Includes Answers

Nanotechnology Core Facility
SAFETY EXAM

Name__________________________________

Advisor________________________________

Department_____________________________

NCF users-to-be,

Safety is an important aspect of your laboratory research career. Each laboratory worker has the responsibility for his or her own safety and the safety of co-workers. To insure your safe conduct in the laboratory you should study this safety exam carefully and learn and follow the safety rules governing the practice of chemistry in these laboratories. You should also constantly watch for unsafe conditions and practices in your laboratory. Be sure you carefully think through an experiment before actually beginning work and consult your research advisor about potential hazards with your work. Your laboratory space will be inspected during your stay at UIC and you should actively participate in this process. The Environmental Health and Safety (EHSO) personnel will be pleased to help you with any problems that might arise and your cooperation will make safety inspections more helpful and effective.

Procedure: Before you begin work in the laboratory, you must take and pass the safety exam. A copy of the exam with answers will first be given to you for study. You will take the test at the date and time and location which will be provided. The test will be graded by the departmental safety representative. Questions that are answered incorrectly or incompletely must be rewritten until satisfactory, in order for the exam to be passed.

Satisfactory safety performance is essential, and your access to cleanroom facilities and processing of official paperwork in the analytical area is dependent upon your continuous exercise of safe laboratory procedures. Willful or neglectful violation of the safety guidelines to which your attention is drawn in the safety exam or during safety inspection will result in your loss of access to these services and facilities.

This copy of the exam with answers is yours to keep for future reference.

University of Illinois
Laboratory Safety Exam
Introduction and References

This safety exam is designed to test your general awareness of laboratory safety procedures. The questions reflect some of the more commonly encountered difficulties. They do not cover all the hazards which you are likely to encounter in the lab.

More details on hazards and procedures are described in the UIC Chemical Hygiene Plan, "Prudent Practices for Handling Hazardous Chemicals in Laboratories", issued by National Research Council and Published by National Academy Press. Further information is available in "Safety in Working with Chemicals", by Michael Green and Amos Turk, published by Macmillan. The "Merck Index" also provides useful information on the physiological properties of many chemicals.

The Environmental Health and Safety Office (EHSO) can be reached at 6-SAFE as a source of information and Material Safety Data Sheets. Hazardous Waste Management (3-CHEM) can be called for advice on managing chemical wastes and for waste collection. The Radiation Safety Office (6-7429) can answer questions related to radiation hazards.

Other reference materials are located in departmental offices and the libraries. Your group expert for safety and your research advisor will also be knowledgeable about specific hazards associated with your work. Your laboratory safety is your own responsibility. You should consult these sources frequently during your work.

1. The most serious hazard for all laboratory workers is fire. It is necessary that each worker knows the location of the fire extinguishers and fire alarm pull stations. It is also very important to know the types of fires for which different commercial extinguishers are designed. There are four general classes of fires. List each of the classes of fires and the type of extinguisher which you should use to put out the fire.

Class A Fires:
Ordinary combustible solids: paper, rubber, textiles. Frequently accompanied by destructive distillation producing flaming vapors or toxic gases. These fires may also leave hot ash or residue capable of re-igniting fire after it looks like it has been put out. These fires are effectively extinguished by water which is recommended if the water would not create additional hazard. These fires are also extinguished by CO2, N2, volatile halocarbons (CF3Br, etc.) and dry chemical extinguishers, though these may lead to spreading the burning material due to the blast of compressed gas from the extinguisher cylinder. Dry ice will usually rapidly smother these fires and can be used if it is close by.

Class B Fires:
Flammable liquids. Spreading of the fire is a major complication which can happen if the container of flaming liquid is overturned or broken. This type of fire can be extinguished by covering the container holding the burning liquid or by spraying it with foam, C02, N2, volatile halocarbons or sometimes dry chemical (depending on the situation) from a fire extinguisher. Again, dry ice or liquid N2 is very effective if it is close by. Compressed gas extinguishers can lead to spreading and worsening of the fire if the force from the extinguisher tips over a container containing the flammable liquid.

