CERTIFICATION QUESTIONS/WITH ANSWERS

1. One of the major hazards which face a laboratory chemist is that of fires. It is necessary that each worker know the location of fire extinguishers and fire alarm pull stations. It is also very important to know the types of fire for which various commercial extinguishers are designed. There are four general classes of fires which are likely to pose a genuine threat to your laboratory safety. List each of the classes of fires and the type of extinguisher which would be required to put out the fire.

ANSWER:

Class A Fires: Ordinary combustible solids: paper, rubber, textiles. Frequently accompanied by destructive distillation producing flaming vapors or toxic gases. Also may leave hot ash or residue capable of re-ignition. Effectively extinguished by water which is recommended if the water would pose no further hazard. Also extinguished by CO_2, N_2, volatile halocarbons (CF_3Br, etc.) and dry chemical extinguishers though these may lead to spreading ashes due to rapid release of compressed gas from the extinguisher cylinder. Dry ice will usually rapidly smother these fires if it is rapidly at hand.

Class B Fires: Involves flammable liquids. Spreading of the fires is a major complication which is commonly encountered if the vessel of flaming liquid is overturned or broken. Easily extinguished by the exclusion of air by covering if in an upright vessel or by blanketing in foam, CO_2, N_2, volatile halocarbons or sometimes dry chemical (depending on the situation). Again, dry ice or liq. N_2 is very effective if it is at hand. Compressed gas extinguishers can lead to spreading and worsening of the fire if the force from the extinguisher overturns a

vessel containing a flammable liquid.
Class C Fires: These are Type A or B fires in which electrical equipment is involved. Can be treated as class A or B if the power is turned off. It is a better practice never to use water as an extinguisher, even in the event power is disabled (some electrical equipment will store charge). If the power cannot be turned off the fire must be extinguished with inert gas or dry chemicals. Again, dry ice or liq. N_2 is very effective if available.
Class D Fires: These fires involve reactive metals (e.g., Li, Na, K, Zn, Al, Mg, etc.) or active hydrides (NaH, KN, $LiAlH_4$, etc.). These fires cannot be extinguished by CO_2 or H_2O) or volatile hydrocarbons. Inert powder must be used (sand, talc, or alkali metal salts). Bicarbonate base extinguishers may not be effective. Metal-X extinguishers are recommended.

2. Chemical hazards are also a problem in the laboratory and it is important to know the hazards you might encounter in a lab. If you are working with a chemical and you do not know the hazards associated with it, you should ask your supervisor or consult the references listed at the beginning of the quiz. Name some common hazards associated with chemicals.
ANSWER:

- Common chemical hazards include:
- Fire hazards
- Explosions hazards
- Extremely toxic chemicals

- Lachrymators (substances that irritate the eyes and produce tears)
- Vesicants (substances that can blister and burn body tissues by contact with the skin or inhalation)
- Carcinogens (substances that produce cancer)

3. Explain the problems which may be associated with wearing contact lenses in a chemical laboratory.

ANSWER:

- If chemicals should enter the eye, these can be held against the eyeball and not washed free due to contact coverage.
- Soft contacts will often absorb organic vapors like MeOH, $CHCl_3$ or serious lachrymators. If you should be unconscious after a laboratory accident, the people attending you may not know that you wear contacts and may not be able to tell easily of the lenses are displaced to the side of your eye so that serious damage could result.
- Contacts should never be worn in the lab and should be replaced by corrective glasses made of impact resistant material and equipped with solid side shields.

The chemistry department has contracted with a local optical concern to provide, free of charge, prescription safety glasses for graduate research students. To participate in this safety eyewear program, contact the departmental administrative assistant for information and appropriate forms.

4. What does the fire alarm sound like and what is its function?
ANSWER:
These alarms are loud clanging bells throughout the building. They call the University Police Department and alert occupants to leave the building.

5. In the event of a fire, chemical spill or other emergency, appropriate safety equipment should be easily accessible and an emergency response plan initiated. What are appropriate circumstances for using fire fighting equipment and indicate an initial response plan that you should follow?
ANSWER:
Lab personnel should attempt to put out only small fires when they are confident the fires can be extinguished rapidly and when they themselves are not endangered. They should then notify the University Police Department and Chemistry Department Safety Committee to report the fire and use of equipment. In the case of large fires, you should immediately call the Police at 911 or use one of the hallway emergency response telephones, activate a fire alarm to evacuate the building and meet the firefighters at the building entrance (by the receiving dock) to direct them to the fire. A similar initial response plan should be instituted for large chemical spills.

