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

vessel containing a flammable li uid.
Class C Fires! These are Type $ or , fires in which electrical e uipment is involved. ' an be treated as class $ or , 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 e uipment will store charge-. If the power cannot be turned off the fire must be extinguished with inert gas or dry chemicals. $gain" dry ice or li .) (is very effective if available.
Class D Fires! These fires involve reactive metals *e.g." Li") a" 0" 1n" $l" 2 g" etc.- or active hydrides *) a3" 0) " Li$l3 4" etc.-. These fires cannot be extinguished by ' O(or 3 (O- or volatile hydrocarbons. Inert powder must be used *sand" talc" or alkali metal salts-. , icarbonate base extinguishers may not be effective. 2 etal%5 extinguishers are recommended.

2. ' hemical hazards are also a problem in the laboratory and it is important to know the hazards you might encounter in a lab. If knowo° l

- Lachrymators *substances that irritate the eyes and produce tears-
- 6esicants *substances that can blister and burn body tissues by contact with the skin or inhalation-
- ' arcinogens *substances that produce cancer-

3. &xplain 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.
- • / oft contacts will often absorb organic vapors like 2eO3" ' 3 ' l+ 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.
- • ' ontacts should never be worn in the lab and should be replaced by corrective glasses made of impact resistant material and e uipped 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.

ANSWER!

#irst 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 9niversity :olice at ;<< or use one of the hallway emergency response telephones" and meet the emergency personnel at the building entrance *or by the receiving

8. / ometimes it may become necessary to turn off the electrical power in a lab due to the development of hazardous conditions. &ach lab area has an & : *&lectrical : anel- for circuit breaker boxes. =ou should familiarize yourself with the location of the circuit breaker box for your lab area. =ou should know the location and scope of the electrical cutoffs available for your lab. 7 hat type of cutoffs are available8
ANSWER!
$ complete lab module is controlled by circuit breaker boxes located in or near your lab. This is a three%phase (>?%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. &lectrical e uipment should always be maintained in good condition. @eplacement of frayed or damaged electrical cords is a must and all e uipment 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 (>? volts. #rayed 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. 7 aste solvent collected in the lab should be properly labeled" tightly capped and should regularly be removed from the laboratory area for disposal. / olvents used and reused in large uanti i oc 7 asOy b

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

11. , roken glassware poses a serious threat to your laboratory safety. #re uently" people are cut by broken drip tips on funnels or by glass tubing which has not been fire polished. 7 hat precautions should you take in this regard8

ANSWER!

, roken glassware must be repaired immediately so that there are no exposed sharp edges. 7 hen 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 0 ') -. / uch e uipment should be cautiously swept into a dustpan or similar e uipment. $ clean and neat bench reduces the likelihood of breakage. 9nusable broken glassware or pipettes should be collected in a labeled glass waste disposal box. 7 hen full" notify your maintenance cleaning person for disposal.

12. . ue to the buildingAs ventilation system" the internal pressure of the building is less than the outside pressure. / ince 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. 3ow can this be avoided8

ANSWER!

0eep all sink traps filled with water and regularly check infre uently used floor drains and cup sinks. . o not pour noxious substances with high vapor pressure down the drains *solutions of 3(/" mercaptans or

3 ')" for example-. $dd a bit of mineral oil to unused sinks. The layer of oil will retard evaporation of water in the traps.

13. #ood in a chemical area is a most serious violation of safe laboratory practice. Outline the problems and steps to avoid this difficulty.
ANSWER!
&ating" 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 * ' 3(' l(is normally not a serious hazard but will generate phosgene and 3 ' l with the aid of a cigarette-. $reas 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. &ating in the laboratory is not allowed and food should never be stored in a chemical refrigerator.

14. Buestion + illustrates some of the problems associated with wearing contact lenses in the laboratory. $ll personnel in a laboratory are re uired to wear eye protection by 9niversity policy and state law. &xtra 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!
2inimally" safety glasses made of impact resistant material with solid side shields are to be worn by all personnel in a lab. $s the danger of exposure increases you should increase your protection %% for example" goggles are re uired when splashes of dangerous chemicals are likely" and special glasses and goggles should be in

use with lasers and other radiation emitting e uipment. $ 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. 7 hat features are available8
ANSWER!
7 ires" 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 6ariacs and other non%explosion proof electrical control e uipment.

