears, across the back of the neck with a heavy blunt object.

NB: Lethal chamber is a common method for killing lab animals, hamsters are killed in the same way as rats

ROUTES OF DRUG ADMINISTRATION

This includes the following:

- Local or topical administration
- Oral administration
- Parenteral administration
- External application

- Inhalation

Local or topical treatment

This is the application of powders or ointments to the body surfaces or instillation of drugs to the ears or eyes.

Oral administration

Remedies for oral administration includes solutions, suspensions, pills capsules or tablets. All of the drugs are swallowed and are absorbed in the gastro-intestinal mucosa. When the drug is taken orally it takes time for the drug to be absorbed especially so if it is in solid form, hence can hinder the onset of action of the drug.

Subcutaneous injection

This route is preferred when slow and continuous absorption of the drug is required, it can take up to 24 hours to absorb the drug. The injection is done in the fatty layer of the tissue just under the skin, the fatty layer between the skin and muscle. The injection can be made at any point of the body surface where there sufficient loose skin.

To inject choose a sight where the skin is loose. Pinch the skin between the thumb and forefinger. Push the hypodermic needle into the fold until the subcutaneous layers are reached.

The amount of inoculation up to 5ml can be injected into the guinea pigs but not more than 1ml should be injected into the mice.

Intraperitoneal injection

It is the injection of a substance into the peritoneal cavity; it is preferred when there is low blood pressure that makes the intravenous injection inappropriate. This route is important because of the great absorbing surface of the peritoneum and the absorbing rate is rapid. The injection is made through the sub-lumbar fossa. Care is made to avoid delivering the solution into the abdominal organs. To inoculate hold the animal facing downwards and then inoculate into the middle of the lower half of the abdomen, the inoculum should not exceed 5ml for guinea pigs and 2ml for mice.

Intradermal injection

This is the injection into the dermis layer of the skin. Vaccines can be injected through the intra-dermal route. Dermis is the skin layer underneath the epidermis, the route is also used for diagnostic purpose e.g. tuberculin testing in cattle.

To inoculate the site of injection is first depilated, removal of fur or hair by chipping and shaving

Pinch the skin between the thumb and forefinger and then insert the intradermal needle into the top of the skin.

Depilating the skin

- Mix barium sulphate one part, with zinc oxide and one part and soluble starch two parts.
- Add water to make a thick paste
- Chip the fur with a pair of scissors and apply the paste
- Leave for a few minutes
- Scrap off the area

- Apply lanoline to the skin after depilating the skin.

Intravenous injection IV

This technique is suitable for rabbits and guinea pigs. The technique is possible when the drug is available in aqueous solution. It is used in the following circumstance;

- For emergency treatment
- When rapid effect is required
- When the drug is too irritating for administration by any other route
- For precise dosage control
- For long term administration by an intravenous drip of drugs with transient action

The proximity of veins to arteries also means that accidental intra-arterial injection can occur, sometimes with some dramatic consequences, hence care should be taken. To inoculate shave the hair to expose the marginal vein in the hino limb, rub the area with alcohol to dilate the veins and then inject directly into the vein.

If difficulty is encountered with guinea pig, ear vein can be used

Intrathoracic and intracardiac injections

These modes of administration are used when performing euthanasia in small animals; they are also used in a range of experiments including medical, pharmacological, toxicological, biological and genetical experiments.

To inoculate, anaesthetize the animal and shave the anterior thorax and then insert the hypodermic needle at the point to the left of the sternum, through the third intercostal space. First withdraw a little blood, in order to ensure the drug enters the heart and then inject the inoculum.

Inhalation route

Is used when the drug is in gaseous or vapour for form, absorption of gas is very rapid because of the very large surface area offered by the respiratory surface. Volatile

and gaseous anesthetics are administered through this route.

External application

Absorption of certain drugs can occur through the skin, absorption is aided by the presence of hair follicles and subcutaneous glands in the dermis.

HANDLING THE ANIMALS FOR INOCULATION

Mice and rats

For subcutaneous,intradermal and intraperitoneal injections, grasp the tail with the left hand and lift until the hind limbs are off the ground completely.

With the right hand grasp the scruff of the neck between the bend of the forefinger and the thumb. Hold the animal sothat its back is stretched across while stretching the tail lightly with the left hand.