6. In the event of an accident, health-related or other emergency, appropriate first aid and an emergency response plan should be initiated. What are appropriate circumstances for using first-aid equipment and an initial response plan that you should follow?

ANSWER:
First aid should be administered, if possible, to a person who is injured or ill to prevent death or further injury until professional medical help arrives, only if this poses no threat to yourself. This includes removal of the victim from the source of the injury and control of life-threatening conditions such as bleeding or shock and lack of breathing or heartbeat. In the case of an accident or emergency health problems you should immediately call University Police at 911 or use one of the hallway emergency response telephones, and meet the emergency personnel at the building entrance (or by the receiving dock) to direct them to the emergency.

7. The fume hoods in the labs are designed to operate in conjunction with the ventilation system for the building. The hood doors should always be kept at the appropriate level when you are not actively working in the hood area. (Under no circumstances should the hood doors be removed.) This will aid in the proper ventilation of the building and help prevent contaminated air from re-entering the lab. The hoods should always be on, but in the case of certain types of fires the hood may actually serve to fan the fire making it difficult to extinguish. One cutoff for each hood is located in the penthouse service area but there is no cutoff in your lab area. In the event of a fire emergency, how should you leave your hood area and how should the hood sash be positioned?
ANSWER:
If possible you should pull the hood sash to the closed position before leaving you lab area.

8. Sometimes it may become necessary to turn off the electrical power in a lab due to the development of hazardous conditions. Each lab area has an EP (Electrical Panel) for circuit breaker boxes. You should familiarize yourself with the location of the circuit breaker box for your lab area. You should know the location and scope of the electrical cutoffs available for your lab. What type of cutoffs are available?

ANSWER:

A complete lab module is controlled by circuit breaker boxes located in or near your lab. This is a three-phase 208-volt box which draws from a vertical main line which is clearly visible in the box. On the vertical main line there may be a main switch that will completely disable all circuits in a given lab. This switch should only be used in extreme emergencies since it will also affect other workers in your lab area. The breaker box itself should be labeled as to the specific function of each breaker and you should verify these labels before you ever begin work.

9. One hazard often faced in modern chemical labs is that of electrocution. Electrical equipment should always be maintained in good condition. Replacement of frayed or damaged electrical cords is a must and all equipment should possess proper electrical grounds. The bench area outlets pose a particularly serious hazard -- explain.

ANSWER:

These circuits are controlled by several breakers in the nearby circuit boxes so that two adjacent outlets will be taken from different legs of the three-phase supply. Thus it would be possible to gain electrical potentials as high as 208 volts. Frayed electrical wires could easily cause a very dangerous exposure to high voltage.

10. The storage of solvents in a chemical laboratory may pose a serious hazard to the safety of the laboratory personnel. Waste solvent collected in the lab should be properly labeled, tightly capped and should regularly be removed from the laboratory area for disposal. Solvents used and reused in large quantities must be adequately stored in nonbreakable containers (fireproof if the solvents are flammable) and under no circumstances should multiple (more than one) glass gallon containers be used for solvent storage in a single aisle. There is also a 10-gallon upper limit for flammable solvent storage in a lab. The department of Environmental Health and Safety has a regular solvent disposal system. Solvents for disposal are best stored if the containers used are fireproof cans or polyethylene jerricans, and are closed and properly tagged or labeled. Outline the reasons for use of these types of containers and the solvents which should be kept in each.

ANSWER:

- The fireproof cans should be used with flammable non-corrosive solvents such as ether, hexane, toluene and alcohol. These solvents will not lead to corrosion of the metal can and thus leakage, but the can will provide protection in the event of a fire, as will an approved polyethylene FLAMMABLES can.
- The polyethylene jerricans are also used for corrosive nonflammable solvents. These could be strong acid solvents or solvents likely to contain acids which do not pose a serious fire hazard. Methylene chloride, chloroform and acetic acid are

examples. The polyethylene containers will provide protection from corrosion from the solvents with no danger of breakage.

