**LABORATORY SAFETY**

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**CONTENTS**

 Introduction 167

 Objectives 167

9.1 General Laboratory Safety and Techniques 168

9.2 Chemical Hazards 170

9.3 Biological Hazards 178

9.4 Radiation Hazards 182

9.5 Fire Hazards 184

9.6 First Aid Treatment 188

**INTRODUCTION**

Safe and clean environment has got special attention of scientists, science educationists and industrialists now a day all over the world. The science teachers more than any other are facing the task of educating the pupils and changing their attitudes towards the concept of safe environment. As part of science education, we must in tide the reasoned consideration of hazardous chemicals, procedures and the best way of minimizing these potential hazards in this course.

For the course to have maximum effect “safety” must be seen as the foundation stone of laboratory work. This first question to be asked about procedure is not “is this better done as a demonstration”? But “Is it sale”? it is too late to ask that question once work is underway, so safety should be a regular topic in the science teaching.

In this unit, you are introducing with general laboratory safety and techniques, chemicals, biological, radiation and fire hazards and first aid treatment.

**OBJECTIVES**

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

1. know about general laboratory safety and technique;
2. recognize the chemical biological, radiation and fire hazards and can protect;
3. can protect you and your students from various laboratory hazards;
4. give first aid treatment when required.

**9.1 General Laboratory Safety and Techniques**

**9.1.1 Systems Checking**

The Head of Department in a school or college has the responsibility to see that the laboratories are safe for his staff and students. Nothing should be taken for granted in this respect and schools and college staff should, on a regular and methodical basis, check all laboratory services – gas, power, water, drainage, and fume extraction, where appropriate.

These items should only be checked. Any faults which are found should then be reported to the appropriate authority for correction.

**9.1.2 Staff and Students Involvement in Safety**

How should one deal with the all-important problem of involving both staff and students in considerations of safety? Rules and regulations imposed from above rarely have the effects on users which occur if the latter have had a hand in deciding policy.

Involving staff is very easy. Not only can staff, through consultation, have a hand in planning a safety policy for a particular institution, but also this involvement can be on-going through science staff meetings, where each your (or each term initially) one item on the agenda could be a discussion of any serious accidents (or avoidable accidents) which have occurred in the school or college laboratories.

Involving students in a meaningful way is not so easy but one possible way is to ask students, at the end of their first year of laboratory work to design a safety poster for use the following year. The whole process can be done as a completion and the best posters retained and displayed.

**9.1.3 Use of Posters**

Published posters, aimed at drawing people’s attention to unsafe practices, are frequently grossly misused. If you are lucky enough to have a set of such posters, do not make the mistake of exhibiting them all at once. Instead, show only two or three at any one time change them regularly, and also change their sitting. It a poster remains fixed in one place too long, students (and staff, for that matter) soon “look but do not see.

**9.1.4 Publications**

Every science department should keep on hand, and in a clearly identified position, a comprehensive list of current safety publications. A fairly comprehensive list of available material is given in Appendix C, on pages 57-58. Schools and colleges can draw from that list those items which they feel are most appropriate to their needs.

**9.1.5 Techniques and Habits**

There are certain ways of working in a laboratory, which are used as a matter of course by experienced staff, and are quite simply, the safest methods of carrying out everyday activities. It will surprise few people to know that the most serious accidents in laboratories are those that affect the eyes. In the U.K., the Department of Education and Science (D.E.S.) has recently taken steps to limit hazards to the eyes by re-issuing its Safety in Science Laboratories booklet (see Appendix C, page 57). All staff can help themselves, school technicians, and students by adopting any of the following techniques which may be new to them.

**9.1.6 Transference of Liquids – I**

Many teachers and technicians suffer accidents to their eyes not only because adequate eye (or face) protection is not used but because staff overlook the fact that liquids being transferred from bulk containers, such as Winchester Quart bottles, invariably splash. Also in the case of hygroscopic liquids (such as concentrated sulphuric acid) a small drop left on the lip of a bottle soon absorbs moisture and runs down the side of the bottle, making it slippery.

Whenever staff are transferring liquids from bulk containers (something pupils should never be asked to do) eye protection should always be worn and the neck of the container cleaned carefully afterwards.

**Transference of Liquids- 2**

Pouring liquids from one container to another sometimes leads to a dangerous situation, again as a result of dripping, etc.The safest way of pouring any liquid (on a small scale) is to make use of the fact that liquids run along a glass surface whenever possible. A glass rod, use as shown in Figure 1.1, prevents dripping. Students should be encouraged to practice this technique, using water.

**Maneuvering Cork and Rubber Bungs**

Far too many staff and students ignore the generally accepted ways of handling even simple equipment such as cork and rubber bungs. As with all processes, there are at least two ways of connecting or disconnecting bungs and glass tubing – one is safe and, possibly slow and the other is convenient quick, and dangerous.

The safe way, and the way that should be adopted for the movement of glass rod or tubing into or out of cork or rubber bungs, is as follows. It is even more desirable to use this technique in cases where the cork or rubber has become aged” which happens once the two have been left in contact for a week or so.

All that is required is the appropriate size of cork borer, which should be used.

Students should be shown this simple technique and be encouraged to use it whenever the need arises.

**Storage of:**

**Glassware**

A hidden (and expensive danger particularly in biology and chemistry laboratories is the common practice of storing certain items of glassware pipettes, thermometers, condensers, etc. in drawers without protective padding. If they are stored loose, there is the constant risk of any small movement causing damage (It wasn’t broken when it was put in sir!). If a drawer holds a number of such items, a broken one, which will not be easy to see, can cause a bad cm.

Whenever possible, draws holding fragile glassware should be lined in such a way as to prevent movement and contact of the contents. Any soft material will do – expanded polystyrenes is ideal.

**General**

Quite often, staff store items of equipment in such a way that frequently used item are in the most convenient position for regular access. This has a number of advantages but on hazard can result if staff is not on their guard.

When storing items on shelving, etc., always make sure that heavy items are at ground level, very close to it. Each year, staff and students have accidents as a result of lifting rarely use, but heavy items from a high shelf, which they have reached by standing on a stool. In addition, a shelf holding more than one line of bottles is dangerous when items are lifted from the back line.

**9.2 Chemical Hazards**

A chemistry laboratory presents the greatest combination of potential hazards. However, careful attention to techniques and the avoidance of known dangers can help to make this area as safe as any other.

**Storage Flammable Chemicals**

Details for the provision of storage areas in new laboratory buildings are given in Chapter 7, pages 35-42. What can be done in an existing chemistry laboratory or even in a laboratory that has had to be adapted to teach chemistry?

First, thought must be given to the storage of flammables – not only how they are to be stored but also what and how much is to be kept in storage at any one time.

The very minimum safety provision that is acceptable is to fit, in place of a normal under bench unit, proprietary steel under bench fire cupboard. The normally accepted limit in terms of quantity of flammable liquid in store in 50 liters. That is, no school, or college, unless it has a special permit to do so, should hold more than 50 liters of flammable liquid on the premises. It, in addition to any such bulk store smaller quantities is held in laboratory reagent bottle; these should never have a capacity greater than 500 cm.