When the tail vein is to be used in intravenous injection a metallic cylinder which is perforated on both ends is very useful. The cylinder is closed with cotton wool at one end and with a cork at the other end. A V-wedge is cut in the cork,through which the tail is passes.

Diagram

GUINEA PIGS

Hold the pig in the left hand on the dorsal part of the animal, reverse the big and place the thumb of the right hand behind the hand limbs i.e. at the rump.

Change the position of the lift hand and place the thumb on the jaw of the pig with the fingers holding the neck from behind.

RABBITS

For intravenous injections hold the loose skin in the middle of the back with the right hand and grasp the ears with the left hand.

Place the rabbit on the flat surface and gently but firmly hold down the rear of the rabbit with the right arm. An inoculation box may be useful as frees both the operating hand for other operations, for intraperitoneal inoculation

roll the rabbit on the rabbit on its back and with one hand extend the hind limbs and with the other hand extend the forelimbs.

NB When handling the animal is important to remember that slow sure movement will not frighten them but sudden movement unsettle animals and make them more difficult to handle.

BLEEDING EXPERIMENTAL ANIMALS

The composition of blood sample will depend on the method of sampling. In long term experiment is essential to use the same method all through, even in the control animal.

Apparatus

All the apparatus to be used must be sterile and in good working condition, this includes

- Surgical blades
- A disinfectant

- Cotton wool
- Needle
- Syringes
- Scissors
- Forceps
- Collecting bottle and anticoagulant solution, if unclotted blood is required
- Vacutainers

The apparatus must be brought to the working room before the animals are brought in

Common bleeding sites

The sites chosen depends on the amount of blood to be collected and the species of the animal

SITE	**ANIMAL SPECIES**
Heart or cardiac puncture	Rabbit, Rat,G.pig, Hamster, Gerbil & Frog
Cephalic vein	Cat, Dogs & Primates

Saphenous veins	G. Pig,Rats,Primates
Femoral veins	Primates & Dogs
Jagular vein	Primates, goat,sheep& cattle
Ear vein	G. Pig & rabbit
Tail vein	Mice & Rabbit
Orbital sinus	Rat & mouse
Wing vein	chicken
Toe & toe neck	Rat, mouse, hamsters, gerbil

Procedure for bleeding common laboratory animal

General preparations

- Bring all the required apparatus and lay them on the working bench.
- Bring the animal into the room

- Prepare the bleeding site as follows;
- Restrain the animal as required
- Disinfect the bleeding site
- Shave or chip the fur as required, if necessary
- Anaesthetize the animal if necessary
- Bleed the required amount of blood from the prepared site
- Transfer the blood to the collecting container
- Put a pad and cotton wool over the site and apply some pressure to stop further bleeding
- Observe the animal for a few minutes and if the animal is able to drink to replace the lost fluid
- Disinfect and clean the room and all the apparatus.

Precautions when bleeding animals

Never bleed the animal in the presence of other animals

Always cover or bandage any cut or bruise on your hands before and during bleeding sessions

Never splash blood in the air when bleeding or transferring it into collecting container

ANAESTHESIA

Is a state of being unable to feel pain, heat or cold. It can divided into

General anaesthesia: it affects the entire body

Local anaesthesia: is one administered by injection and affects only part of the body.

Inhalable anaesthetics:

Ether

It is a good anaesthetics for most small animals

A high concentration of ether should be given in the early stages. This can be maintained with a much lower concentration from the a face mask or funnel

How to administer Ether

Small animals (mice and rats)

Place the animal under a bell jar or a large funnel,
Then administer ether into the jar dropping it onto a cotton pad already placed under the jar. Cover the cotton wool with wire gauze. This prevents the animal from coming into contact with ether for it is irritating.
Alternatively, ether/air mixture can be blown into the fur from a woulfs bottle.
The jar or funnel must be of glass so that the animal may be observed, when the animal is unconscious, take it out and place it on the a board.
Maintain the anaesthesia using a mask or a funnel
Diagram

Rabbits and G.Pigs

Administration of anaesthesia into guinea pigs and rabbit is very difficult as they get laryngeal spasm very easily and resist anaesthesia, it is not therefore advisable to put

them into a box, as they will struggle a great deal and injure themselves.

