SCIENCEMADNESS.ORG - THE AMATEUR EXPERIMENTER'S GUIDE TO LABORATORY SAFETY by Hexavalent

A complete and comprehensive safety guide for the practicing amateur chemist, featuring discussions on Personal Protective Equipment (PPE), mechanical safety devices and general lab practices.

The techniques used in modern chemistry in all fields of research, from physical to synthetic organic to preparative inorganic, often demand the handling of hazardous chemicals, equipment and other supplies which can cause fatal injury or death if misused. Thus, the necessity of laboratory safety is highlighted and many an amateur experimenter has been admitted to hospital with serious injuries or have even died due to the careless handling of their chemicals and supplies. In this article, we will discuss the types of safety equipment used in laboratories, their usage, why they are needed, as well as what must be done in the event of an accident and general lab practices that supplement safety and significantly reduce the possibility for the latter to happen.

The primary aspect of laboratory safety is Personal Protective Equipment, or PPE. There are five main aspects of this section, namely protective eye/facewear, protective gloves, protective clothing, respiratory protection and hearing protection. We shall initially discuss eyewear, perhaps one of the most important aspects, as the eyes are very sensitive to foreign materials and debris. It is here, before and further discussions, it should be noted that contact lenses are usually forbidden in laboratories, as vapours, mists and corrosive liquids can often 'weld' them to the surface of the eye, potentially seriously damaging the latter and hindering irrigation if a chemical is splashed into the eyes. Thus, they should be removed before entering work areas and replaced, if absolutely necessary, with prescription spectacles. However, the most most common type of protective eyewear to protect the eyes in the event of a splash is the popular safety glasses, seen below, and many different models exist—standard versions, those that are designed to fit over prescription spectacles, brand-name glasses and so forth. The lenses are usually made from polycarbonate plastic, due to its high impact resistance, and glasses are often favourited as they are light on the face and thus more pleasurable to wear for extended periods of time.

Many modern models are also available, which reduce the 'bulky' feeling to an even greater extent. Presciption safety glasses, which essentially combine the adjustments required for the correction of an individual's vision and a safety device, are also widely available, in addition to simple clip-on shields for normal glasses, but these may be expensive.

However, safety glasses are often diapproved by many chemists, many of them working in the professional and/or industrial fields, mainly as they do not seal completely to the face, thus potentially exposing the eyes to harmful materials—a fateful accident involving deuterated chloroform that rendered a student partially blind was once observed, when she incorrectly filled a chromatography setup with the aforementioned solvent, causing pressure to build up, a minor explosion, and the solvent seeping in through the gap where the safety glasses met her forehead. In this situation, safety goggles, which essentially provide a complete seal around the eyes, would have significantly reduced the chances of her being injured. However, even with these special care must still be taken to select the correct type; many goggles sold, for example, in hardware stores contain rows of tiny holes poked in the sides for ventilation (see below) that make them unsuitable for laboratory use. These goggles are designed to protect against impact hazards, such as using a grinder or other power tools, not for resisting against splashed liquids; they can simply run through the holes and into the eye cavity area. Therefore, models featuring 'cap vents', as shown in the blue goggles on the left, should be purchased; they still allow for adequate ventilation, to reduce fogging up of the goggles, but due to their design do not allow liquids to pass through. These goggles are sometimes carried locally, but often enough the best location for purchasement is on the internet, notably from websites such as www.eBay.com where they are available inexpensively, often in packs of two which is convenient as a spare or for lab assistants, and in multitudes of colours for personal preference.