**Checking Stock**

No matter how careful laboratory staff is, it is inevitable that chemistry laboratories gradually accumulate a varied stock of materials that are best disposed of. A quick examination of a chemical store will undoubtedly uncover one or more of the following:

1. Reagents without labels or with unreadable (faded) labels;
2. The presence of materials that are now recognized a hazardous and whose use in a teaching situation is either banned or at least inadvisable;
3. Stocks of materials liela ID unnecessary large quantities;
4. Materials that have deteriorated with keeping. None of the above should be tolerated.
5. Represents a hazard in all cases and any such reagent containers should be cleaned out.
6. Covers such materials as those substances now recognized a carcinogenic (cancer-forming) and other materials once commonly used such as hydrogen sulphide. Materials whose use is banned in the U.K. under the carcinogenic substances regulations include 4,4-biphenyldiamine (benzidine), napthalen-2-amine (S-naphthylamine) and naphthalene-i-amine (a-napht-hylamine) as the 2 QS)-form is nearly always present as a impurity 5 all nitrosoamines all nirrosophenols all nitronaph-thalenes, and many substituted biphenyls.
7. Covers materials such as metallic sodium and potassium, elementary bromine, white phosphorus; etc. In the past, laboratory suppliers have always supplied these materials in large quantities – 2 kg (5 Ib) cans were once quite common. Such a bulk is quite unnecessary and excess of such dangerous materials should disposed of (see page 15, Disposal)
8. Materials that deteriorate on keeping include. Particularly those materials unstable in the presence of moisture – non-metallic chlorides, phosphorus oxides, calcium (n) dicarbide (calcium carbide) 5 etc. once a stock of these is found to be deteriorating, it should be destroyed. A stock check should be undertaken each term, by a senior member of staff who knows the properties of, and, therefore; the hazards presented by, each material held in stock.

**Incompatibles**

One thing that should be avoided is the storage system that places incompatible materials in close proximity. The commonly used; and very helpful alphabetical storage system, where each substance is stored in alphabetical order has its dangers unless modified to overcome them. One can, for example, have phosphorus (white) close to potassium (metal) 5 which is safe until either the labels are lost or fade 5 or there is a fire. Another combination that has obvious dangers is to store a material such as bromine in the vicinity of any metal container, such as those used to hold metallic sodium.

The alphabetical system is quite satisfactory 5 so long as separate provision is making for the storage of bulk liquids, flammables, and poisons. If flammable materials are put in a separate room, it should be a room free of any source of flame or electric spark, such as a room holding fuse boxes or switch gear, and should be one that has forced ventilation through an external wall.

**Practical Work (General)**

First and foremost, all staff should appreciate that in any laboratory where chemicals are being used there is a constant-hazard from splashes or irritant dust particles entering the eye. Steps should be taken to ensure that everyone in the laboratory – student, technician, teacher or visitor – wears eye protection while the practical work is being carried out.

1. Large bottles – particularly Winchester Quarts (2 ½ liters) – should never be lifted by the neck. Small baskets, that hold two Winchester bottles, are available and facilitate their movement and use.
2. Gas cylinders must always be kept strapped in a trolley or provided with some means of stability and the valves should never be subject to any sudden mechanical shock (such as being knocked over or stuck by a hammer).
3. Whenever possible, loose asbestos products should no longer be used. This includes soft asbestos tiles; asbestos paper, wool, tape and string; and asbestos – centered gauzes. Although the asbestos normally met with in these items is not the very dangerous ‘blue form, the materials mentioned, when subjected to heating (as they nearly always are), tend to create airborne asbestos fibers whose long-term effect is known to be hazardous.

Various alternative materials are now coming on to the market that avoids the use of asbestos. No list of materials can hope to remain up-to-date for long but the following should be helpful. Gauzes (Asbestos-centered). Schools normally use squares of mild-steel mesh with a central area that may hold asbestos filler. Possible alternatives are:

1. Similar gauzes made with central ceramic filler. The few tests on these to date seem to indicate extreme brittleness, particularly after the gauze has been heated;
2. Plain stainless steel gauzes, without central filler. Two varieties are available in the U.K. – wire gauzes, usually of 0-457 mm diameter (26 SWG) wire, and gauzes made from expanded stainless-steel mesh. Both of these seem to give satisfaction but schools should be wary of choosing gauzes made from wire any finer than 0-457 mm diameter (26 SWG). Asbestos Wool and Paper. The only really acceptable substitute for asbestos wool and paper-type products are the ceramic alternatives (schools should avoid using glass wool), though some schools find the increased brittleness of ceramic paper to be a major disadvantage to its use.

Asbestos Boards. These are used to protect benching when using heated experiments and many cheap (but perishable) alternative materials are available, for example, hardboard squares, etc. The best heat-resistant product available at present would appear to be ‘Supalux’ – a calcium silicate (IV) (calcium silicate) matrix material which is available from a number of suppliers.

**Specific Cases**

Twenty-two specific materials or activities are given below that each present a hazard to the unknowing. As time passes, additional hazards will became evident and careful note should be made of these, and circulated to as wide an audience as possible, via local and national teacher’s organizations and publications.

1. Benzene. This liquid presents a wide range of unacceptable hazard to the user. It has a low flashpoint (-11 C) and so can be rated as highly flammable. Far more serious, however, are the dangers of inhalation of the vapour and absorption of the liquid through the skin. Not only can skin absorption give rise to narcosis and dermatitis, but repeated inhalation of the vapour has been shown to give rise to bone marrow damage. This material should be phased out of teaching laboratories as quickly as possible.
2. Boiling Liquids. When a small quantity of a solution is to be boiled, this should always be done in a large (boiling rube) test-tube “containing, if appropriate, fragments of porcelain. (Collect all old broken porcelain dishes, etc. and keep them for this purpose.) These two steps should prevent hasty causing dumping’ of the liquid, but even if it does occur, the hot liquid stands less chance of spurting out of the, tube.
3. Broken Glass. It is inevitable that some glassware will get broken in the course of experimental work. Once large pieces have been carefully picked or swept up, a safe way of ensuring that small slivers of glass are collected is to use a small lump of plasticize, a proprietary material (such as ‘Blu-Tack’), or even most clay to wipe over the area suspected of harboring glass fragments. Once the material has been used in this way, it must, of course, be discarded.
4. Tetra chloromethane {Carbon Tetrachloride). Although limited exposure to this material is not dangerous, the long-term effects of high-level exposure include liver and kidney damage as well as a more immediate narcosis and irritation. Laboratories should hold only small quantities of the material which should be used only with adequate ventilation.

Note: Some forms of fire extinguisher use tetra chloromethane (carbon tetrachloride) as the active principle. Such extinguishers should never be used on a fire in an enclosed area.