Class C Fires:
These are Type A or B fires in which electrical equipment is involved. These fires can be treated as class A or B if the power is turned off. It is a good practice to never use water on a fire when electrical equipment is present, 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 liquid N2 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, KH, LiAIH4, etc.). These fires cannot be extinguished by CO2 or H20 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.

Common chemical hazards include:

- **Fire Hazards**
- **Explosions Hazards from incompatible chemicals**
- **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.

If chemicals should enter the eye, these can be held against the eyeball and not washed free due to contact coverage. Also, soft contacts will often absorb organic vapors like MeOH, CHCI3 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 if the lenses are displaced to the side of your eye so that serious damage could result.

4. What does the fire alarm sound like and what is its function?

These alarms are loud buzzers throughout the building. If you hear the fire alarm, leave the building right away! The alarms call the UIC police and the fire department.

5. In the event of a fire, chemical spill, or other emergency, appropriate safety equipment should be easily accessible. Air packs and respirators should only be used by those personnel trained to use them. It is preferable to call the fire department where personnel are highly trained in the use of air packs. What are appropriate circumstances for using fire fighting equipment and first aid equipment?

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 call UIC police and EHSO to report the fire and use of equipment. If the fire is too big to put out very quickly, call the fire department (if possible by phone), activate a fire alarm to evacuate the building, and meet the fire fighters at the building entrance to direct them to the fire. First aid should be administered to anyone who is hurt. This includes removing 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.

6. If an emergency arises and you have to leave the lab quickly there are emergency doors interconnecting some of the labs. These doors are usually kept locked to avoid the spread of fire and maintain security. How are these doors used?

The doors are weakly bolted closed so that a hard impact will cause the bolt to break and the door to open. (Only doors marked "EMERGENCY" will give in this manner.) These doors should never be blocked since that could become the only exit from a dangerous area.

7. The fume hoods in the labs are designed to operate with the ventilation system for the building. The hood doors should ALWAYS BE KEPT CLOSED 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 reentering the lab. The blower pulling air into the hoods should always be on but in the case of certain types of fires this 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 also a cutoff in your lab area. Where is it and how should it be positioned?

Each set of hoods in a "lab module" is operated through the same blower. The switch for this blower is a red panic button just inside the doors to the lab. There is also an ON/OFF switch on the hood. This closes the damper on that particular hood.

8. Sometimes it may become necessary to cut the electrical power in a lab due to a hazardous condition. You should know the location and scope of the electrical cutoffs available for your lab. What type of cutoffs are available?

A complete lab module is controlled by a single circuit breaker box located at one of the lab entrances. This is a three-phase 208 volt box which draws from a vertical main line which is clearly visible in the closet on which the box is located. On the vertical main line is a main switch which will completely disable all circuits in a given lab module. This switch should only be used in extreme emergencies since it will also affect other workers in your module. 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 (since the hood and bench modules are connected to the breaker boxes via plugs located on the floor of the closet area, these may become mixed up during regular building servicing).

9. One problem in modern chemical labs is 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.

These circuits are supplied by several adjacent breakers in the circuit box so that two adjacent outlets will be taken from different legs of the three-phase main power supply. It is possible to have electrical potentials as high as 240 volts at 50 amps. Frayed electrical wires can easily cause a very dangerous exposure to high voltage.

10. State the correct procedure for labeling a waste chemical container.

To label the waste container, use the Hazardous Waste labels specifically designated for this purpose. Mark the name of the chemical and the date. Place the label on a waste bottle to completely cover any previous label on that container, to prevent confusion "what is the chemical inside?" Chemical waste is collected by EHSO every so often, even if the container is not full.

11. 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 non breakable containers (fireproof if the solvents are flammable) and under no circumstances should more than one glass gallon containers be used for solvent storage in a single aisle. There is also a 10 gallon limit on the total volume of flammable solvent in a lab. The department of EHSO has a regular solvent disposal system. Solvents collected for disposal are only accepted if the containers are fireproof cans or polyethylene jerricans. Outline the reasons for use of these types of containers and the solvents which should be kept in each.

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 used for corrosive nonflammable solvents. These would 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 prevent corrosion from the solvents with no danger of breakage.