11. Broken glassware poses a serious threat to your laboratory safety. Frequently, people are cut by broken drip tips on funnels or by glass tubing which has not been fire polished. What precautions should you take in this regard?

ANSWER:

Broken glassware must be repaired immediately so that there are no exposed sharp edges. When cleaning up broken glassware be sure to use protective leather gloves. In some cases broken glassware should never be handled directly (e.g., a broken flask which contained ethanolic KCN). Such equipment should be cautiously swept into a dustpan or similar equipment. A clean and neat bench reduces the likelihood of breakage. Unusable broken glassware or pipettes should be collected in a labeled glass waste disposal box. When full, notify your maintenance cleaning person for disposal.

12. Due to the building's ventilation system, the internal pressure of the building is less than the outside pressure. Since the drainage system is vented to the atmosphere on the roof, it is easy for odors and noxious gases to be swept back into your lab through open sinks and floor drains. How can this be avoided?

ANSWER:

Keep all sink traps filled with water and regularly check infrequently used floor drains and cup sinks. Do not pour noxious substances with high vapor pressure down the drains (solutions of H_2S, mercaptans or

HCN, for example). Add a bit of mineral oil to unused sinks. The layer of oil will retard evaporation of water in the traps.

13. Food in a chemical area is a most serious violation of safe laboratory practice. Outline the problems and steps to avoid this difficulty.

ANSWER:

Eating, drinking and smoking are never allowed in a chemical area as accidental ingestion of dangerous chemicals can result from contamination by airborne dust, unclean surfaces and vapors which may be harmful if inhaled through cigarette (CH_2Cl_2 is normally not a serious hazard but will generate phosgene and HCl with the aid of a cigarette). Areas where food is to be consumed or stored must be clearly labeled as non-chemical areas and laboratory reagents and chemicals kept clear of this space. Eating in the laboratory is not allowed and food should never be stored in a chemical refrigerator.

14. Question 3 illustrates some of the problems associated with wearing contact lenses in the laboratory. All personnel in a laboratory are required to wear eye protection by University policy and state law. Extra safety glasses must be available for visitors to your lab. Outline the types of eye protection you may need to use in a laboratory.

ANSWERS:

Minimally, safety glasses made of impact resistant material with solid side shields are to be worn by all personnel in a lab. As the danger of exposure increases you should increase your protection -- for example, goggles are required when splashes of dangerous chemicals are likely, and special glasses and goggles should be in use with lasers and other radiation emitting equipment. A complete face shield should be used in particularly hazardous procedures (e.g., the generation of diazomethane).

15. To keep the air circulation in your hood working properly and to reduce the chance of initiating dangerous electrical fires in your hood, the hoods have been designed to allow routing of cords and cables in a special way. What features are available?
ANSWER:
Wires, cords or tubes should not be routed between the doors or out either side of the hood face. There is a flap at the front of each hood which is designed for the passage of wire or cords which will not alter the air flow. The shelf under your hood is the proper place for Variacs and other non-explosion proof electrical control equipment.

16. In the event of a laboratory accident, what sources of help will always be available?
ANSWER:
The University Police Department is available to assist in emergencies 24 hours/day by dialing 911 from any University phone. The University Police dispatcher will contact the most appropriate emergency response personnel and send them to your aid. When using this number, it is always important to let the emergency dispatcher hang up first. This will verify that the dispatcher has all the necessary information.

17. Unlabeled chemicals are a very dangerous hazard in the lab. Labels should always be securely placed on stored chemicals. Even if you think you can remember, don't trust your memory -- something could happen to you to prevent you from identifying these materials. Also, we have no mechanism for disposing of unknown chemicals (current regulation of the U.S. Environmental Protection Agency makes it illegal to dispose of any unknown chemicals), so someone will have to identify the chemical before it is disposed of. Identification may be difficult, dangerous, and expensive. If you find unlabeled chemicals in your laboratory, how should you treat them?

ANSWER:

They should be disposed of properly and promptly and not stored indefinitely as frequently happens in refrigerators. Identify the chemical to the best of your ability (consult your co-workers and research adviser as a first step). Particular hazards should be noted on the label (explosive, pyrophoric, highly toxic, etc.). The material should then be taken to the hazardous waste collection site.