16. In the event of a laboratory accident" what sources of help will always be available8
ANSWER!
The 9niversity : olice . epartment is available to assist in emergencies (4 hours(day by dialing ;<< from any 9niversity phone. The 9niversity : olice dispatcher will contact the vcOfor tuc enta t

- / ynthetic clothing material *i.e. nylon" dacron" etc.- should not be worn since it will meltG upon contact with acid and some chemicals etc.-. 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. Hloves 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 dn fnnnµbbeidintod beisswaarnd Knnnķ cling

20. $ properly designed and supported lab shield should be used when working with pressurized e uipment 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. &xplain the explosion protection afforded by your hood.1

' ontact of ' hemicals with the /kin over a large part of the body!
3elp the injured person to the safety shower" and flush skin exposed to the chemical for at least <E minutes. @emove all layers of contaminated clothing" shoes" and jewelry. If clothing or jewelry adheres to a chemically%burned area of skinI do not pull it away. Immediately call 9niversity :olice at ;<< for additional assistance.
' ontaminated clothing should be removed. It would be desirable for there to be a change of clothes in the labs for such emergencies.
/weats are recommended because of the size adjustment.

22. ' ompressed gas cylinders can pinwheel or rocket through masonry walls if the regulators or valves are broken off and can explode if substantially weakened structurally. 7hat precautions can be taken to avoid rocketing" damaged cylinders8
ANSWER!
' ylinders should be firmly secured at all times with a belt or chain and capped when not in use. $n appropriate hand cart with a cylinder strap should be used for moving cylinders. ' ylinders should be kept away from sources of heat or ignition. @outinely check for leaks.

23. ' hemicals 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. $cids should always be separate from cyanides and from bases" while oxidizers should always be kept away from organics and reducers. ' arcinogens should be stored in ventilated cabinets. List the five hazard classes recommended for segregating chemicals in storage.

ANSWER!
$cids" bases" flammables" oxidizers" reactives

24. The proper flow of air through your fume hood is critical in

which would likely endanger building occupants. 7 hat procedures can be followed to minimize the chance of breaking glass bottles8
ANSWER!

- •$lways use a bottle carrier when transporting glass containers in halls" stairwells and elevators.
- •) ever store glass containers on the floor where they can be accidentally kicked or positioned on a stool or other insecure surface.
- • 2 inimize the size of working containers.

27. 7 orking alone in the lab can be very hazardous under most circumstances. . escribe some of the laboratory situations under which you should never work alone.
ANSWER!

- •) ever work alone in a laboratory unless assistance is close at hand and others are aware of your presence.
- • . efinitely never work alone when working with the following!
- •3igh energy materials or high pressures
- •Buick%acting" highly toxic materials *e.g. 3 ') -
- •Transfer of flammable material except in small uantities
- •&xperimental research or laboratory procedures where previous experience has shown the desirability of having assistance available.

28. The &nvironmental : rotection $gency re uires that all waste solvent containers be kept capped and clearly labeled. The

&nvironmental" 3ealth and / afety 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. 7 hy shouldn't metal safety cans or glass

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

30. #looding caused by plugged sinks and by carelessness in unattended water use has caused major damage to research e uipment" 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!

- 9se a water line with a regulator on it for all unattended water use.
- @eplace tubing before it becomes decomposed or brittle.
- . on t use pure gum rubber tubing for water lines.
- / ecure all tubing connections with wire or clamps.
- 9se locking uick disconnects where needed or secure non locking uick disconnects with clips to hold them together.
- 2ake sure that there are no objects or debris in the sinks that could restrict flow down the drains.

31. ' ommonly used solvents such as ether" dioxane and T3# can form explosive peroxides after exposure to air. 7hat can be done to minimize the hazards associated with peroxidizable compounds8

ANSWER!

- . ate and label when initially opening the container.

- / tore the compound in an obvious location where it will not be forgotten.
- ' heck ether solvents and other peroxides formers for peroxides six months after opening the containers and every six months thereafter or dispose of them. : eroxide test strips can be purchased from safety suppliers laboratory.

32. 2 ercury 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. 7 hat can be done to reduce the chance of mercury spills8
ANSWER!

- 9 se a catch pan of appropriate size and depth under all mercury% containing e uipment.
- 9 se non%mercury%containing thermometers where possible.
-) ever 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 temperatures8
ANSWER!
: otassium metal.

34. In the event of a small solvent or corrosive li uid spill which you can clean up yourself" explain the four steps for cleaning up spills.
ANSWER!

+. / lowly and carefully add) a(' O+ *sodium carbonate- or) a3 ' O+ *sodium bicarbonate- until neutralization is complete.

4. . ecant the li uid down the drain with at least E> times its volume of cold running water.

E. . iscard the solid as regular waste *except chromic acid.

• : rocedure for neutralizing most inorganic base spill materials!

<. / lowly add the caustic spill materials to a large volume of ice water with stirring *approximately a <!<> dilution-.

(. $dd E L hydrochloric acid until neutralization is complete.

+. ' heck with p3 paper.