1. Charcoal Blocks. Although work with charcoal blocks, for example, when used for ‘blowpipe reduction’ experiments, etc., is now less frequent, they regularly cause fires after use. Charcoal blocks retain their heat for a long period and, when stacked in an enclosed space (such as a drawer) can be subject to spontaneous combustion. When finished with, the blocks should be stacked loosely on ametal tray and left in the open laboratory overnight.
2. Chlorine. Although this gas is not now produced experimentally in the same quantity as previously, its preparation presents two hazards. First, from the gas itself, when is a well-known vesicant and respiratory irritant. Second, from the usual method of preparation in which concentrated hydrochloric acid is reacted with dry potassium manganite (VII) (potassium permanganate crystals. These two reagents have been known to explode on contact, presumably due to an impurity in one or other of them. This problem can be overcome by covering the crystals with cold water prior to running in the hydrochloric acid.
3. Chromate (Vt) {Chromates}Salts of chromium (VI) – chromates and dichrofnates – should always be handled with care. Both the dry chemicals and their solutions can cause dermatitis and non – malignant skin cancers. Users should always was their ands immediately after using any of these compounds.
4. Hydrogen. Explosions occur regularly when experiments are performed in which hydrogen in passes over a heated material, usually a metal oxide. Two precautions need to be taken to minimize this risk. First, the experiment must be carried out behind safety screen. Second, the material under test must not he heated until hydrogen has been flowing through the test apparatus for at least five minutes and all air has been flushed out.
5. Hydrogen Sulphide. This is another gas which is not now prepared as frequently as it has been in the past. It is as poisonous as hydrogen cyanide and cause irritation to the eyes and mucous membranes even at very low concentrations. Its preparation should be avoided. Work with sulphides should be limited to situations where accidental formation of the gas is vented from the laboratory,
6. Mercury and its Compounds. Not only should great care be taken to avoid spillages of metallic mercury (stand equipment in a plastic tray to retain any globules which are spilt) but schools and colleges should avoid heating mercury compounds in the open. All mercury compounds are poisonous and the majority is volatile or decomposes on heating to yield the volatile metal. Experiments in which materials such as mercury oxide are heated to yield oxygen and the metal do, in fact, fill the room with an unacceptably high level of mercury vapor, far higher than the recommended threshold limit value (T.L.V.) (see Appendix D, page 59).
7. Ninhydrin. This material is being increasingly used to ‘develop’ chromatograms of amino acids etc. In these experiments it is frequently used as a spray. Such use must be confined to a fume cupboard giving a good rate of extraction or, better still, be carried out outside in the fresh air. Ninhydrin is a respiratory poison and is easily absorbed into the system, especially if present in the form of a fine mist.
8. Nitrogen Oxide or Nitrogen Dioxide {Nitrous Fumes’). Thankfully, nitric (V) acid is not now used as widely as it has been in the past. Reactions of this acid with metals and other reducing agents produce copious fumes of nitrogen oxide (nitric oxide) or nitrogen dioxide which can give rise to pulmonary edema. Reactions which might produce these fumes should either be avoided or carried out in such a way as to localize the fumes.
9. Phosphorus Residues. In any experiment in which white phosphorus it used (or where red phosphorus has been subjected to heat and would, therefore, probably contain white phosphorus), all residues from the experiment must be collected and burnt off by a responsible member of staff Residues washed down the sink constitute a very real fire hazard.
10. Pipetting. Mouth-pipettes are still in common use; even to transfer dangerous liquids and solutions. Whenever possible this form of pipette should be replaced by the slightly more expensive safety pipettes, a number of varieties of which are available from supplies catalogues. Even if all mouth pipettes are not replaced, each chemistry laboratory should have two or three of the safety variety for operations involving the more hazardous liquids.
11. Plastics. Many establishments are now experimenting with plastics, and rightly so. However, these substances present a new range of hazards in the laboratory, from the solvents used, from the organic peroxide catalysts, and, at a simpler level, from the combustion products formed when pupils experiment on different kinds of plastic materials. Staff should ensure athat work with materials of this kind and done on a very small scale and always under well- ventilated conditions.
12. Potassium. Mention has already been made of the hazard presented by large stocks of this and similar materials. Potassium affords another hazard due to ageing. Old stocks of potassium that have discolored (the sticks develop a greasy yellow color) have passed the stage when they may be considered safe. Well-documented cases are recorded where old potassium has exploded on being cut be a knife, probably due to the formation of the unstable peroxo compound (peroxide), a powerful oxidizing agent, and its being brought into contact with the fresh metal, a powerful reducing agent, in the cutting process. Old stocks should be destroyed, see page 15.
13. Scheduled Poisons. The U.K in common with most developed countries operates a system of control over the sale and use of poisonous materials. These substances appear on a schedule and those that fall into category z, i.e.. Schedule I (Si) poisons, are subject to rules of both use and storage. A list of the more common scheduled poisons is given in Appendix B, pages 55-56, and these materials should not be available to pupils (except possibly sixth formers) in the solid or pure form except under strict control. Some scheduled poisons, barium chloride, for example, are common laboratory reagents and whereas solutions of them may be on laboratory shelves or benches, the solid reagents should be kept under lock and key in a poisons cupboard 18. Sucking Back. There are a whole range of experiments in which a substance or mixture of substances are heated to prepare a sample of a gas which it then collected over water. The reagents and the gas collected may do so. The equipment should be so arranged as to prevent cold water being drawn back into the reaction chamber when heating has stopped. The cold water will soon fracture the hot glass. In such an experiment, once heating has stopped; the line of glass must be ‘broken’ so as to allow air to enter the apparatus, either by uncorking at A or at B.
14. Typical layout which could cause suck-back when heating it stopped Sulphuric Acid/Water Mixtures. Although the vast majority of staff must be aware of the dangers of incorrectly mixing concentrated sulphuric acid and water, details of the correct method always bear repeating. If water is simply added to concentrated acid, the less dense water will form a separate phase and a violently exothermic reaction will occur at the interface. The generation of heat is minimized by :( a) adding acid to water ;(b) stirring continuously.
15. Urea-methanal Resin {Urea-formaldehyde Resin)/. The preparation of urea-methanal resin, as usually performed, involves the reaction of hydrochloric acid and methanol (formaldehyde). These two materials undergo a secondary reaction in which bis-chloromethy ether is produced. This is a member of a family of chemicals, all of which are known to give rise to carcinomas (cancers). Schools and colleges are advised not only to cease preparation of this particular resin using hydrochloric acid, but to take steps to see that methanol (formaldehyde) has no chance of reacting with either hydrochloric acid or metal chlorides in any other preparation.
16. Venting of Reagents. Certain compounds and solutions must have their containers checked regularly to prevent a build-up of internal pressure. Reagents that have given rise to explosions because of lack of venting include solutions of hydrogen peroxide, sodium chlorate (I), (sodium hypochlorite), and silicon or titanium tetrachloride. In the case of these latter materials, their reaction with moisture forms the solid dioxide in each case, which often seals the bottle, especially if this is fitted with a ground-glass stopper. In all cases of seized stoppers in reagent bottles, great care must be taken on opening, which should be done remotely, if this can be arranged.
17. Violent Reactions. Any list under this heading must be selective and incomplete and staff will undoubtedly wish to add to it. Reactions between the following pairs of chemicals should be avoided at all costs as they are unpredictable and often extremely violent.
18. Concentrated acids concentrated alkalies.
19. Concentrated acids alkali or alkali earth metals.
20. Oxidizing agents metal powders.
21. Oxidizing agents powerful reducing agents,
22. Oxidizing agent’s organic liquids.
23. Alkali metals hot water.
24. Alkali metals organic chlorinated Compounds.
25. Alkali metals non-metallic chlorides.
26. Metal hydrides water.
27. Heavy metal nitrates heated with organic acids or their salts.
28. Heavy metal nitrates any powerful reducing agent.

