

Physics 3330 - Safety in the Laboratory

A laboratory should not be a dangerous place. Usually only a small amount of effort is needed to make your time in the lab as safe as the time you spend at home. Common laboratory hazards include electrical shock and fire, wet chemicals and their vapors, dry chemicals, power tools, lasers, compressed gases, vacuum, radioactivity, exposed belts and pulleys, electromagnetic radiation, and cryogenic liquids.

In this section we cover general safety precautions and electrical safety. You might be exposed to other hazards depending on the project you choose. If you feel you are exposed to a hazard that you do not fully understand, stop what you are doing and ask your instructor.

GENERAL PRECAUTIONS

Never work with any hazard that you do not understand.

Never work in a laboratory alone. This can sometimes be a very frustrating constraint.

Always wear eye protection when using power tools or handling chemicals.

Never use any chemical if you are not aware of the hazards it presents.

Never use any chemical that you do not know how to dispose of.

Keep your work area neat and uncluttered.

Keep all electrical cables off of floors and away from traffic.

Know where fire extinguishers and exits are located.

In case of any emergency, call 911, and notify an instructor if possible.

Never bring food or drinks into a laboratory.

ELECTRICAL SAFETY

Electrical equipment and circuits are a major hazard in the lab. You must read this entire section during the first week of the lab.

The chief sources of electric power in the lab are the 110 V ac power outlets in the walls, extension cords and consoles and the dc power units with up to 50 Volts between their terminals. Much higher voltages occur inside some instruments, but these are generally not exposed. Do not stick your fingers or conducting objects inside an instrument when the power is on.

It is the current that passes through your body that is dangerous. The voltage required to produce a dangerous current depends, by Ohm's law, on your body resistance. The damage it does to you depends on the current path through your body. The danger is much greater for a current that enters one hand, passes through your body, and exits by the other hand, than for a current that passes between two fingers of the same hand. Therefore, keep one hand behind your back if you ever work on a hazardous electrical system.

Shock is relatively more severe as the current rises. At values as low as 20 mA, breathing becomes labored, finally ceasing completely at about 75 mA. As the current approaches 100 mA, ventricular fibrillation of the heart occurs -- an uncoordinated twitching of the

walls of the heart's ventricles. Above 200 mA, the muscular contractions are so severe that the heart is forcibly clamped during the shock. This clamping protects the heart from going into ventricular fibrillation, and the victim's chances for survival are better. Immediate first aid is crucial, so call 911 immediately if you suspect someone has been shocked

The internal resistance of your body (right hand to left hand, or hand to leg) is typically 500 Ω . In series with this is the surface resistance of your skin, which varies from 1000 Ω when moist to over 100 k Ω when dry. Thus a voltage as low as 50 V can potentially produce a hazardous current if your hands are wet.

Never work with electrical equipment if your hands or clothing are wet. Dry yourself thoroughly before you start work. Note that when you are hot the perspiration on your hands increases the hazard.

Be sure the power is off before touching a helpless person.

The Fatal Current

(Reprinted through the courtesy of Fluid Controls Company, University of California, Safer Oregon)

Strange as it may seem, most fatal electric shocks happen to people who should know better. Here are some electro-medical facts that should make you think twice before taking that last chance.