18. The clothing you wear in the laboratory is a factor which will influence your safety. Outline the do's and don'ts of the clothing worn in a chemical laboratory.

ANSWER:

- Loose clothing should not be worn since it may be accidentally exposed to chemical contact or become caught in machinery. It also presents a greater fire hazard. Long hair can also be a problem by easily catching fire or becoming entangled in equipment. Skimpy clothing will offer little protection in the event of a chemical spill or splash. Shoes must be worn at all times. Perforated shoes or sandals should not be worn in lab. Further information is available in Prudent Practices, p. 158.

- Synthetic clothing material (i.e. nylon, dacron, etc.) should not be worn since it will “melt” upon contact with acid and some chemicals. The “melted” synthetic fabric and chemicals trapped in it could adhere to the skin and are likely to increase the severity of the chemical burns.

19. Gloves are another form of personal protection which you are likely to need in a chemical laboratory. Outline the major classes of gloves and their usage.

ANSWER:

- Leather gloves - for handling broken glassware or glassware or glassware under strain (pressure vessels, tubing being inserted into stoppers, etc.). They do not provide protection from chemicals.
- Insulated gloves made of Zetex and Kevlar are useful for working with temperature extremes but cannot provide protection from chemicals.
- Rubber gloves or synthetic composition gloves which are intended to give protection from chemicals. Of the varieties available, the nitrile materials offer the best all around chemical protection but other materials may be more suitable to specific situations. Latex surgical gloves offer little or no protection against most laboratory chemicals. Care should be taken not to spread contamination with your gloves -- door handles and water or utility handles should not be contacted with contaminated gloves. Other workers contact those surfaces with their bare hands. See Prudent Practices for more details.

20. A properly designed and supported lab shield should be used when working with pressurized equipment or reactions which are known or suspected to be potential explosion hazards. These shields are a necessary supplement to the explosion protection offered by your hood design. Explain the explosion protection afforded by your hood.

ANSWER:

The doors to the hood are made of laminate safety glass to be blast resistant. There is also a blast vent on the top front of the hood which will be blown open during an explosion, thus providing an outlet for the blast force while directing it up and away.

21. In the event of chemical splashes or spills it is urgently necessary to thoroughly flush chemicals from contact with your skin. For spills on your hands or arms you will usually be able to wash the chemicals off over your sink. Remember you should use cool water to rinse with since warm water will open your pores making systemic absorption faster. The affected areas should be washed for at least 15 minutes. For large chemical spills or contamination in or around the eyes, each lab should have access to a safety shower and an eye wash. Where are these located and how are they marked and used?

ANSWER:

<u>Contact of Chemicals with the Eyes</u>:

Take the victim immediately to the nearest eyewash station. Flush the eyes for at least 15 minutes. Eyelids must be held open with the eyeballs continuously rotating for optimum flushing. Immediately call Public Safety at Ext. 911 for additional assistance.

Contact of Chemicals with the Skin over a large part of the body:
Help the injured person to the safety shower, and flush skin exposed to the chemical for at least 15 minutes. Remove all layers of contaminated clothing, shoes, and jewelry. If clothing or jewelry adheres to a chemically-burned area of skin; do not pull it away. Immediately call University Police at 911 for additional assistance. Contaminated clothing should be removed. It would be desirable for there to be a change of clothes in the labs for such emergencies. Sweats are recommended because of the size adjustment.

22. Compressed gas cylinders can pinwheel or rocket through masonry walls if the regulators or valves are broken off and can explode if substantially weakened structurally. What precautions can be taken to avoid rocketing, damaged cylinders?

ANSWER:

Cylinders should be firmly secured at all times with a belt or chain and capped when not in use. An appropriate hand cart with a cylinder strap should be used for moving cylinders. Cylinders should be kept away from sources of heat or ignition. Routinely check for leaks.

23. Chemicals should be separated from each other by hazard class, whenever possible to avoid unwanted reactions in the event of a fire or due to leaking or broken containers. Acids should always be separate from cyanides and from bases, while oxidizers should always be kept away from organics and reducers. Carcinogens should be stored in ventilated cabinets. List the five hazard classes recommended for segregating chemicals in storage.