**Dealing with Spillages**

Spillages of solid materials should rarely present any hazard. Only in the case of white phosphorus could delay cause serious harm and, so long as the lumps of phosphorus are regularly dowsed with cold water, they can quickly be returned to their container and immersed in water.

Liquids, however, present an unusual array of hazard and are best dealt with in groups.

**Organic Liquids**

As soon as any organic liquid has been spilt, extinguish all flames and remove all sources of heat. Even if tetra chloromethane (carbon tetrachloride) is spilt, it would be unwise to leave flames burning, as in the presence of heat and moisture, tetra chloromethane (carbon tetrachloride) can form carbon dichloride oxide (phosgene), COCI2, which is very poisonous. If the spillage is at bench level, it should be washed into a sink and followed by a copious flow of water.

Spillages on the floor should be absorbed in a neutral material (sand or keiselguhr) 5transferred to a bucket, and disposed of outside the building. Staff should never try to mop up organic solvents using a cloth, because of the risk of absorption through the skin.

**Concentrated Acids**

In common with any other water-soluble substance, the first treatment must be washing with an ample supply or water. Never add sawdust to laboratory spillages. (Sawdust (a reducing agent) and, for example, concentrated nitric acid (an oxidizing agent) react very violently.) Once diluted a bench spillage can be washed down a sink and a floor spillage mopped up.

**Mercury**

As mentioned on page 10, experiments in which elementary mercury is used should be carried out on a wooden or plastic (not metal) tray so that spillages of this expensive and unusual metal are localized.

If the spillage is more widespread, then a mercury potter see figure 2.2, should be employed to collect together the individual droplets of metal prior to its being cleaned and returned to stock. Any area affected by mercury spillage that cannot be collected, can be dusted with sculpture/calcium hydroxide mixture to help fix any free metal.

Staff should remember that at 25 c the equilibrium concentration of mercury vapor arising from a recent spillage of the metal is some 200 times the threshold limit value (see Appendix D, page 59) of 0-05 mg m, which is recommended as the maximum acceptable atmospheric concentration. At a temperature of 40C, the mercury vapor concentration is 600 times this safe level (quoted TLV’s are those accepted in the USA).

**Disposal of Chemicals**

Every school and college ultimately faced the problem of what to do with unwanted materials. Again, these are best dealt with under general headings. Because such a list cannot possibly be exhaustive, staff needs to assess, in the light of what follows, the best ways of dealing with the various materials that, inevitably, do not fit easily under one heading or another.

One basic rule, which is often overlooked, is that heavy metal compounds are already dangerous and should be disposed of by a recognized disposal agent. Small quantities of bio-degradable compounds can be destroyed by being buried in such a way that they remain undisturbed for at least four years.

**Flammable Solids**

Alkali metals, their hydrides, phosphorus, 2,4,6-trinitrophenol (picric acid), etc, can be disposed of, in small quantities, by burning in an open fire. This is far less violent than by, for example, dissolving alkali metals in water! It is best done in the open, all containers having previously been opened.

**Organic Solids**

The bulk of organic solids can similarly be burnt, but any material subject to sublimation, or whose vapor is harmful, should be treated by an alternative method.

**Heavy Metal Compounds, etc**

Some safety booklets have suggested the obvious treatment with regard to the disposal of compounds of elements such as mercury, barium, cadmium, arsenic, antimony, etc. that is, to bury them. Unfortunately, all compounds of materials such as mercury are poisonous, and no matter what ground bacteria do, the result is always poisonous.

Materials such as these, should be returned to the supplier or to the recognized area environmental protection agency (in England, advice should first be sought from the Country Science Adviser).

**Organic Solvents**

Organic solvents should never, in any quantity, be thrown down the drains to facilitate their disposal – this merely passes on the problem to someone else. Most solvents can be disposed of by burning in an open dish but large quantities, or materials about which there is any question of hazard should be dealt with as heavy metals above.

**9.3 Biological Hazards**

Laboratories used for teaching biology present the teacher with a wide range of insidious hazards. Besides hazards specific to biological work, dangers can arise from the presence in the laboratory of animals, micro-organisms, and plants. Because a possible hazards often does not make itself obvious until several days after infection, biological work must be treated as a special case.

**Animals in the Laboratory**

All animals in the laboratory must be treated as reservoirs of possible infection and, as such great care must be taken in their purchase and maintenance.

All mammals can carry diseases such as salmonellosis (caused by S. typimurium or S. enteriditis), ringworm, and similar infections. Certain creatures also carry specific diseases: rates carry Weil’s disease; parrots carry psittacosis, and so on. There are approximately 120 diseases of animals transmissible to man, so this is not a matter to be treated lightly.

Schools which are contemplating keeping animals need to give careful thought to what it is they hope to achieve by this. There can be no doubt that for the majority of children, particularly young children living in cities, there is great educational benefit in being personally responsible for the well-being of another living creature. Benefits may include:

1. Social benefit of pupils, as mentioned above;
2. To give the opportunity to observe a living creature at close quarters;
3. For genetic experiments;
4. For dissection work;
5. For work in animal husbandry;
6. To minimize and many other reasons also spring to mind.

The animal (s) selected for keeping will also need to fulfill certain requirements which can easily be identified. They need to have:

1. a high breeding rate
2. small food consumption;
3. Small physical size (because of limited accommodation); and so on.

Careful planning will point clearly to one or other species of creature and the school should keep strictly to just the one or two types that best suit the school situation and need.

Having decided what species to use, the next question is where to obtain them from. This is not as simple as it seems. Many schools obtain their stock iron local breeders or pet shops. *This is most inadvisable*. Such a stock is almost certain to consist of animals that carry one or other pathogenic organism and a scratch or bite from them can infect pupils.

Stock should always be obtained from a recognized supplier of Specific Pathogen Free (SPF) animals. If these are not accessible, then a local university should be able to offer help and advice, if not an actual supply of acceptable animals.

It is because of the ease with which animals can because infected, that “SPF” stock should not be mixed with domestic animals or pets or, worse still, wild animals. This means that great care should be exercise when allowing students to take animals home and in protecting laboratory animals from casual contact with wild animals: mice, rats, etc.

One of the implications of keeping animals in the laboratory is that no school should contemplate doing so unless they have both adequate living accommodation and holiday care arrangements.