12. 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 fired polished or broken wafers. What precautions should you take in this regard?

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 cardboard box or sharps box. When full, seal with tape for disposal.

13. Where is the sharps box located?

The sharps box is located in the cleanroom corridor next to the characterization bay. Ask NCF staff to show you the location of it. Discard waste and broken silicon wafers, glassware, masks, glass wafers in sharps box only.

14. Because the building ventilation is so good the internal pressure is less than the pressure outside. Since the water 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. How can this be avoided?

Keep all sink traps filled with water. If a sink or drain is not used very often, regularly check it to make sure there is water in the trap. Do not pour noxious substances with high vapor pressure down the drains (solutions of H_2S, mercaptans or HCN, for example.

15. Food in chemical area is also a health hazard. Outline the problems and steps to avoid difficulty.

Food, drink, or smoking is never allowed in a chemical area. Accidental ingestion of dangerous chemicals can result from food that gets contaminated by airborne dust, unclean surfaces and vapors. CH_3Cl is normally not a serious hazard but will generate phosgene (a very toxic nerve-gas) and HCI if it is heated by a cigarette. Areas where food is to be consumed or stored must be clearly labeled as non-chemical area and laboratory reagents and chemicals kept clear of this space. In any event eating in the laboratory is not allowed and food should never be stored in a chemical refrigerator.

16. All personnel in a laboratory are required to wear eye protection by University policy and state law. Extra glasses must be available for visitors to your lab. Outline the eye protection which you should use in a laboratory.

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, use goggles when splashes of dangerous chemicals are likely, and special glasses and goggles for use with lasers and other radiation emitting equipment. A complete face shield should be used in particularly hazardous procedures (e.g., when you are using HF).

17. 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?

Wires, cords or tubes should not be routed between or under 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.

18. Your hoods are also designed to give good ventilation in a variety of different situations such as with heat producing equipment. How is ventilation controlled?

The portion of the hood which is swept most rapidly is controlled by the positioning of the baffles in the rear of the hood. Upper ventilation is enhanced if the upper baffle is open (down) and the back baffle is closed (back). Lower ventilation is enhanced if the upper baffle is closed (up) and the back baffle is open (forward). The latter setup provides the best general flow for most operations.

19. In the event of a laboratory accident what sources of help will always be available?

The University Police Department and Chicago Fire Department are available for emergencies 24 hours/day by dialing 5-5555 from a University phone, or 312-355-5555 from a mobile phone. The emergency operator will contact the most appropriate emergency response team(s) and send them to your aid. When dialing this number, it is always important to let the emergency operator hang up first. This will verify that the operator has all the necessary information. During regular working hours, Monday through Friday 8:00 AM to 5:00 PM, call the Environmental Health and Safety Office at 6-SAFE (67233).

20. 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. Sometimes identification is easy but it may be difficult and dangerous. If you find unlabeled chemicals in your laboratory, how should you treat them?

They should be disposed of promptly and not stored indefinitely as frequently happens in refrigerators. Identify the chemical to the best of your ability (consult your coworkers and research advisor as a first step). Particular hazards should be noted on the label (explosive, pyrophoric, highly toxic, etc.). The material may then be properly disposed of, or added to the regular hazardous material collection.

21. 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.

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. Always wear a head cover inside the cleanroom. Skimpy clothing will offer little protection in the event of a chemical spill or splash. Always wear a cleanroom gown or coverall inside the cleanroom, and a chemical gown when working with chemicals in any other area. Closed-toe shoes and socks 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. Hosiery should not be worn since it will "melt" upon contact with acid and some chemicals. The "melted" hosiery and chemicals trapped in it will adhere to the skin and are likely to increase the severity of the chemical burns.

22. Gloves are another form of personal protection which you are likely to need in a chemical laboratory. Describe different kinds of gloves and their usage.

<u>Leather gloves</u> -for handling broken 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 very hot or cold equipment but cannot provide protection from chemicals.
<u>Rubber gloves</u> 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.
<u>Latex</u> 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 touched with contaminated gloves (these surfaces should be cleaned with DI water each week during NCF cleaning). Do not touch your face with gloves and absolutely no hand-shaking inside the cleanroom. It is generally a good practice to wash hands with water after leaving the cleanroom and taking gloves off.