ANSWER:
Acids, bases, flammables, oxidizers, reactives

24. The proper flow of air through your fume hood is critical in protecting you from the vapors you are working with. List five practices you can follow which will help to maintain a proper flow through your fume hood.
ANSWER:

- •Store chemicals in ventilated chemical storage cabinets (not in a hood).
- •Place equipment used in the hood on feet or stands at least 1 1/2 - 2” high to allow proper air flow under the equipment.
- •Keep materials at least 8” into the hoods.
- •Minimize cross currents from open windows or people walking by.
- •Keep laboratory doors closed.

25. The storerooms carry a variety of pipetting equipment for many applications. Why should pipetting never be done by mouth?
ANSWER:
Pipetting by mouth is extremely hazardous both from the possibility of drawing liquids into the body and from drawing vapors into the mouth which can get absorbed into the body.

26. Glass containers are easily broken. Hazard associated with broken bottles include cuts and contamination from fragmented glass, large spills which may be difficult to clean up, and hazardous fumes which would likely endanger building occupants. What procedures can be followed to minimize the chance of breaking glass bottles?

ANSWER:

- •Always use a bottle carrier when transporting glass containers in halls, stairwells and elevators.
- •Never store glass containers on the floor where they can be accidentally kicked or positioned on a stool or other insecure surface.
- •Minimize the size of working containers.

27. Working alone in the lab can be very hazardous under most circumstances. Describe some of the laboratory situations under which you should never work alone.

ANSWER:

- •Never work alone in a laboratory unless assistance is close at hand and others are aware of your presence.
- •Definitely never work alone when working with the following:
- •High energy materials or high pressures
- •Quick-acting, highly toxic materials (e.g. HCN)
- •Transfer of flammable material except in small quantities
- •Experimental research or laboratory procedures where previous experience has shown the desirability of having assistance available.

28. The Environmental Protection Agency requires that all waste solvent containers be kept capped and clearly labeled. The

Environmental, Health and Safety Office recommends emptying the containers regularly regardless of how full they are and using polyethylene jerricans for collecting both halogenated and non-halogenated waste solvents. Why shouldn't metal safety cans or glass bottles be used for collecting waste solvents?

ANSWER:

- •Problems arise from using metal safety cans for any waste because the safety cans frequently get plugged from solid materials and eventually rust through because it is difficult to keep chlorinated and/or corrosive materials out of any waste solvents.
- •Glass bottles shouldn't be used to collect waste solvent because they are too easily broken.

29. All lab workers generating hazardous waste should should set up and follow a waste minimization program. Minimizing wastes also minimizes safety hazards. List several procedures for minimizing hazardous waste.

ANSWER:

- •Periodically inspect inventory of chemicals and discard those which are outdated or for which you have no further use.
- •Avoid purchasing larger quantities than needed.
- •Check the departmental chemical inventory lists for items before ordering from an outside vendor.
- •Minimize the amount of required materials -- can the experiment be performed on a smaller scale?
- •Substitute less hazardous materials for more hazardous materials used in experiments.

- Before accepting "donations", know what the material is and its age, and ask yourself if you can really use it.

30. Flooding caused by plugged sinks and by carelessness in unattended water use has caused major damage to research equipment, flooring furniture, and project records on both the flooded floor and floors below. In addition to physical damage, the standing water creates potential hazards of electrical shock and slippery surfaces. List six measures that can be taken to minimize the chance of flooding.

ANSWER:

- Use a water line with a regulator on it for all unattended water use.
- Replace tubing before it becomes decomposed or brittle.
- Don’t use pure gum rubber tubing for water lines.
- Secure all tubing connections with wire or clamps.
- Use locking quick disconnects where needed or secure non-locking quick disconnects with clips to hold them together.
- Make sure that there are no objects or debris in the sinks that could restrict flow down the drains.

31. Commonly used solvents such as ether, dioxane and THF can form explosive peroxides after exposure to air. What can be done to minimize the hazards associated with peroxidizable compounds?

ANSWER:

- Date and label when initially opening the container.

•Store the compound in an obvious location where it will not be forgotten.

•Check ether solvents and other peroxides formers for peroxides six months after opening the containers and every six months thereafter or dispose of them. Peroxide test strips can be purchased from safety suppliers laboratory.