All laboratory animals should be housed in scrupulously clean accommodation. Arrangements should be made for the regular clearing of cages tanks, hutches, etc. and for the hygienic disposal of waste material and bedding.

Careful through needs to be given to the dissection of creatures which have been living in the laboratory. Students can be caused great distress if dissection work is carried out on species that they have previously treated as pets; white mice, rabbits, etc.

Some staff overcomes this problem by importing other specie or dissection work: worms, embalmed rats from suppliers, etc. this is safe enough if done carefully, but the important into the classroom of wild animals for dissection should be forbidden. Many otherwise sensible teachers put their class at risk by brining into the laboratory some animal that has been found dead on the roadside, and then using it for dissection work. Not only are these animals certain to carry some pathogen specific to their species but they may well carry other infections as a result of the carcass having been visited by wild predators period to its remove. Dissection work in any case carries special risks with it and unless staffs have had a great deal of experience in the various techniques used it is something best omitted from the course.

No matter which species are used, schools and colleges will need to face up to the problem of the destruction of the dead material.

There is no doubt that. The best way is. Incineration but in many modern establishments in the U.K. this be becoming increasingly difficult as a result of the move away from solid fuel heating systems. It burning in a large open fire is not practicable, staff have only one other viable alternative, which is deep burial in a part of the school rounds, that will not be, disturbed for at least two years. Any student who is believed to have been exposed to the risk of infection (say, by receiving a cut from a scalpel previously used for dissection, or from having been bitten or scratched by a laboratory animal) should seek medical advice as soon as possible.

The final risk to be mentioned in connection with animals is that of allergies. Many people suffer unknowingly from allergic reactions that are triggered by contact with certain animals, either their fur or skin dust (particularly common with staff in contact with locusts). It pupils or staff are known to have allergic reactions to particular animals, little can be done except to keep them apart. Allergic reactions of staff, would, of course, be one of the deciding factors in the initial provision of laboratory stock.

In the U.K. a number of very useful publications are available offering sound advice regarding the maintenance of laboratory animals and these are also available, through normal channels, in other countries. They include publications by the Universities Federation of Animal Welfare (U.F, A.W.) and the Institute of Animal Technicians (I.A.T.).

**Micro-organisms**

The use of micro-organisms as teaching species is growing rapidly. Their use, in any climate, creates special problems both in terms of use and disposal. No establishment should consider introducing work with micro-organisms in laboratories where the bench tops are old and scored. Such uneven surfaces harbor bacteria and cannot be easily cleaned. Surfaces which are suitable for this kind or work should be such that they can be easily disinfected and in some cases, this could be achieved by covering existing benching with an adhesive plastic top.

Provision must also be made before micro-biological work in begun, for the safe disposal of cultures, tec., once work is completed. A disinfecting solution should be one and (either sodium hypo-chlorite (chlorate (I) or a proprietary disinfectant solution). After cleaning treatment, apparatus should be properly autoclaved prior to re-use. Partly as a result of this need for adequate cleanliness, disposable equipment should be avoided, except for very special purposes. “The temptation to re-use equipment specifically designed as disposable is sometimes too great, but it presents unacceptable hazards if, in its re-use, it has not been adequately sterilized.

Correct procedures in dealing with micro-organisms are vital: disinfected benches; provision for final disposal; avoidance of cultures open to the air; and total avoidance of operations in involving the month (such as pipetting). Staff or pupils with open cuts or sores on exposed areas of skin should either avoid such work or ensure the wound is adequately covered before commencing practical work.

**Plants**

The safest work on living materials in undoubtedly that involving plant material. None the less, certain hazards are present and both pupils and staff should be aware of those plants whose leavers or fruit are poisonous. Always assume an unidentified plant is poisonous until a definite identification proves otherwise.

Even apparently harmless materials, such as commercial grain, can be dangerous if the seed has been treated with a mercurial fungicide. Handling a material such as this can lead to mild mercurial poisoning, either by skin absorption or through ingestion or food contaminated by unwashed hands.

Plants, or rather, their pollen, are another source of allergic reaction and once identified as the cause, particular species would need to be removed from the laboratory.

**Other Hazards Specific to Biological Work**

By the nature of the work, biology makes use of techniques and materials not found in other laboratories and in addition to the general areas of hazard already identified, the following specific materials or operations need to be carefully controlled.

**Insecticides and Pesticides**

Proprietary materials used as pesticides in greenhouses present special hazards especially by absorption through the skin or inhalation. In all cases of use, the manufactures recommended procedure on the container should be followed. In the event of a-student accidentally ingesting any of these materials, it is advisable to extremely toxic herbicide Parquet; it should not be used in schools or colleges.

**Million’s Reagent**

As Millon’s reagent is used regularly in biology laboratories for easy identification of protein material, staff and pupils should be aware that it is, in fact, a solution of mercury (II) ions (mercuric ions) in concentrated nitric (V) concentrated acid) but also that of an insidious poison (the mercury) and the material must be treated with due care.

**Ninhydrin**

The chemical, which is used regularly as a “developing agent with chromatograms of amino acid mixtures, is a respiratory poison, IN common usage, it appears in the form of a spray and the dangers are therefore magnified as a fine mist of the chemical is more easily absorbed by the body. Any use of this chemical should be restricted to situations limiting the hazard/by either using it inside a fume cupboard or, if one is not available, in the open air.

**Osmium (VI II) oxide Solution (Osmic Acid)**

Still used in the biological identification of fatty cells, osmium (VIII) oxide solution (osmic acid), and aqueous solution of osmium (VIII) oxide (osmium tetroxide), can cause irritation to both eyes and skin. Bottles holding this reagent should always be stoppered when not in use – osmium (VIII) oxide (osmium tetroxide) itself being appreciably volatile.

**Stains**

Many of the stains and specialist materials used in the preparation of slides are reagents in solution in alcohol, dimethy benzenes (xylenes), or some other flammable solvent. Great care should be taken in handling even small quantities of such material, especially if the process used involves heating.

**Students as Experimental Species**

Many textbooks now suggest simple experiments involving the use of pupils, for example, in respiration experiments using a spirometer, and in sensory experiments using oliphactory chemicals, etc.

Staff should be very careful when involving pupils in any experiment and ensure that not only are pupils aware of any possible danger, but that they have complete freedom to refuse to participate.

Kymograph experiments may seem innocuous, but for pupils with weak hearts, the experiment can be very dangerous.

Experiments with bacteria such as Serratiamarcescens can be shown to constitute an unacceptable hazard to many pupils, especially those suffering from asthmatic complaints.

**Surplus Apparatus**

A number of schools obtain some material as surpluses from local hospitals, for example, syringes, petri dishes, etc. This is particularly dangerous and no school should accept equipment surplus from another establishment, especially a hospital, unless it can be shown to be new or otherwise totally free of possible infection.

**9.4 Radiation Hazards**

Each year seems to bring more and more items of equipment into the teaching laboratory that only a short while ago were confined to research laboratories. Then years ago, few educational establishments would have needed to concern themselves with the topic of radiation hazards but curriculum changes as well as improvements in equipment design are bringing a novel range of experimental procedures into the hands of most science teachers.