They should gently be restrained by an assistance, then the ether be administered with a mask, increasing the concentration as rapidly as possible, but allowing some air intake.

Other inhaled anaesthetics include chloroform and ethyl chloride. For a simple operation a funnel containing cotton wool soaked in ether is placed over the head of the animal.

INJECTABLE ANAESTHETICS

They are injected through intramuscular, intraperitoneal and intravenous route.

Thiopentone sodium

It causes irritation and must therefore be administered intravenously. It last only for a short time because it is detoxicated and excreted from the body.

Penta- barbitone sodium (nembatal)

It is given either through intravenous or the intraperitoneal route.

It produces a greater depth of anaesthesia than thiopental and also last longer, for major operations, an intraperitoneal injection of nembatal is given.

The dose is 1ml for each 5 lbs of body weight.

For mice appro 0.1ml for a 10% solution of nembatal is given, in case of asphyxia following anaesthesia, spontaneous breathing may be obtained by holding the

mouse by its tail and gently swinging it in a horizontal circle.

Ketamine hydrochloride

Administered through intravenous or intramuscular route, Very useful in birds

NB A period of fast sufficient to empty the stomach should be allowed prior to anaesthesia, this prevents voting, 12 hours is sufficient for most mammals and birds.

Postmortem

It is the surgical operation of a dead animal to find out the cause of death by observing body organs and testing some tissue of the dead animal. It is done when the animal suddenly dies in the cage, to prevent the spread of the disease.

It also helps to know of the drug to be given to the surviving animals so that the infection does not spread.

Post mortem room

- It must be a separate room used for no other purpose other than post mortem examination only.
- It must have surfaces that are easily cleaned and disinfected
- Must be fitted with apparatus that are easily cleaned and disinfected such as stainless still tables and trolleys
- Must be fitted with a good hot and cold water supply
- Must be well drained.

Apparatus and materials required

- Scarpels
- Scissors
- Forceps
- Bone saw
- Syringes and needle

- Pins
- Enamel tray and board
- Packing containers e.g. specimen bottles
- Disinfectants e.g. 5 % Lysol
- Protective clothing
- Digest broth
- Grease pencil
- Record book
- Microscope slides

PROCEDURE

- Note the date of death, cage number and any other relevant details in the record book
- Sterilize the scissors or forceps
- Label the blood, macConkey plates, broths and slides with the details of the animal and tissues that is to be examined or inoculated into plates and broths.
- Bring the animal into the PM room

- Put on all the necessary protective clothing
- Immerse the animal into 5% Lysol for few seconds to kill all fleas or mites and to prevent loose hairs from contaminating the tissues when the animal is opened.
- Pin the legs to the board so that each leg is stretched towards its appropriate corner of the board
- Heat the shearing iron and use it to remove fur along the line that the incision is to be made
- The animal is now ready to for post-mortem which is performed using aseptic techinques
- Cultures taken are incubated, smears are stained by the appropriate stains and tissue for histology placed in the appropriate fixatives
- All observations and cultural findings are recorded, and the cause of death noted in the record.

Signs of ill health of the lab animals

The state of ill health of the animal can be assessed from observation on the pulse rate, body temperature, and body

conformation, condition of the skin or coat the visible mucus membrane and feeding habits.

Appearance

Look for obvious missing parts e.g. claws, tail, teeth, digits or lumps.

A normal animal will have a normal posture, when standing or lying down. It will be upright alert and responsive to touch and also steady in gait

Any diseases affecting muscles or joints results to abnormal posture and restlessness

BEHAVIOUR

A sick animal will appear gloomy and disinfected when approached. Some diseases may cause it to appear aggressive

Sick animal may also segregate and move away from the rest.

Some may move to a shake or a cold place.

Feeding and appetite

A health animal will have a good appetite for food and will feed to satisfaction, if given feed of the right smell and taste.

A sick animal may be reluctant to feed, swallow with difficulty or chew for abnormally longer time. Increased appetite can be a symptom of some metabolic disorders such as diabetes, brain diseases or parasitic infection. Unnatural ingestion of some substances not normally in the diet e.g. licking of timber material or rocks may indicate mineral deficiency.