23. The blast shield should be used when working with pressurized equipment or reactions which are known or suspected to be explosion hazards. These shields add to the explosion protection offered by your hood design. Explain the explosion protection afforded by your hood.

The doors to the hood are made of laminated 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. This provides an outlet for the force of an explosion and directs it up and away from you.

24. If a chemical is splashed or spilled on you, you must thoroughly wash the chemicals off of your skin. For spills on your hands or arms, you will usually be able to wash the chemicals off in the sink. Remember, you should use cool water to rinse with since warm water will open your pores, this makes your skin absorb the chemicals faster. The affected areas should be washed for at least 15 minutes. For large chemical spills you should use a safety shower. For contamination in or around the eyes you should use eyewash. Where are these located and how are they marked and used?

Contact of Chemicals with the Eyes:
Take the victim immediately to the nearest eyewash station. Flush the eyes for at least 15 minutes. Eyelids must be held open with your hands. You must continuously rotate your eyeballs for good washing. Go to a doctor right away at the University Health Service or UIC Emergency Service Department.

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 sticks to a chemically burned area of skin, do not pull it away. Seek medical attention. Contaminated clothing should be removed. There should be a change of clothes in the labs for such emergencies. Sweats are recommended because they will fit everyone.

25. Compressed gas cylinders can spin very fast 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 damaging cylinders?

Cylinders should be always tied with a belt or chain so they can not be knocked over 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. Compressed gas cylinders are filled to a pressure of 2400 PSI (16.5 Mpa, 163 atm, 170 Kg/cm2). The large cylinders in the NCF hold over 3 MJ of stored energy.

26. Chemicals should be kept separated by hazard class whenever possible to avoid unwanted reactions in the event of a fire or between leaking or broken containers. Acids should always be separate from cyanides, and bases, and oxidizers should always be kept away from organics and reducers. Carcinogens should be stored in ventilated cabinets. List the five hazard classes recommended by Environmental Health and Safety for separating chemicals.

Acids
Bases
Flammables
Oxidizers
Reactives

27. The proper flow of air through your fume hood is critical to protect you from the chemicals you are working with in the hood. List five practices you can follow which will help to maintain proper airflow in your fume hood.

Store chemicals in ventilated cabinets rather than in the hoods.
Place equipment on feet or stands at least 1 1/2 - 2" high to allow proper airflow under the equipment.
Keep chemicals at least 8" inside the hoods.
Minimize cross currents from open windows or people walking by.
Keep laboratory doors closed.

28. Laboratories have variety of pipetting equipment for many applications. Why should pipetting never be done by mouth?

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.

29. 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 can endanger other people in the building. What procedures can be followed to minimize the chance of breaking glass bottles?

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 placed on a stool or other insecure surface where they can be knocked off. Minimize the size of working containers.

30. Working alone can be very hazardous under many circumstances, When should you never work alone?

Never work alone in the cleanroom. Make sure there is a second person within a hearing distance from you while working in the cleanroom. Doors to the lithography bay are fireproof. Therefore, while working in the lithography bay, a second person must be present at the same room with you. For more information regarding after hours work in the cleanroom, please consult the NCF policies.

31. The Environmental Protection Agency requires that all waste solvent containers be kept capped and clearly labeled. UIC Hazardous Waste Management 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?

Problems arise from using metal safety cans for any waste because the safety cans 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.

32. All labs that produce hazardous waste are required to have a waste minimization program. Minimizing wastes also minimizes safety hazards. List six procedures for minimizing hazardous waste.

a) Periodically inspect inventory of chemicals and discard those which are outdated or for which you have no further use.
b) Avoid purchase of larger quantities than needed.
c) Check the Department Storeroom or the EHSO chemical redistribution service (3-3707) for items before ordering from an outside vendor.
d) Minimize the amount of required materials - can the experiment be performed on a smaller scale?
e) Substitute less hazardous materials for more hazardous materials used in experiments.

