

Research Methods Inquiries Lab Handbook

Table of Contents

Designing your inquiry

- Sample 2
- Chemicals 3
- Biological materials 4
- Storage requirements 5
- Glassware 6
- Equipment and Instrumentation..... 9

Basic chemical procedures

- Making solutions 11
- Dilution..... 11

Basic microbiological procedures (still to be added)

Safety

- Personal safety 13
- Lab safety 14
- Material Safety Data Sheets (MSDS) 15
- Room Access 16

Waste Disposal 17

Designing your inquiry

Part of designing an experiment is determining a complete list of all the supplies needed to perform that experiment. To make such a list, **you need to work out the details of your experimental procedure and make a list of exactly what you will need to do to perform every step of your procedure** (this is called a wetlab strategy). In doing this, you'll be able to make a complete, detailed list of chemicals and glassware that you'll need to complete your inquiry. In addition to avoiding any surprises by being prepared, you will also save a lot of time if you already have a clear idea of what you will be doing before setting foot in the lab.

The items that you may need to perform your experiment will fall into one or more of the following categories:

- Sample
- Chemicals
- Biological materials
- Storage requirements
- Glassware
- Equipment and Instrumentation

These items will be found in a variety of locations. Details of these different categories are listed below, along with how you can request what you need for each category. Once you have requested an item (chemical, biological, storage, other equipment) from the stockroom (not including the UTeach inventoried items), your instructor, TA and mentor can all access the master list that will show the status of your request (e.g., requested, ordered, received, ready for pickup). If what you have requested is available in the stockroom, the turn-around time from when you sent your request until when you can pick up your materials may be quite short, probably 24 hours. Biological materials take about one week to be delivered. Chemicals that we have to order for you may take that long also. The message is to plan ahead and order early.

Sample

Many inquiries involve some sort of “real world” sample. Perhaps you want to measure the amount of Vitamin C in orange juice, or the dissolved oxygen in the water in the turtle pond, or see whether there is bacteria on your dormitory doorknob. **In most cases, you have to supply your own sample.** Very occasionally your sample is very specific and you need us to purchase it; e.g., a specific bacteria. Talk to your TA if you think this might be the case, and follow the information in the appropriate section below (chemical or biological) to request such a sample. **You may not do any experimentation on blood**, including your own. Bloodwork involves a variety of hazards, and would involve extra safety precautions that we are not prepared to supply. **You may not experiment on vertebrates, including humans.** That requires extensive documentation and approval by government agencies that normally would take too long. Sometimes you will make your measurement *in situ*, meaning you take

your experiment to the location; e.g., taking a turbidity probe to various locations on a river bank. If you have to collect your sample and bring it to the lab, you need to consider the number and size of samples you need to collect, and request appropriate sampling containers/equipment that will not contaminate your sample. You also need to determine whether your sample is time-sensitive, meaning how quickly do you need to make your measurements once the sample is collected.

Chemicals

Many of you will need to obtain chemicals for your inquiry. First, you need to decide exactly which chemicals and how much of each you will need, as discussed in the Basic Chemical Procedures section. Next, you need to fill out a "Requisition for Chemicals" form that includes many fields ALL OF WHICH NEED TO BE FILLED IN, and an explanation of each field follows. Finally, you need to email it to the address at the bottom of the form. Please do not submit paper copies.

Chemical name

This is fairly self-explanatory; it is the name of the chemical being requested. Do NOT use abbreviations – give the full name of each chemical required. The formula is not needed. It is sometimes not obvious which chemical is needed, especially if you need a **standard**. For example, if you are using a technique to measure the amount of sodium in your sample, then you need a **standard** sodium solution. Using that standard, you can see how much signal or how large a response a known amount of sodium will produce. You can compare that to the amount of signal/response your sample produces. Sure we can supply you with a chunk of sodium, but that's dangerous stuff. There are lots of common sodium salts (e.g., NaCl, NaOH, NaHCO₃, NaNO₃, etc.), which you can dissolve to make a solution with a known concentration of sodium. If you need a standard, and you don't know how to choose the chemical to make that standard, ask for help. Don't forget to request both the **solvent** (liquid you will dissolve your chemical in) and the **solute** (chemical you are dissolving) if it is something other than water. If you are making an aqueous solution, use deionized water, not regular tap water.