DEFECATION

Excessively hard or watery faeces are indicators of ill health.

Blood stained faeces or those contaminated with segments or particles of the alimentary tissues also indicates diseases.

URINATION

Any abnormality in the colouring or consistency of the urine may indicate disease

SKIN AND COAT

The coat of a health animal should be glossy and shiny in bright light. It should be streamlined, clean and show complete cover. When diseased the coat will appear, dull, and hair will fall out.

A healthy skin should be warm to touch soft and moist, but when it is cold, dry and inelastic or scaly, it indicates, diseases the skin may crack and peel off or develop itches and wounds when the animal is diseased.

The visible mucous membranes

The inside lining of eyelids, nose, mouth and external urinal-genital tract of a normal animal are usually moist or watery and pinkish

When an animal is ill, these lining may appear bright red, pale or anaemic sometimes yellowish or bluish, depending on the type of disease which the animal is suffering

Copious discharge hemorrhages or pus exudates are indicators of some internal infection.

BODY TEMP, PULSE RATE AND RESPIRATION RATE

Any change in the temp above or below the normal range may indicate ill health

Pulse is the rate or force of blood passing through blood vessel per minute

This reflects the heart beat

When the pulse rate is outside the normal range, unless it can be explained physiologically e.g. after the animal has been running, increased rate is a sign of ill-health.

BODY CONFORMATE

Excess fatness may results from overfeeding or disease, while leanness or emaciation, may be as a result of underfeeding, starvation and disease.

A normal animal usually show the proportion of the organs and tissue characteristics of the breed or strain of the animal.

When you observe the above signs:

- Separate the animal into a different cage.
- Call a veterinary officer to administer drugs
- Give vitamins to the animal and fresher food.

ZOONOSES

These are infectious diseases of lower animals that can be transmitted from animal to human.

More than 100 animal diseases are infectious to humans.

This involves both domestic and wild animals.

Examples include anthrax, cowpox rabies bovine tuberculosis e.t.c.

Regardless of the natural host or type of organisms responsible for the disease, all zoonoses have several common characteristics which they share, this include:

They are usually occupational hazards for those who have close contact with the animals or animal products e.g. veterinarians butchers farmers, hide and skin handlers etc

They are rarely transmitted from person to person

In humans these diseases are clinically similar to those in animals if the portal entry is the same in both

When the disease in humans is caused by eating meat or products of the diseased animal, the disease will resemble that in animals.

Modes of disease transmission

Animal bites

This introduces a mixture of microorganisms present in the saliva or on the teeth. Such bite are always infective and should immediately be opened, cleaned, disinfected and covered with a sterile gauze

Most dangerous pathogens by animal bites is the rabies virus.

Rats

Their faeces transmit the food infectious salmonellosis; their urine transmits leptospirosis or hemorrhagic jaundice i.e. yellowing of the skin

Fleas of the rats transmits bubonic plague

CONTROL

Prevent any wild rats or mouse from entering the animal house. This can be done by

Poisoning

Trapping

Depriving them food

The fleas may be temporarily eliminated their runaway with DDT

ANTHRAX

Is a disease of domestic animals, they get infected by inhaling the spores of bacillus anthraces passed in faeces, in man anthrax is an occupational disease of farmers, butchers dealers in hides, animal hair or fur and handlers of bone meal in endemic areas.

Control

- Vaccinate the healthy animals against the disease
- Vaccinate persons who are at high risk
- Bury diseased animals in deep pit
- Wear protective clothing when handling these animals

Weil’s disease leptospirosis

Is caused by a spirochaete bacteria called leptospiraicter whose host is rat and other rodents

It is transmitted to man through infected urine of rats and other rodents.

The bacteria can penetrate the skin or mucosa of man, the disease begins with a mild fever, in severe infections the disease appear abruptly with headache and vomiting, there may be rashes and enlargement of liver and spleen.

PSITTACOSIS

It is caused by a bacterium called chlamydia psittaci, it is contracted from infected birds.

The pneumonia associated with it may cause severe toxaemia a localized bacterium that produce toxin that spread out throughout the body.

Headache is usually an early symptom followed by chills and fever, sore throat, intolerance to light and vomiting, the organism may be transmitted to other birds which may come into contact with the psittacines.