33. Flooding caused by plugged sinks and hood gutters, 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.

a) Use a water line with a regulator on it for all unattended water use.
b) Replace tubing before it becomes decomposed or brittle.
c) Don't use pure gum rubber tubing for water lines.
d) Secure all tubing connections with wire or clamps.
e) Use locking quick disconnects where needed or secure quick disconnects with clips to hold them together.
f) Make sure that there are no objects or debris in the sinks or hood gutters (under the front hood flaps) that could restrict flow down the drains.

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

a) Date and label the container when it is first opened.
b) Store the compound in an obvious location where it will not be forgotten.
c) Check ether based solvents and other chemicals that form peroxides every six months after opening the containers or dispose of them. Peroxide test strips can be purchased from safety suppliers laboratory.

35. Teflon, a common component of lab equipment (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?

Potassium metal.

36. Mercury vapor is highly toxic and mercury spills are very difficult to clean up because the mercury splashes 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?

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.

37. EGEE is one of the glycol ethers that have been found to cause birth defects and damage to the testicles in lab animals. If you are pregnant or trying to conceive, discuss these dangers with your physician. Male users must be cautious as well. When handling chemicals containing glycol ethers, consider them as potential hazards to your reproductive health. How can glycol ethers enter your body?

Besides entering your body when they evaporate into the air you breathe, glycol ethers are rapidly absorbed into your body if the liquids contact your skin.

38. Name standard NCF chemicals that contain glycol ethers.

Spin-on Boron:
    ethoxyethanol (EGEE) ethylene glycol monoethyl ether
Microposit Remover 1112A:
    ethylene clycol monobutyl ether (EGBE)
    28% diethylene glycol n-butyl ether (DEGBE)
    14% dipropylene glycol methyl ether (DPGME)
Microposit S1818 Photoresist:
    86% Propylene Glycol Monomethyl Ether Acetate (PGMEA)
    Microposit Primer Thinner:
    Propylene Glycol Monomethyl Ether Acetate (PGMEA)

39. Remember, most of your exposure to glycol ethers could come through skin contact. Butyl rubber, neoprene, and nitrile rubber are recommended materials for protection from glycol ethers, and even these materials will be penetrated quickly and should be replaced often. Ethylene glycol ethers can damage red blood cells or damage the bone marrow, where blood cells are formed, causing anemia. List possible symptoms:

Symptoms may include tiredness, weakness, and shortness of breath, especially during or just after exercise. You can easily have anemia without knowing it; but it can be easily diagnosed with a blood test. Overexposure to glycol ethers can intoxicate you in much the same way that drinking alcohol can. You may feel dizzy, "high," disoriented, confused, sluggish, or unusually tired.

Other symptoms include headache, nausea, trembling, appetite loss, weight loss, and personality changes. Exposure levels that are high enough to cause intoxication or eye and nose irritation are more than high enough to cause anemia and to damage the reproductive systems of test animals. If you experience intoxication or eye and nose irritation, your exposure should be reduced.

40. 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.

a) Personal safety - if someone comes into contact with a chemical, immediately rinse the affected area thoroughly with cold water for at least 15 minutes and contact the Health Service. Wear appropriate personal protective equipment when cleaning up the spill. Wear a respirator when you are near volatile chemicals.

b) Contain the spill - close lab doors and windows. Outline the area of the spill with spill adsorbent. (Activated charcoal or commercially available adsorbent for solvent spills). Absorbing pads and plastic bags can be found on bottom shelf of metal cabinet in wet bay I.

c) Adsorb the spill - begin to adsorb the rest of the spill with the appropriate adsorbent. Use a dustpan or scoop to stir the mixture.

d) Cleanup - for solvents, scoop the spill mixture into a plastic bag, seal the bag, put a label on the bag that says what kind of chemical is in the bag, and call Hazardous Waste Management at 3-CHEM for pickup. Scoop corrosives into a large beaker or pail and rinse spill area clean.

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

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.

42. How should spilled mercury be cleaned up?

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 emptied into a container for general recycling of heavy metals. 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.