Another form of PPE that protects the eye and face area is the increasingly-popular face shield. The visors of these are made from polycarbonate too, and may sometimes feature a metal band around them for additional support. They can be invaluable when running reactions which are very hazardous, such as preparing bromine or handling compounds such as explosives and pyrophorics, extreme corrosives, or water reactives etc. or apparatus under pressure or vacuum as they protect the entire face and often the neck. It should be noted, however, that face shields are a supplement to safety glasses or goggles, and NOT a replacement. Their use in laboratories is invaluable, but splashed liquids, particularly from the sides, can occasionally hit the eyes. The mechanism on which they operate can sometimes also make users forget to put it down when close to their reactions or apparatus, and it is sadly often enough during these times that such accidents happen. It is therefore imperative to wear safety glasses or goggles at all times, regardless of any other PPE being worn or what chemicals are actually being handled; you making up a saturated brine solution may not be particularly hazardous, but what if the person next to you handling, say, a poison or a corrosive spilt their media, or a bottle fell off the shelf in front of you, throwing chemicals everywhere?? It is better have the basic safety measures in place and not need them than need them and not have them.

However, even when PPE is worn accidents, although their chances of happening are massively reduced, can still happen, either because the chemist was not using the item correctly, it failed etc. In this instance, if a chemical is splashed in one's eye, the first priority should be immediate irrigation of the affected eye. Sterilised saline eye washes are often availably inexpensively online or at specialist pharmacies, and should be the first choice in the event of an accident. If they are not available, or they run out, the next best option is irrigation using cold tap water. The tap should be turned on to a medium setting, and the eye, held open, placed gently under the stream, with the contaminated exit water going away from the user. Whilst this is happening, another person should dial the appropriate number for the emergency services to get medical aid. Flushing of the eye should be continued for at least fifteen minutes or until help arrives, longer if possible in the presence of strong alkalis. Infact, strong acids in the eye often do less damage as the acid precipitates a protein barrier that helps resist further attack, whilst this effect is not obtained with strong, concentrated alkalis. Toxic or otherwise hazardous chemicals should be treated in the same manner, irrigating for fifteen minutes at the least or until help arrives. It should be noted, however, that under no circumstances should you attempt to neutralize or otherwise react away a particularly potent chemical, e.g. If HCl (aq) is splashed in the eye, the dripping of even sodium bicarbonate or very dilute hydroxide in the eye could cause even further damage and thus the only materials to enter the eye after an accident are sterile saline eye wash solution or water. If an ambulance is probably not necessary, a second person should usually take the victim to the hospital him/herself just to be certain of no residual damage.

The next section of PPE that we shall discuss it protective gloves. Many different types of gloves exist, but the two most common in labs are disposable ones and re-usable ones. The disposable ones come in many different types, but the most common are latex, nitrile and vinyl. All are available in many different colours, but traditionally latex were white/cream, nitrile blue and vinyl transparent—this system was employed to help professionals quickly determine what type of gloving material was most appropriate, particularly in medical situations such as in hospitals. Such gloves are widely available for variying prices online or in pharmacies or drugstores. All three materials are acceptable in a lab, but nitrile generally has greater chemical resistance than the other two—although you should check any specific incompatibilities before working, as, for example, concentrated nitric acid can set nitrile gloves on fire. Latex obviously has the diadvantage of having allergy issues associated with it, and thus the author of this document recommends, if your budget permits, to invest in a box of vinyl gloves and a box of nitrile gloves. Huge compatibility tables for gloving materials are widely available on the internet, and can easily be printed with several pages on a sheet to fit into your lab binder for easy reference. However, no glove will protect you forever. Many individuals are lulled into a false sense of security when wearing disposable gloves, when in reality all they are are a temporary barrier between your skin and the chemicals being handled. Thus, they should be replaced any time a cut or fair chemical damage is observed, and removed in the following fashion to avoid contacting the remains of chemicals on the glove; firstly, take your left hand and pinch the right glove 2cm before its cuff. Slide if off backwards off the fingers, and then screw it up and place it into the still-gloved left hand. Then, take your right hand, and insert 2 fingers down the cuff into the glove, and pull backwards again, over the fingers and the other glove held in the hand. This way, no exposure the the surface of the glove is sustained and the waste gloves are easily disposed of as one small ball in regular trash, wrapped up in some cling film if extremely dirty.

The next aspect that we shall focus upon is protective clothing. There are several guidelines on how to dress appropriately for working in the laboraotory