32. Mercury vapor is highly toxic and mercury spills are very difficult to clean up because the mercury breaks into microscopic balls which roll into cracks and crevices where they cannot be easily seen or removed. What can be done to reduce the chance of mercury spills?
ANSWER:

•Use a catch pan of appropriate size and depth under all mercury-containing equipment.

•Use non-mercury-containing thermometers where possible.

•Never use a mercury thermometer in a heated oven.

33. Teflon, a common component of lab supplies (e.g. containers, tubing, and stir bars) is considered inert in most circumstances, but what common substance can react explosively with Teflon at elevated temperatures?
ANSWER:
Potassium metal.

34. In the event of a small solvent or corrosive liquid spill which you can clean up yourself, explain the four steps for cleaning up spills.
ANSWER:

1.Personal safety -- if someone comes into contact with a non-water reactive chemical, immediately rinse the affected area thoroughly with water for at least 15 minutes and contact Public Safety at Ext. 911. Wear appropriate personal protective equipment when cleaning up the spill .

2.Containment of the spill -- close lab doors and windows. Outline the area of the spill with spill adsorbent. Use Activated charcoal (organic solvents spill), sodium bicarbonate /speediDri (acid spill) or Citric acid/speediDri (base spill). Containers of these materials are available in each emergency closet located in your research areas. Adsorb the spill -- begin to adsorb the rest of the spill with the appropriate adsorbent. Use a dustpan or scoop to stir the mixture.

3.Cleanup -- for solvents, scoop the spill mixture into a plastic bag, label the container, and call Environmental Safety and Health at 777-2211 for pickup.

4.Neutralize the spill

•Procedure for neutralizing most inorganic acid spill materials:

1. Slowly add the beaker content to a large volume of cold water (approximately a 1:10 dilution). Never add water to acid, this causes excessive generation of heat in a very localized area and may result in an explosion (especially in the case of sulfuric acid).
2. Check pH. If neutral, skip step 3 and proceed to step 4.

3. Slowly and carefully add Na_2CO_3 (sodium carbonate) or $NaHCO_3$ (sodium bicarbonate) until neutralization is complete.
4. Decant the liquid down the drain with at least 50 times its volume of cold running water.
5. Discard the solid as regular waste (except chromic acid.

- Procedure for neutralizing most inorganic base spill materials:

1. Slowly add the caustic spill materials to a large volume of ice water with stirring (approximately a 1:10 dilution).
2. Add 5% hydrochloric acid until neutralization is complete.
3. Check with pH paper.
4. Decant the liquid down the drain with at least fifty times its volume of cold running water.
5. Discard the solid as regular waste.

For additional assistance in determining the appropriate method of treatment and neutralization, consult Lunn and Sanson's Destruction of Hazardous Chemicals in the Laboratory, or M.A. Armour's Hazardous Laboratory Chemicals Disposal Guide.

35. The sinks in the laboratories are made of material which is quite inert chemically. Explain why dry ice or liquid nitrogen mixtures should not be poured into the sinks.

ANSWER:

While sinks are chemically inert, they are subject to mechanical damage because of their glass-like properties. The material from which the sinks are made has a fairly high thermal coefficient of expansion and can be cracked by pouring extremely hot or cold substance into the sinks.

36. How should spilled mercury be cleaned up?

ANSWER:

Mercury droplets can be amalgamated with calcium polysulfide, zinc dust, sulfur powder or Merconvap for spill clean-up. Aspiration of mercury droplets into a suction flask should be used to remove all visible mercury. The flask can then be taken to a hazardous waste collection site. While coating of mercury with flowers of sulfur temporarily lowers vapor pressure, vibration loosens the HgS coating, and equilibrium pressure is reestablished. Thorough room ventilation may keep total vapor loading down; the best approach is to use all mercury over a catch pan to prevent spills in the first place. The Environmental Health and Safety Office at 777-2211 can assist in clean up and will monitor for mercury vapor.

37. Equipment that produces high current or high voltage poses a special hazard in many research labs. As a general warning of the dangers, equipment using high currents or high voltages must be clearly marked and rooms containing this equipment in use should have warning signs at the entrance doorways. List additional precautions that must be taken to minimize personal risks when using this equipment.