Dry faecal material is an important source of airborne infection as well as dust from the cages.

SALMONELLOSIS

It is caused by infection with salmonella bacteriae e.g. S.typhimurium and S. enteritidis, it is transmitted to man either directly or in food, mainly by poultry

Salmonella may cause typhoid or food poisoning through food handlers, the food are infected in two ways:

Salmonella are natural pathogens of domestic animals and their meat or products may contain the organisms. Eggs from the infected chicken may contain the the organism in the yolks hence raw eggs or partially cooked eggs can be a source of infection.

Personal hygiene especially for food handlers is essential, they should also be vaccinated, food may be excreta of mice or rats.

Ducks tend to be carriers of salmonella organisms in their oviducts and alimentary tract, and their eggs are not suitable for preparation of lightly cooked foods. Hens are rarely affected

Rabies

It is caused by a virus which enters the central nervous system and the salivary glands. The patient anxiety rises, the characteristic fear of water becomes evident, although the patient is thirsty, an attempt at any drinking provokes violent contractions of the diaphragm and inspiratory muscles.

Hallucinations may develop accompanied by bitting.

CONTROL

Pre-exposure prophylaxis is required for those who handle potentially infected animals, those who work with rabies in the laboratories and those who live in rabies endemic areas. Rabies can usually be prevented if treatment is started a day or two after a bite.

Post exposure prophylaxis

Clean the wound thoroughly with a swab and the damaged tissues should be removed. Put some antiseptic e.g. Dettol or tincture followed by treatment for rabies.

Methods for disease control

Vaccination of animal handlers

Isolation (quarantine) of diseased animals

Population control

- **Culling:** selecting and killing to reduce the number of animals, these includes the diseased and injured animals, the unproductive due to age and the physically impaired ones
- **Separation of sex:** the male and female should be placed in separate house.

STORES MANAGEMENT

Types of stores management

Types of stores depend on the nature and size of the establishment they are supposed to serve.

They are classified into three types

- Central stores
- Main stores
- Dispensing stores

CENTRAL STORES

They are found in very large research or teaching institutions and in industry, they hold large stock in order to meet the requirements for such institutions. The individual requirements for each department necessitates that the stocks from central stock be distributed to subsidiary or departmental stores.

The advantage of the central stores is that bulk purchasing arrangements may be made for items which are common to several departments.

The disadvantage is that the large volume of stock may be a problem to determine the exact number and type of goods and material available in the stores. The supplies to the departmental stores may not be satisfactory in terms of quality.

MAIN STORES

This serves a particular department or division, the stored material are usually applicable to or used in one technological subject, such stores may be found in universities and colleges, they serve from a central position, many laboratories within the same departments, petty issues to individual are not allowed from the main store, only major issues such as complete containers and case lots are made to the dispensing stores, sometimes a case lot may be divided up and shared between several dispensing stores. Open chemical containers are not normally kept in the main stores

DISPENSING STORES

Within a particular laboratory, a third type of store is required for dispensing small quantities of material for local use.

The storeman in charge of this store is responsible for maintaining his stocks by signing from the main store. In

educational institutions students go to the dispensing store for their requirements e.g chemicals and apparatus.

The student is supposed to sign for apparatus at the store and may be charged for it if the items are not returned or damaged.

DESIGN OF THE STORES

Main stores

It should be located at the rear of the building and should be on the ground floor. This facilitates the delivery of goods. A good lift or hoist is necessary when laboratories serviced by the store are on the upper floors in a storied science block.

The store must be large enough to accommodate all the necessary stock. There should be enough room to accommodate movements of boxes and to provide a freeway for trolleys to avoid dangerous hazards.

The floor of the store must be strong to avoid sagging due to the weight of the stored material. The unpacking facilities are essential for and should be provided close to

the main door at which the goods are delivered. Facilities should be provided so to allow the delivery van to back up close to the door of the store so that the goods can be uploaded near the check point. For checking counter tops with shelves below or long tables can be installed. There should be adequate room for unpacking and checking the delivered goods, as the boxes are unpacked the contents are placed are placed on the counter top.

After checking the goods can be may be stored in the counter shelves below until they are recorded in the inventory book. Inflammable substances should be kept in the outside store. Acids ammonia and gas cylinders should be stored in specially designed room.