**Radio Active Materials**

In the U.K regulations divide radio- active sources into three distinct categories:

1. The metals uranium thorium potassium and rubidium and their salts;
2. Closed source of other radio-nuclei such as radium or plutonium where a closed source is define as one in which the sample of radio active material is firmly bound to an inert base
3. Open sources loose compounds or solutions of salt containing a radio nuclei say, carbon-14 in the form of a solution of sodium carbonate.

There is no restriction on experiments involving materials of category (a) so long as establishment hold no more than 2kh, do not dispose of more than zoog per day as waste and do not attempt to concentrate or recover radioactive material.

Current U.K. regulations concerning category (b) are that as long as the source is one provided by a recognized supplier and no establishment holds more than a total activity of 30 Curies, then staff using the sources do not need special training though the Department of Education and Science must be informed (details available on A.M.2/76).

Category © is a special case. For schools and colleges to use ‘open’ sources, the staff involved must have attended a Department of Education and Science approved course on radio-activity even though work with radio-active sources may have been part of the teacher’s training or degree work.

All radio-active sources in categories (b) or (c) above should be held in a locked and properly labeled radio-active cupboard or store. Suitable warning sign for displaying such cupboards are available from normal laboratory suppliers. Whenever a school or college wishes to increase (or dispose of) its stock, the Education Authority should always be informed.

**Ultra-violet Radiation**

Ultra-violet lamps are being used widely to aid the detection of certain classes of compounds which fluoresce in ultra-violet light. Whenever a ultra-violet lamp is being used. It should always be properly shielded and eye protection should be ‘worn by those in the immediate vicinity of the work. Excessive exposure of the eyes to this type of radiation causes severe conjunctivitis.

**Lasers**

Small lasers for school and college work have been available for several years and guidance for their safe use has been issued by the U.K. Department of Education and Science in their A.M. 7./70.

The very concentrated pulse of light form a laser, though of short duration can cause very severe eye damage if entry to the eye is direct or by reflection. The following rules should be obeyed whenever work is done with the lasers.

1. Under no circumstances view the laser directly. Do not use a collimating instrument such as a microscope or a telescope when setting up.
2. Never look along the laser beam nor expose any part of the skin to the direct beam.
3. Do not align a laser beam with the power on. Always use optical alignment first.
4. Check that there is no possibility of specular reflection. When such reflection cannot be avoided for example at a lens surface, position. Screens so that neither those under instruction nor the teacher will be exposed to the reflections.
5. Position pupils so that screens are effective and *insist* that these position are maintained.
6. Screens should be made of a non-flammable material be optically opaque, and be painted a matt-grey color.
7. Operate the laser in a room with as high a level of illumination as practicable, thus ensuring that the pupil of the eye is as small as possible. Do not operate in total darkness.
8. Report any accidental exposure or suspicion of exposure at once.
9. Impress on students the dangers of direct viewing and of specular reflection so that in the event of accidental exposure they will react instantly by closing the eye outside the laboratory when a laser is in use so as to warn any visitors to the class. (k) When not in use, lasers should be kept in a secure store and should be accessible to authorized staff only.

**X-ray Sources**

A number of commercial X-ray sources are now available for use in schools and colleges and in the U.K. advice concerning the use of this kind of apparatus (in fact, ay vacuum or discharge tube, used with high voltages, may produce Z-rays) is given in A.M. 2/76 available from the Department of Education and Science.

**9.5 Fire Hazards**

Most books dealing with fires and fire prevention make the point that for a fire to break out three things must be present -these being represented by the mnemonic fire triangle.

**Figure**

This is in some ways an over simplification. A fire will continue so long as these three constituents are present but, for a fire to start 5 a fourth thing is often required, and that could be (a) oversight or forgetfulness; (b) carelessness; or (c) faulty apparatus.

Clearly, a fire is not created simply by distilling ethoxyethance (diethylether) (in which all three elements of the fire triangle are present) 5 a fire may start, however, if (a) 5(b) or (c) are also present. In other words the majority of fires can be prevented by vigilance.

The simplest way of preventing fires is to ensure that if the triangle is present then staff and students. Make sure they are aware of any eventualities that could lead to a fire including the checking beforehand of all equipment to be used.

Unfortunately 5 accidents do occur a heated flask cracks, spilling flammable contents, or a sealed container of flammable liquid slips form the hand near a naked flame.

Staff and students should remember that a fire has one true ally panic A panic reaction, in the event of a fire is always a bad reaction and always worsens the situation. Whatever is done, it must be done with calmness and assurance.

**What to do on discovering a fire?**

1. Quickly and calmly draw everyone’s attention to the situation and organize an orderly exit from the laboratory instructing the leading students to inform nearby classes and the school or college office, so that a general alarm can be raised (or to trigger a general alarm using the fire buttons).
2. Using the power and gas isolators in the laboratory (see Chapter 75 page 39) switch off supplies (but not the water supply at this stage), and shut ALL FIRE DOORS and window, if possible to limit the supply of air to the fire.
3. If the fire is a small one or much localized staff, BUT NOT STUDENTS, might attempt to limit the spread of damage by using the fire extinguishers supplied for the purpose. However, if the fire is a bad one, or one in which noxious fumes are produced all firefighting should be left to trained and competent fire staff.

Steps can be taken in all laboratories to minimize the scale of any possible fire and these should be accepted practice for all staff.

1. Make sure basic fire-fighting equipment is present in every laboratory and that this is checked regularly. Items should include a sand bucket fiberglass fire blanket, and a fire extinguisher of an appropriate variety.
2. The quantity of flammable solvent held in a laboratory should be no more than is required for the experiments in progress at the time.
3. Students should be forbidden to discard any used solvent by tipping it down sinks. Those solvents most likely to be cause of liquid fires are listed in Appendix E, page 61, together with data relating to their flammability.

Small, localized fire caused by burning phosphorus, small quantities of solvent, etc, is best dealt with immediately by staff. No universal procedure can be adopted in the case of science laboratory fires, as the range of materials and their particular burning characteristics are too vast. The best policy for staff to adopt, when planning an experiment, is to be clear in their own mind how best to deal with each flammable material prior to starting the lesson.

It follows, therefore, that no-one should plan a lesson in circus, fashion in which one student may be handling sodium or potassium, while others are using say phosphorus. Clearly, under these circumstances, should fire begin, students and staff may, temporarily, be unsure as to which material it is that is burning (though the voluminous clouds of white smoke form phosphorus usually give a clue.) This uncertainty would fan the flames both of panic and therefore, of the conflagration itself.

There is ion a number of countries recognized code for types of fire determined by the type of material undergoing combustion. This may seem academic initially, but it is very important as it is the type of material actually burning that determines the kind of extinguisher best suited to dealing with it.

**Fire Classification**

The system used until recently in both the U.K. and the U.S.A divided fires into four categories.

**Class A:** Ordinary combustible materials – wood, cloth, paper rubber, plastics, etc. They produce glowing embers or incandesce and are accompanied by destructive distillation.