ANSWER:

- •Use a 3-prong plug for proper grounding unless other grounding provisions are made and checked.
- •Work with only one hand while keeping your other hand at your side or in your pocket, away from all conducting materials. This prevents accidents resulting from current passing through the chest cavity.
- •Avoid becoming grounded by staying at least six inches away from all metal materials including walls and water.
- •If you design and build your own equipment be sure to plan for proper shielding to be purchased and/or constructed around your equipment to produce a safe lab environment.

38. Describe sequence of steps in following safe procedures for repairing electrical equipment.

ANSWER:

1. Turn the equipment off. Leave it plugged in for a few seconds so the internal capacitors have time to discharge to ground potential.
2. Unplug.
3. If you are not well versed in electronics or if no instruction manual is available, take the device to the electronics shop.
4. Do not replace blown fuses with fuses of higher ratings -- determine why the fuses blew and correct the problem.
5. If working on any apparatus that is or was capable of production high currents or high voltages, assume that the voltage is still resident within the device when probing for problems. Never have

more than one hand in the apparatus -- keep the other hand at your side.

6. Do not use a standard voltmeter with standard leads to measure high voltages, as the voltmeter could explode.

39. On a 115V power cord, what is the standard North American color code? (Caution: other systems may be employed on foreign manufactured equipment adapted for use in North America.)

ANSWER:

1. Black -- live 115V AC
2. White -- neutral return
3. Green -- ground, not current carrying

40. As with other special hazards, it is important to have warning signs at the entrance doorways for optical light hazards. Not all laser light or other potentially dangerous light can be seen by the human eye. What other precautions should you take when working with optical light?

ANSWER:

- Eye and skin protection should be used when operating UV light sources (including UV absorbance, LC detectors, and hollow cathode lamps)
- Mark the paths of intense laser light. Anticipate and examine projected light paths before adding or removing optical components.

• All reflective jewelry should be removed before working with lasers (a laser reflected off a ring while changing samples can permanently blind you).

• Keep laser beams at or below chest height.

41. What kinds of eye protection are available for optical hazards commonly encountered in a research lab?

ANSWER:

•Laser light can be partially blocked with specially designed goggles which absorb at specific wavelength regions. Different goggles are designed for each type of laser.

•Glass lenses with side shields provide moderate UV protection, but plastic safety glasses cut off at longer wavelengths and are preferred.

42. The fume hoods located in the research lab areas have a warning alarm to indicate complete loss and/or incorrect air flow to the hood. This may result in a significant hazard or cause injury to yourself and laboratory co-workers. List the appropriate steps that you may have to consider in order to facilitate the emergency shut-down of experiments being conducted in the fume hood.

ANSWER:

1.Have an understanding of the hazard associated with the materials being used in the hood. Keep toxic materials to a minimum.

2.Have a planned shut down procedure, so that the experiment may be shut down safely. (some experiments may be safely interrupted, but for others it may be safer to drive the reaction to completion). Shut-down includes: closing chemical containers, closing off heat supply, relieving all pressures, removing hazardous substances.

3.Determine if evacuation of the lab would be required and if University Police should be notified.

43. When using, transporting, disposing of or storing chemicals, care must be taken to be sure that substances that are incompatible cannot accidentally come into contact with each other. Contact between incompatible chemicals may result in serious explosions, as well as the formation of toxic and/or flammable products. Appendix IV on page 73 of your ACS handbook, Safety in Academic Chemistry Laboratories, lists a number of the more common incompatible chemicals. Select three chemicals from this list and comment on their incompatibility. Use predicted reaction products, where possible, to illustrate the possible result of combining the incompatible chemicals selected.

ANSWER: (Note: For exam purposes you are expected to use other examples than the ones listed below)

- •Ammonia(anhydrous) and/or Ammonium Nitrate is incompatible with chlorates. Reaction may produce, NH_4ClO_4, ammonium perchlorates generated are similar to the oxidizer used in solid fuel booster rockets.
- •Peroxides are incompatible with all forms of organic solvents and flammable materials. All peroxides are highly oxidizing materials.

Considerable energy can be released in their reactions. Some peroxide compounds are unstable and can explode.

44. When an emergency situations occurs, it is too late to devise a plan of action and to find the safety equipment that may be required for that emergency. Each research group should have contingency plans for emergency response. This includes a working knowledge of the location and availability of emergency equipment. In the space provided indicate the location of the following in or near your lab.