CAS number

Every chemical has a **Chemical Abstract Service Number** (CAS#) that is a unique identifier for that chemical. Chemicals often have a number of different names, but the CAS number tells you, for example, that acetone and dimethyl ketone are the same substance. (It does not, however, distinguish between various concentrations of the same chemical. The CAS number for 0.1 M hydrochloric acid will be the same as the CAS number for 12 M hydrochloric acid. Also, be aware that mixtures will have multiple CAS numbers; one CAS number for each component in the mixture.) You must supply the CAS number for every chemical you request. This is standard procedure in any chemistry lab, so you need to get used to doing it. The CAS number is usually given inside square brackets, e.g., NaCl is [7647-14-5]. The MSDS for every chemical includes its CAS number, as does the catalog for any chemical company. We usually buy from <http://www.sigmaldrich.com/> OR <http://www.fishersci.com/>.

Chemical quantity

To determine the amount of each chemical you will need, you need to do preparation calculations. Most often, you will be making chemical solutions. You will need to know how much of each solution you will use, which means thinking out how much you will need per experiment, and how many samples and how many replicates (repeated experiments) you will perform. Once you know what volume of solution you need, you need to know whether the chemical comes as a solid or a liquid, and then what mass or volume of the chemical you will need to make the whatever molarity solution you require. If you need a series of solutions of different concentrations, rather than make each of them from scratch, you make the strongest concentration solution, and then dilute it to make the weaker solutions needed. Information on how to make solutions and dilutions is provided in the Basic Chemical Procedures section. Do not over-estimate the quantities you need on purpose to cover errors in your lab technique; we will make that estimate for you. Although the calculation is easier, do not plan to make one liter of every solution. Determine how much you actually need, and make the smallest volume possible, making sure there is a volumetric flask of that volume available. (Standard sizes of volumetric flasks are 10, 25, 50, 100, 250, 500, 1000 mL.) Note that you will not be able to weigh < 10 mg accurately, so if your small volume low concentration sample requires that small a mass, make a more concentrated solution and dilute it down to reach the desired concentration (as described in the Basic Chemical Procedures section). When filling out the Chemical Request form, round the required mass and volume quantities up to two significant figures. Reduce waste.

Chemical hazards and storage

Chemical storage is based on both hazards and physical characteristics. You may need to store chemicals in a refrigerator or freezer depending on their melting/boiling point. Hygroscopic chemicals absorb water from our humid atmosphere and need to be kept in a desiccator. Light-sensitive chemicals should be stored in dark containers, such as amber (actinic) glass, or wrapped in aluminum foil, and kept in a cupboard. Flammable chemicals need to be stored in a flammable cabinet. This information can be obtained from the chemical's MSDS (Material Safety Data Sheet). For more information about MSDSs, refer to the safety section.

Biological materials

Some of you may need to obtain biological materials for your inquiry. Once you have designed your inquiry, you need to fill out a Media Request Form. We hope to create a Basic Microbiological Procedures section for this manual in the future.

Solid Media Request

If you plan on streaking bacterial samples on plates, fill in the "Solid Media Request" section. Type of media is what the bacteria will be grown on; you will probably use TSA (Trypticase Soy Agar). You also need to indicate the number of plates you need for your inquiry. Slants and deeps are available, but they are used primarily for samples requiring longer term storage than you will typically require

for your inquiry.

Liquid Media Request

If you are planning to use liquid media, you still need to indicate the type of media you need, which will most likely be TSB (Trypticase Soy Broth). Liquid media is readily available in tubes containing 5 mL (a 5 mL “aliquot”). If your inquiry requires liquid media in something other than 5 mL aliquots, liquid media is available in bulk upon request.

Microbial Request

A variety of live cultures is available for you to use, as well as some yeasts and fungi. Contact the Analytical/Physical Chemistry Teaching Stockroom to see what is available.