LAB INSPECTION AND MAINTENANCE

Objectives

- **Explain the need for inspection and maintenance of lab facilities**
- **Outline the major areas of inspection**
- **Explain what preventive maintenance entails**

Need for inspection and maintenance in the lab.

The various services provided in the lab and the expensive equipment in them needs regular inspection in order for the department to work efficiently

Major maintenance work in busy lab should be undertaken when the lab are not in use

INSPECTION

A report concerning the repairs required for the upkeep of the building or equipment should be given when the departmental budget is being prepared. During the course of inspection useful information is obtained regarding the repair work needed.

Areas of inspection

The general condition of the lab

Decolouration

The paintwork should not be allowed to deteriorate to the extent of exposing the material it covers to fumes. This is especially in metal windows.

Windows

Windows and window frames should be inspected and particularly the sash cords, if they are fitted. Nylon and other fume resistant cords are recommended for lab windows. The windows are used to open the windows. Damaged window panels are a source of danger to people inside and outside the building. Check for faulty windows

fasteners which may be the course of pane breakages especially windows with metal frames.

Ceilings

They may deteriorate due to dampness and the cause must be investigated. Dampness in a balance room and chemical stores is a serious matter.

Drainage system

Inspect the channels and traps for if they are neglected may results in a serious flooding. Drainage channels may become silted, especially due to use of cleaning powders in sinks and controlled use of such powders may be necessary, other blockages are due to broken or missing or waste grilles and these should be replaced.

Water taps and Water filter pumps

Washers in water taps should all be replaced at the same time e.g. once a year. This prevents the recurrence of leaking taps. Check the efficiency of all water filter pumps. Faulty ones should be dismantled and cleaned and the jet replaced if necessary.

Gas Taps

Regularly check the taps for leaks, as they tend to loosen with constant use.

Electrical fittings

Replace the bulbs and discharge tubes if faulty or deficient. The metal shades should be repainted if corroded. Inspect the possible causes of problems in switches and plugs. Conduits should be checked for signs of corrosion. The electrical cables for various instruments must be kept in good repair as shock circuits in them will cause fuses to blow. This is common in water bath, hotplates and stills, where heat causes rapid deterioration of the cables.

Safety Apparatus

Safety of the whole building depends on efficient upkeep of the firefighting and other safety equipment. Fire extinguishers must be regularly tested, and in some cases the content renewed. The date of their refilling should be labeled or written on the cylinder. Check the cylinder for

signs of corrosion, CO2 cylinder is checked by weight. Whenever the cylinder is used it should be reported. Check the safety equipment inventory to ensure that other apparatus such as respirators, gloves and gloves are in good order and at their proper place in the lab.

Fume cupboards

Poor disposal may cause inconveniences in the lab. Check the velocity of the air drawn through a fully open front of fume cupboard. Note any deterioration in the performance of the extraction of the fan or the efficiency of the fume ducting. At regular intervals oil or grease the bearings of the fan motors, depending on the type of bearings.

Lab Workshop

Check that guards on the machine comply with the laid down regulations. Check the machines belts for wear. During inspection the age and efficiency of the machinery is investigated and new equipment purchased if necessary.

Stores

Dry storage especially where chemical stock are involved is important hence note any signs of dampness and effect any repairs as possible. Check the condition of the various safety devices, functioning of fans and firefighting equipment

Renew shelf labels if necessary, rearrange and tidy up the stocks if new stocks are expected to arrive.

OVERHAUL, MAINTENANCE AND CLEANING OF FURNITURE AND EQUIPMENT AND APPARATUS

Periodic overhaul, maintenance and cleaning of equipment and apparatus in labs and workshop is key to efficiency of the department.

EQUIPMENTS

Rotary vacuum pump

It should be checked periodically. Check the external parts and pay special attention to the condition and tension of the belt. Check the oil level and adjust as necessary. Determination of the pump oil through leaks or

contamination by vapours is indicated by a marked fall off in the pumps performance, hence; regularly renew the oil in order to prolong the life of the pump. The performance of the pump depends on the grade of the oil used; hence the correct grade of oil to be used should be marked on the pump body.

Electric furnaces

Periodically lubricate the moving parts e.g. the