4. . ecant the li uid down the drain with at least fifty times its volume of cold running water.

E. . iscard the solid as regular waste.

#or additional assistance in determining the appropriate method of treatment and neutralization" consult Lunn and / anson s . estruction of 3azardous ' hemicals in the Laboratory" or 2.$. $rmour s 3azardous Laboratory ' hemicals . isposal Huide.

35. The sinks in the laboratories are made of material which is uite inert chemically. &xplain why dry ice or li uid nitrogen mixtures should not be poured into the sinks.

ANSWER!

7 hile 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. 3ow should spilled mercury be cleaned up8

ANSWER!

2ercury droplets can be amalgamated with calcium polysulfide" zinc dust" sulfur powder or 2erconvap for spill clean%up. $spiration 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. 7 hile coating of mercury with flowers of sulfur temporarily lowers vapor pressure" vibration loosens the 3g/ coating" and e uilibrium pressure is reestablished. Thorough room ventilation may keep total vapor loading downI the best approach is to use all mercury over a catch pan to prevent spills in the first place. The &nvironmental 3ealth and /afety Office at KKK%cfbse al/ bs.@ f

ANSWER!

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

M. . o not use a standard voltmeter with standard leads to measure high voltages" as the voltmeter could explode.

39. On a <<E6 power cord" what is the standard) orth $merican color code8 * ' auPapparatus sinnbr$8.

interrupted" but for others it may be safer to drive the reaction to completion-. / hut%down includes! closing chemical containers" closing off heat supply" relieving all pressures" removing hazardous substances.

+. . etermine if evacuation of the lab would be re uired and if 9niversity : olice should be notified.

43.

' onsiderable energy can be released in their reactions. / ome peroxide compounds are unstable and can explode.

44. 7 hen an emergency situations occurs" it is too late to devise a plan of action and to find the safety e uipment that may be re uired for that emergency. &ach research group should have contingency plans for emergency response. This includes a working knowledge of the location and availability of emergency e uipment. In the space provided indicate the location of the following in or near your lab.
ANSWER!

45. 2 any research laboratories use hypodermic syringes on an ongoing basis. The syringe is considered as a controlled substance and violations of 9 niversity approved rules and procedures regarding use" disposal and appropriate storage of syringes will result in immediate withdrawal of the violatorAs access to hypodermic syringes and needles. . escribe the re uired procedures for use" storage" and disposal of hypodermic syringes andCor needles.
ANSWER!

- •&very 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.
- •3ypodermic syringes and needles shall be stored in a locked" secure place when not in use.
- •@ed plastic sharps containers will be provided for appropriate disposal of syringes and needles.) eedles and syringes must never be disposed of in waste baskets or dumpsters.

46. ' ryogenic li uids pose a uni ue hazard in the research laboratory due to their extremely cold temperatures and ability to displace oxygen when vaporized in a confined space. / erious injury or death can result from improper use and storage of these li uids. List two common cryogens used in the lab and describe how they should be properly stored8

ANSWER!

The two most common cryogens are li uid nitrogen and li uid helium. , oth are unreactive and inert. , ut their low N temperature properties make them substances with which we must take serious precautions. 3elium should be stored in the helium dewarI nitrogen goes into the nitrogen dewar. . o not mix the two" and do not put $) =T3 o t `y2 ogwieÀmiõ

<.9se gloves to protect your skin.

(. . O) OT T9 ' 0 =O9@ : $) T / I) TO =O9@ / 3O& / O@ , OOT / ◊ 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.

+.9se low pressures *(%4 psi- when transferring li uid helium. 3igh pressures *<> psi- in transfer is both dangerous and wasteful.

4.

49. $ good electrical ground protects you by giving the electrical current a safe path to follow in the case of an e uipment failure or fault. List at least three common situations that can result in a piece of e uipment having a bad electrical ground8

ANSWERS!

<.9sing (%prong plugs instead of +%prong plugs.

(.9sing a +%prong plug adapter in a (%prong outlet.

+.9sing the e uipment with wires that are bare of insulation.

4.9sing the e uipment with wires that are broken.

50. Heneral electrical safety includes the proper use of outlets" extension cords and outlet strips. 7hich of the following situation*s- describe unsafe practices in the use of outlets" extension cords or outlet strips.

- : lacing one or more extension cords along the floor in areas where people may trip over them.
- : lugging too many pieces of e uipment into the same outlet.
- 9sing extension cords that aren't rated to carry the current re uired by a piece of e uipment.

ANSWER!

$ll of the above represent unsafe laboratory situations which could result in fire" accident and ℃or electrocution. ' onstant 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.
 7 hat additional precautions will you need to follow in your graduate research8
ANSWER! *This is highly variable and should be discussed with your research adviser.-