ANSWER:

Emergency Equipment	**Location**
Fire alarm pull stations	____________
Electrical breaker control boxes	____________
ABC dry chemical extinguishers	____________
Metl-L-X (class D) extinguisher	____________
Emergency exits	____________
Adsorbent for solvent spills	____________
Adsorbent for corrosive spills	____________
Emergency eye wash	____________
Safety shower	____________
Emergency phone	____________

45. Many research laboratories use hypodermic syringes on an ongoing basis. The syringe is considered as a controlled substance and violations of University approved rules and procedures regarding use, disposal and appropriate storage of syringes will result in immediate withdrawal of the violator's access to hypodermic syringes and needles. Describe the required procedures for use, storage, and disposal of hypodermic syringes and/or needles.

ANSWER:

•Every user shall maintain a fully current record of all syringes and needles. Includes type, size, number, date of disposal and name of person using and disposing them.

•Hypodermic syringes and needles shall be stored in a locked, secure place when not in use.

•Red plastic sharps containers will be provided for appropriate disposal of syringes and needles. Needles and syringes must never be disposed of in waste baskets or dumpsters.

46. Cryogenic liquids pose a unique hazard in the research laboratory due to their extremely cold temperatures and ability to displace oxygen when vaporized in a confined space. Serious injury or death can result from improper use and storage of these liquids. List two common cryogens used in the lab and describe how they should be properly stored?

ANSWER:

The two most common cryogens are liquid nitrogen and liquid helium. Both are unreactive and inert. But their low—temperature properties make them substances with which we must take serious precautions. Helium should be stored in the helium dewar; nitrogen goes into the nitrogen dewar. Do not mix the two, and do not put ANYTHING else in either dewar.

47. List five important safety precautions that must be followed when transferring cryogenic materials.

ANSWER:

1.Use gloves to protect your skin.

2.DO NOT TUCK YOUR PANTS INTO YOUR SHOES OR BOOTS! If a cryogen momentarily collects around your foot, you will not be able to get your shoes off fast enough to prevent damage to your skin.

3.Use low pressures (2-4 psi) when transferring liquid helium. High pressures (10 psi) in transfer is both dangerous and wasteful.

4.Do NOT leave your dewar pressurized at anytime after completing the transfer. Always open the pressure release valve.

5.Maintain adequate ventilation in the lab when using and transferring a cryogen. Areas suspected of being oxygen deficient due to the release of large quantities of cryogenic vapor should be evacuated immediately and further access to the area prevented until area is determined to be safe.

48. List at least three safety considerations that you need to follow before using any cryogenic instrumentation and/or equipment.

ANSWER:

1.Make sure that cryogenic equipment has a working pressure relief valve.

2.Make sure that the pressure relief device is configured such that if it is actuated that the flow of gas does not present a danger to the operator or other lab equipment.

3.Vacuum integrity must be maintained at all times. Cryogenic equipment must be kept clean.

49. A good electrical ground protects you by giving the electrical current a safe path to follow in the case of an equipment failure or fault. List at least three common situations that can result in a piece of equipment having a bad electrical ground?

ANSWERS:

1. Using 2-prong plugs instead of 3-prong plugs.
2. Using a 3-prong plug adapter in a 2-prong outlet.
3. Using the equipment with wires that are bare of insulation.
4. Using the equipment with wires that are broken.

50. General electrical safety includes the proper use of outlets, extension cords and outlet strips. Which of the following situation(s) describe unsafe practices in the use of outlets, extension cords or outlet strips.

- Placing one or more extension cords along the floor in areas where people may trip over them.
- Plugging too many pieces of equipment into the same outlet.
- Using extension cords that aren't rated to carry the current required by a piece of equipment.

ANSWER:

All of the above represent unsafe laboratory situations which could result in fire, accident and /or electrocution. Constant surveillance of the research lab electrical utilities is mandatory to insure a safe work area for all lab personnel.

51. This safety certification program cannot cover all of the hazards that you are likely to encounter in your own research laboratory area. What additional precautions will you need to follow in your graduate research?

ANSWER: (This is highly variable and should be discussed with your research adviser.)