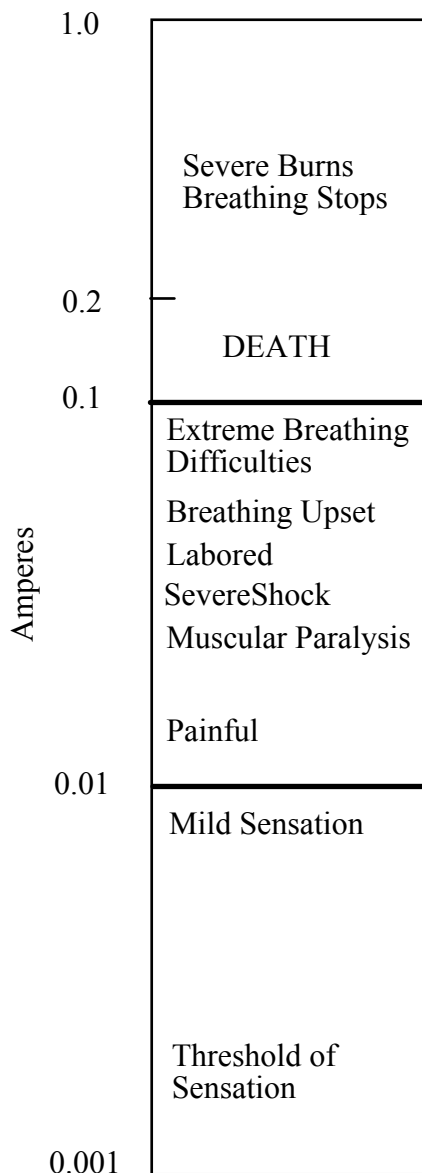
IT'S THE CURRENT THAT KILLS

Offhand it would seem that a shock of 10,000 V would be more deadly than 100 V. But this is not so! Individuals have been electrocuted by appliances using ordinary house currents of 110 V and by electrical apparatus in industry using as little as 42 V direct current. The real measure of shock's intensity lies in the amount of current (amperes) forced through the body, and not the voltage. Any electrical device used on a house wiring circuit can, under certain conditions, transmit a fatal current.

While any amount of current over 10 mA is capable of producing painful to severe shock, currents between 100 and 200 mA are lethal.

Currents above 200 mA, while producing severe burns and unconsciousness, do not usually cause death if the victim is given immediate attention. Resuscitation, consisting of artificial respiration, will usually revive the victim.

From a practical viewpoint, after a person is knocked out by an electrical shock it is impossible to tell how much current passed through the vital organs of their body. Artificial respiration must be applied immediately if breathing has stopped.



Physiological Effects of Electrical Currents

DANGER -- LOW VOLTAGE!

It is common knowledge that victims of high-voltage shock usually respond to artificial respiration more readily than the victims of low-voltage shock. The reason may be the merciful clamping of the heart, owing to the high current densities associated with high voltages. However, lest these details be misinterpreted, the only reasonable conclusion that can be drawn is that 75 V are just as lethal as 750 V.

The actual resistance of the body varies depending upon the points of contact and the skin condition (moist or dry). Between the ears, for example, the internal resistance (less than skin resistance) is only 100 Ω , while from hand to foot it is closer to 500 Ω . The skin resistance may vary from 1000 Ω for wet skin to over 500,000 Ω for dry skin.

When working around potentially hazardous electrical equipment, move slowly. Make sure your feet are firmly placed for good balance. Don't lunge after falling tools. Kill all power, and ground all high-voltage points before touching wiring. Make sure that power cannot be accidentally restored. Do not work on ungrounded equipment.

Don't examine live equipment when mentally or physically fatigued. Keep one hand in your pocket while investigating live electrical equipment.

Above all, do not touch electrical equipment while standing on metal floors, damp concrete or other well grounded surfaces. Do not handle electrical equipment while wearing damp clothing (particularly wet shoes) or while skin surfaces are damp.

Do not work alone! Remember, the more you know about electrical equipment, the more heedless you're apt to become. Don't take unnecessary risks.

WHAT TO DO FOR VICTIMS

Cut voltage and/or remove victim from contact as quickly as possible -- but without endangering your own safety. Use a length of dry wood, rope, blanket, etc., to pry or pull the victim loose. Don't waste valuable time looking for the power switch. The resistance of the victim's contact decreases with time. The fatal 100 to 200 mA level may be reached if action is delayed.

If the victim is unconscious and has stopped breathing, start artificial respiration at once. Do not stop resuscitation until medical authority pronounces the victim beyond help. It may take as long as eight hours to revive the patient. There may be no pulse and a condition similar to rigor mortis may be present; however these are the manifestations of shock and are not an indication the victim has succumbed.