**Extinguishing Agent**

Cooling and wetting with water or chemically loaded streams of water is the best method. Blanketing with foam will extinguish with fore, but hot embers may re-ignite if exposed to the air.

**Class B:** These involve the heavier petroleum products and other Flammable liquids.

**Extinguishing Agent**

Use of water is rarely effective with Class B fires as the burning agent is probably immiscible with and lighter than, water Flame extinction is achieved by means of blanketing usually by foam, inert gas (carbon dioxide) or solid powder.

**Class C:** Involve energized electrical equipment (motor switch gear, transformers, etc.)

**Extinguishing Agent**

Once the equipment is switched off or otherwise disconnected from the source of electrical power, solid powder or inert gas extinguisher are usually sufficient to deal with this class of fire.

**Class D:** Involve any combustible metals such as magnesium alkali, metals or their hydrides.

**Extinguishing Agent**

On a teaching laboratory scale, metal fires are best dealt with using an excess of DRY sand. Proprietary extinguishing agents which are useful in the case of Class A, B, or C fires, can give rise to considerable hazard in the case of Class D fires.

**Types of Fire Extinguishing**

From what has been said above, it should be clear to all laboratory staff sufficient. Care must be taken to ensure that the laboratory is fitted with an extinguisher appropriate to the potential hazard presented by the work to be done. What kinds are available?

**Sand Buckets**

Every laboratory should have one. A regular check should be made to see that they have not, inadvertently, become contaminated with combustibles, (charcoal, for example) nor been allowed to become damp. If used on a Class D fire (involving say magnesium or potassium metal), the addition of damp sand could have catastrophic results.

**Fire Blankets**

These are valuable in the event of either a localized solvent fire (say, in a sink) or in the event of personnel having clothing on fire. In both cases, they should be used in such a way as to exclude air and so extinguish the flames. Early blankets were always made of asbestos cloth. Not only are these somewhat heavy and inflexible, they also carry with them the small risk of liberating asbestos fibers into the air whenever they are used. The safest variety, for lightness, flexibility, and smothering capacity, are undoubtedly those made form glass fiber.

**Water Extinguishers**

Many laboratories may still possess either a fire bucket holding water or perhaps a water extinguisher (either a carbonate/acid or CO expelled variety) As has been said earlier, these extinguisher rely on the cooling and quenching properties of water for their effectiveness and their use must be limited to Class A fires only. They also cause a great deal of damage themselves either through water staining or in the case of the soda/acid, type, through corrosion from the acid element.

**Foam Extinguishers**

These contain an aqueous, solution of a foaming agent wand whilst there is some slight cooling effect; they act primarily by the exclusion of air from the fire. As the foam is stable and of low density, they can be used on Class A or B fires, though with Class A fires there is sometimes a risk of Re-ignition of glowing embers if the foam is removed before adequate cooling has occurred.

**Carbon Dioxide Extinguishers**

These contain liquid carbon dioxide under pressure. On being released the jet of gas has a slight cooling effect coupled with good air exclusion properties. They have one drawback in that their use can be of only very limited duration. They are the most effective agent for Class B fires and can safely be used on Class A or C fires if these are not too extensive.

One point about these extinguishers, especially if installed in physics laboratories is that they should be checked regularly to see that they have not been used Physics staff sometimes make use of them as a handy source of dry ice for a variety of experiments.

**Vapourizing Liquid Extinguishers**

Though very effective this variety of extinguisher, which relies on delivering a heavy vapor such as tetra chloromethane (carbon tetrachloride) or bromochlorodifluoro methane, should not be used on any enclosed fire such as is often found in a laboratory the vapors can decompose when hot giving rise to irritant and toxic fumes.

**Dry Powder Extinguishers**

These deliver a jet of sodium hydrogen carbonate powder which not only covers a fire with a solid blanket but achieves considerable cooling effect through the endothermic reaction.

2NaHCO Na2 CO3 + H 2O +CO2

which is assisted by the heat of the fire.

The principal drawback with this variety of extinguisher is that besides fire damage the user is faced with a considerable cleaning up operation once these units have been used. They are however, extremely effective in the case of Class A, B and G fires.

In Great Britain the recently published BS4547 (European Standard EN) has altered the classification of fires as detailed above. But for the specialist purposes of science teaching where the range of fire hazards is so wide, staff will find this classification simple and easy to operate when it comes to dealing with fires.

**9.6 First Aid Treatment**

The essential thing to remember about first aid is that it is just that

**First Aid**

First aid is the immediate and temporary care given to the victim of an accident until the services of a qualified medical practitioner can be obtained.

As in the case of dealing with fires a person giving first aid must

1. Avoid panic and (b) inspire confidence.

Again the parallel between giving first aid and dealing with fires is shown in the main objective of first aid- to save life. The course of action for a person giving first aid might conceivably follow the sequence.

1. Separate the victim (s) from the source of the hazard;
2. Prevent any heavy loss of blood;
3. Maintain breathing
4. Deal with burns, chemical or otherwise;
5. Prevent shock’
6. deal with localized injuries, e.g. to the eye.

It is essential that in the event of an injury requiring any of these treatments, action is initiated immediately to obtain the services of a medical practitioner. The advice that follows is not more than could be expected of untrained staff in an emergency. It is obvious, therefore, that there is much to be said for all laboratory staff having received some basic training in modern first aid methods.

**Dealing with a heavy loss of blood**

A heavy loss of blood can kill in as little as four minutes and results from wounds close to large blood vessels. No time should be lost in dealing with such a blood flow. Pressure must be applied directly over the site of bleeding, preferably by means of a clean pad of cloth, a handkerchief, or simply with bare hands.

The patient should be kept in a prone position and if possible the wound (in an arm or leg, say) raised above the general level of the body. I broke bones are suspected however; the patient should not be moved.

**Do not apply a tourniquet**

Once bleeding has been checked begin dealing with the other needs of the victim and simultaneously, call for expert medical help.

**Breathing**

In the majority of accidents in teaching laboratories breathing has generally been affected by fumes and gases, and has rarely stopped entirely. Without doubt, the best form of artificial respiration is that given mouth to mouth which is performed as follows.

1. Lay the victim on his or her back.
2. Put one hand under the beck and the other hand on the forehead of the victim and tilt the head back so that the chin is raised up. (This prevents the tongue blocking the air passage)
3. Block the victim’s nostrils by pinching with the fingers. (Once the head is tilted back. The hand on the forehead can be removed.)
4. Breathe in deeply, closed your own lips around the victim’s mouth, and blow into his lungs until his chest is seen to rise.
5. Remove your mouth and allow the victim’s chest to fall.
6. Take another deep breath and repeat until skilled medical help is available. In the case of breathing affected by fumes, remove the victim to the fresh air and instruct them to breathe deeply. If no immediate relief is obtained breathing in the fumes of bench strength ammonia solution is often helpful.

**Burns Heat Burns**

As soon as possible, heat burns should be cooled- preferably by immersion in cold water. Oils and creams must not be applied during the early stage of treatment.