43. Equipment that produces high current or high voltage is a special problem in many analytical labs. Equipment using high currents or high voltages must be clearly marked to warn people about the danger and rooms containing this equipment should have warning signs at the entrance doorways. List three additional precautions that must be taken to minimize personal risks when using this equipment.

a) Use a 3-prong plug for proper grounding unless other grounding provision are made and checked.
b) Work with only one hand while keeping your other hand at your side or in your pocket, away from all conducting materials. This prevents current from passing across your chest cavity and heart in case of accidental electric shock.
c) Avoid becoming grounded by staying at least six inches away from all metal materials including walls and water.

44. Describe safe procedures to use in repairing electrical equipment.

a) Turn the equipment off. Leave it plugged in for a few seconds so the internal capacitors have time to discharge to ground potential. Even when you do this some capacitors must be individually shorted or they can give you an electrical shock that can kill you.
b) Unplug.
c) If you are not well versed in electronics or if no instruction manual is available, take the device to the electronics shop.
d) Do not replace blown fuses with fuses of higher ratings - determine why the fuses blew and correct the problem.
e) If working on any apparatus that is or was capable of producing high currents or high voltages, assume that the voltage is still resident within the device when probing for problems, even when unplugged. Never have more than one hand in the apparatus - keep the other hand in your pocket.
f) Do not use a standard voltmeter with standard leads to measure high voltages (over 1000V), as the voltmeter could explode.

45. On a 115V AC power cord or wiring, what is the standard color code for the wires?

Black - live 115 Volts AC
White - neutral return
Green - ground, does not normally carry current.

46. 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?

Eye and skin protection should be used when operation 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.

47. What kinds of eye protection are available for optical light hazards commonly encountered in the analytical labs?

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 block longer wavelengths of UV light and are preferred.

48. The clean room service corridor (back hallway) is part of the clean room. It is cleaned regularly and has HEPA filters in the ceiling. What precautions should be used in the service corridor.

Doors to labs should be kept closed. Most service gases and some equipment sections are located in service corridor. Care should be taken while walking through the corridor.

Outdoor coats and bags should be kept inside the blue lockers. Never bring outdoor clothing or bags inside the cleanroom gowning area.

When several people enter the cleanroom as a group, each person must swipe his/her card.

49. How is the DI water being used in the cleanroom – in water cascades and sinks?

In the DI water cascade, drainage water is cleaned, re-purified and reused. Water in sinks goes directly to the drain. Never pour any chemicals into the sinks. Rinse water after rinsing the beakers must be poured into appropriate chemical waste container and not down the drain.

50. Which of the following statements is true?
A. Hydrofluoric Acid (HF) reacts with Silicon
B. Pyrex and Glass contain Silicon
C. HF should NOT be stored in Glass

D. All of the above are true

51. Full waste containers should be:

Put in a pass-through and then transferred to the appropriate waste chemical locker in the service corridor – where EH&S will pick it up. Do not leave chemicals in the pass-thoughs – they are not ventilated and chemical vapor will get accumulated.

52. Inside the clean room there are how many fire extinguishers and where are they located? What class of fire extinguisher are they?

There are two fire extinguishers inside the cleanroom – in the dry bay and in photolithography bay. Another fire extinguisher is located in the service corridor.

53. The NCF is equipped with 2 emergency 5 minute oxygen respirators. Where are they located?

5 minute oxygen respirator is to be used in case of fire when oxygen supply is depleted. Bold orange cases containing the respirators are located: 1) in dry bay, 2) in service corridor.

54. What special precautions will your research require?

The NCF uses many chemicals that contain HF. Every fume hood has a tube of calcium gluconate to use for First Aid if case of HF spill. After washing any spilled HF off of your skin have someone who is wearing gloves put lots of calcium gluconate on the place the HF touched your body. Go to the UIC emergency room.

The LPCVD and PECVD sometimes use silane gas (SiH_4). Silane will burn on contact with air, large volumes of silane will explode.

The NCF uses a lot of concentrated nitric acid (70%/w HNO_3). Any flamable liquid (any alcohol, acetone, or toluene) will form an explosive chemical if it is mixed with nitric acid.

55. Tell where the safety showers and eye washers are located inside the cleanroom.

Ask NCF staff to show you.