Sterile Materials Request

If you need any other sterile items for your inquiry, such as cotton swabs or inoculating loops, you can request them here.

Storage requirements

When you receive chemicals from the WEL 2.128 stockroom, they will be labeled with your name and the chemical name. Whenever you put chemicals into another container, you need to similarly label that container. If you do not plan to store the chemical in that container past the end of your lab period, use a sharpie marker on glass or plastic containers. If you do plan to store something, e.g., a solution, after the lab period ends, get one of our premade chemical labels from the stockroom or WEL 5.132 and fill in all the blanks, which will include a “dispose by” date, meaning a date after which you will be finished with it. Ask your TA or mentor where you may store your chemicals, making sure you pay attention to the storage requirements of those chemicals.

Recognize that most biological materials cannot simply be stored on a shelf. Incubator space for Petri dishes is limited and must be requested ahead of time. There is a small amount of incubation space available in PAI 4.14. There is no incubator space in WEL 5.132. We may obtain access to some other incubator space in an FRI research lab, but this needs to be arranged ahead of time. For this reason, we prefer that you work with aliquots of bacteria in eppendorf tubes or test tubes that can be stored at the appropriate temperature in water baths. This must also be arranged ahead of time, but we have more available space in water baths. Storage at other temperatures (e.g., refrigerators or freezer) is available if you request it from the WEL 2.128 stockroom ahead of time so it can be arranged.

If you need to store any other part of your experiment in the lab, you must make sure your experiment is placed out of the way in a box/tray/container labeled with your name, TA name, mentor name, and disposal date. The WEL 2.128 stockroom can supply clean storage containers. You need to specify number, size and what the containers need to be made from, if that matters. Be aware that not all solutions can be stored in

just any container – some solvents will dissolve our plastic bottles, for instance. Ask your TA or mentor for the location in your lab where your experiment may be stored.

Glassware

In doing an inquiry, a variety of different types of glassware may be needed. This section includes a brief description of some of the more common items and the circumstances under which they may be used.

Locating glassware

The first place to look for glassware is in the lab in which you are experimenting (WEL 5.132 or PAI 4.14). PAI 4.14 has one large cupboard full of glassware, and WEL 5.132 has a set of drawers with an inventory telling you the location of each type of glassware that is available in the room. If what you need is unavailable in your lab, you may request it from the Analytical/Physical Chemistry Teaching Stockroom (WEL 2.128). Any glassware used must be cleaned and returned at the end of that lab period for others to use. If you wish to store anything between lab periods, ask for a secondary container (bottle, jar, vial, etc) to use as storage instead.

Cleaning glassware

Always start with clean glassware. Be aware that water spots on glassware indicate that it is NOT clean. Water will “sheet” on clean glassware and not leave water spots. There are several ways to clean glassware, but for the most part you will only need to use one of two methods. The bulk of what you will be using should come clean with a general purpose lab detergent (e.g. Alconox) solution, and the typical concentration used is 10g/L of water. Our labs have squeeze bottles containing already diluted lab detergent beside the sinks. If this doesn't work, doubling the concentration of the detergent may help. If this still doesn't work, then you may need to try some more aggressive methods. Check with the TA.

Acetone, ethanol and hexanes are also used to clean glassware, but they are typically only necessary you are using organic compounds. For instance, if there is a layer of naphthalene crystals coating the inside of a flask, acetone would be an excellent choice for cleaning. If, however, the glassware is contaminated with something like sodium hydroxide solutions or even organic solvents like ethanol or chloroform, washing with acetone is unnecessary and a waste of solvent. Note that any solvent used to clean glassware (other than water) MUST be disposed of in the appropriate waste container, NOT DOWN THE DRAIN.

The glassware in WEL 5.132 belongs to two FRI research streams who do organic chemistry research. They have the additional requirement that after cleaning as described above, their glassware must also rinsed with deionized water and then acetone-dried before being returned to where you found it. There is one deionized water faucet at the back sink. To rinse with acetone, use a squeeze bottle available at any sink to put a SMALL amount of acetone in the container. Swirl it around so that all inside surfaces of the glassware have been coated in acetone. Tip out the liquid

into an acetone waste bottle, available at every sink, and put the lid back on the waste bottle when you are done.