If the victim has clothing on fire, they must be put in a horizontal position and rolled in a fire blanket to smother the flames. Once the flames have been extinguished, outer layers of clothing can be removed to assess skin damage. If charring is such that clothing has stuck to the skin it must not be removed. Once cooled, minor burns and scalds can be given an antiseptic dressing but more serious cases must be left to a medial practitioner.

**Chemical Burns**

With the exception of one class of burns, chemical burns must initially at least, be treated as heat burns, that is they must be well irrigated with water. The exception of course, is the case of a pupil receiving a burn from molten sodium, potassium, etc. and there the first step must be to remove adhering metal prior to irrigation with water.

A number of materials cause such serious chemical burns to the skin and their antidotes are listed separately below.

Treatment of skin contact with”

1. Bromine, Causes severe blistering and discoloration on the skin after only a very short contact.

Best treatment initially is by washing with bench strength ammonia solution followed by copious quantities of water.

1. Phenol, Causes whitening of the skin followed by painful burns. After initial dousing with water immerse in propane-1,2,3, trial (glycerol0 and dab affected area for five or six minutes. Then continue washing in water.
2. Phosphorus (white). Causes heat burns to the skin in a very short time, body heat igniting the material after only a few seconds.

Immerse the affected area in water (or cover with a damp sponge or cloth). If possible, remove any visible particles with tweezers. Then wash for 20 minutes with a 3% solution of copper (II) sulphate in water. Finally wash with more water.

1. Potassium, metal. In contact with the moisture of the ski, this metal will cause severe caustic and heat burns. First remove any visible particles of metal and then Immerse the affected area under water or cover with a soaking wet cloth (this will ignite any small particles but a bulk of water will not only minimize heat generated, it will dilute the caustic potassium hydroxide formed).
2. Sodium metal. Deal with as for potassium-above.
3. Sodium hydroxide. The solid material (or very strong solution of it) causes very rapid deterioration of the skin leading to irritation and septic sores. Wash with copious quantities of water and finally with a weak solution of ethanoic (acetic) acid.
4. Sulphuric acid (concentrated). Very quickly dehydrates the skin causing blackening and blistering leading to dermatitis. Wash with copious quantities of water and finally with a magnesium oxide/water paste.

**Shock**

Shock occurs in almost every case of physical injury or fight. In fact, a person who has splashed themselves with, say, concentrated sulphuric acid, may be in more danger from the effects of shock (once the acid has been dealt with) than from the after effects of the acid itself.

A state of shock is indicated when the victim has a cold or clammy skin, trembling, faintness, pallid skin or blurred vision, and often, vomiting.

Protect the person concentrated against cold or draughts, by wrapping them in warm blankets or clothing, but do not heat them by exposure to electric fires, etc. Quite often, the worst effects of shock can be overcome by;

1. Giving calm assurances that all is well
2. Keeping the victim still, either lying down or, if not too serious, seated;
3. Giving a small quantity of a warm, sweet beverage, tea, coffee, etc. (but not if the victim is unconscious or is suspected of having sustained internal injuries).

**Localized Injuries the Eyes**

Because sustaining injury to the eyes is more dangerous, in the long term, than skin damage, their treatment in cases of accident must be considered as a special case. In any case all students and staff working in laboratories where there is the chance of solid practices or chemicals entering the eyes must be afforded eye protection, either by the use of eye goggles or, better still, by face guards.

Eye goggles reduce peripheral vision. Also, if the wearer is involved in an accident that throws material in their face, their instinctive reaction is to tear off the goggles, thus providing an opportunity for any material resting on their forehead above the goggles to enter the eyes, defeating the whole object of the goggles.

Even trivial circumstances can lead to foreign matter entering the eye, some examples of which have been mentioned earlier in this book pouring liquids out of Winchester Quart bottles, for example, or heating magnate (VII) (permanganate) crystals, either in an open dish or in a boiling tube.

No staff would knowingly take risks with either their eyes or with the eyes of their students. Even so, the occasion may arise where a pupil has ignored the warnings of their teacher and material has entered their eyes. With such a delicate organ, which unlike the skin may heal in such a way as to limit its further use, both speed and great care are required in the event of an accident.

Without exception the first and only treatment is to bathe in large quantities of water whilst the services of la skilled medical practitioner are sent for. It is not generally realized that the most dangerous materials which commonly enter the eye are caustic rather than acidic ones. Acids tend to precipitate out a protective barrier of protein from eye tissue and this tends to limit further penetration. This is not the case with strong alkalis and the damage caused by these materials can become progressively worse for several days after the actual accident.

Remember, it is easier to prevent damage to the eye than to treat it once it has happened.

**The Heat: Concussion**

Any case of concussion must be seen by a qualified nurse or medical practitioner. The victim should immediately be allowed to sit out of the way of draughts and be given a warm, sweet drink.

**Individual Susceptibilities**

In any large school or college, there will be a small number of students who have specific susceptibilities that make them a danger to themselves in laboratories. Under this heading must come conditions such as color blindness, hemophilia, epilepsy, and allergic reactions?

Staff should ensure that, if any of the above conditions are known to exist in students, then all members of the teaching and laboratory staff must be informed.

**Color Blindness**

This can lead to danger if the inability to detect a color change means the student overlooks an early warning of a reaction becoming too hot or proceeding too quickly.

**Hemophilia**

This does not present a hazard in itself but clearly, for any student known to be suffering from this disease, staff must take special precautions to limit the likelihood of cutting or scratching the skin.

**Allergic Reactions**

Students can be allergic to a wide range of materials without being aware of it until they first handle say, Lycopodium powder or some other finally divided soils. Allergy to airborne particles is signified by the victim complaining of headaches or of nasal pain, usually accompanied by copious watering or swelling of the eyes. Medical attentions should be sought immediately.

Allergy to liquids is less common, but a victim might show an unusually fast swelling or reddening of the affected area. Again medical advice should be sought, once surplus irritant liquid has been removed with water.

The most common allergic reaction is that towards animals and to their skin dust in particular.

Once a specific allergy has been identified in a student, every precaution should be taken to prevent accidental contact with the material giving rise to the allergy.

**Epilepsy**

To anyone who has not witnessed an epileptic attack, this can be a frightening experience. Make sure the victim of such an attack is gently moved way from equipment or apparatus that could do him harm, and, without restraining the violent motions of the person having the attack, prevent them from striking themselves, particularly the head, on any sharp objects. Attacks rarely last more than a few minutes (if they do, medical advice should be sought as to the advisability of the person concerned doing work in a laboratory) and, once calmed, the victim should be left quiet, with warm covering.

**Self Assessment Questions**

Q.1: What are general laboratory safety methods.

Q.2: Identify Chemical hazards in laboratory.

Q.3: Identify Biological hazards in laboratory.

Q.4: Identify Fire hazards in laboratory.

Q.5: Identify Radiation hazards in laboratory.

Q.6: Describe different first aid techniques during laboratory work.

 Chemical and Biological hazards in laboratory/ Unit 9