Beakers

Beakers are a quintessential part of any lab and serve a variety of functions, such as satellite containers (a container into which reagents to be used are placed so as not to contaminate the stock reagents), temporary storage containers, mixing vessels, and containers to use on a hot plate. The volume markings on the sides of most beakers are only within approximately 5% of the indicated quantity; therefore, they are not used to make standards of a specific concentration. A volumetric flask is more appropriate for that task (see below). In the Analytical/Physical Chemistry Teaching Stockroom, beakers are available in a range of sizes from 10 mL to 4000 mL.

Volumetric flasks

Volumetric flasks are used when a quantity of a solution needs to be prepared at a specific concentration, as the final volume of the solution is easily controlled. Most volumetric flasks are available calibrated “to contain” (TC) meaning that when the container is filled such that the bottom of the meniscus just meets the mark etched in the neck of the flask (fiducial mark), there will be the specified volume in that flask within the tolerances of the flask. Volumetric flasks are available in various sizes; the following sizes are available in the Analytical/Physical Chemistry Teaching Stockroom: 1 mL, 2 mL, 5 mL, 10 mL, 25 mL, 50 mL, 100 mL, 200 mL, 250 mL, 500 mL, 1000 mL and 2000 mL. There are also some sizes available in actinic (amber) glass for solutions which are light-sensitive. DO NOT put a volumetric flask on a hotplate. It will no longer provide an accurate volume measurement once you have done so.

To prepare a solution in a volumetric flask:

- Add the solute to the flask
- Add solvent to the flask, filling it approximately half- to two-thirds full.
- Mix the contents of the flask by repeatedly inverting the flask (making sure that the stopper is securely seated in the flask. (The added room in the flask will facilitate dissolution of the solute.)
- When the solute is completely dissolved, dilute the contents of the flask to the fiducial mark with solvent.

Volumetric (transfer) pipets

Volumetric pipets are used to transfer a specific quantity of a liquid to another container. They are almost always calibrated “to deliver” (TD), meaning that when the pipet is filled to the fiducial mark and then allowed to drain into the desired container, the volume delivered is that which is indicated on the pipet within the tolerances of the pipet. Most pipets (and all of the pipets available from the Analytical/Physical Chemistry Teaching Stockroom) are designed such that when the pipet is drained, there will be a small amount left in the tip of the pipet. Do NOT blow out the last bit of liquid in a pipet that is calibrated to deliver. Doing this will

deliver more than the quantity indicated on the pipet and skew your results. Finally, always use a pipet of the volume desired when possible. If the goal is to dispense 4 mL, use a 4 mL pipet instead of a 2 mL pipet twice or a 1 mL pipet 4 times. It may mean dirtying a few more pieces of glassware, but accurate results are worth it. Volumetric pipets are available from the Analytical/Physical Chemistry Teaching Stockroom in the following sizes: 0.5 mL, 1 mL, 2 mL, 3 mL, 4 mL, 5 mL, 7 mL, 10 mL, 20 mL, 25 mL, 50 mL and 100 mL

To transfer a liquid using a volumetric pipet:

- Rinse the clean pipet with a small amount of the liquid being transferred.
- Use a pipet bulb to fill the pipet via suction from your satellite container until the level of the liquid is ~1 cm above the fiducial mark.
- Remove the pipet bulb and place your thumb or finger over the top of the pipet and use pressure to control the flow of liquid.
- Use a clean kimwipe to wipe any excess liquid from the outside of the pipet.
- Still holding the pipet over the initial satellite container, allow the meniscus to slowly fall until it reaches the fiducial mark.
- Touch the tip of the pipet against the side of the satellite container to remove any drops hanging from the tip of the pipet.
- Hold the pipet over the target container and allow the liquid to flow from the pipet. Once the liquid stops flowing from the pipet, hold the tip of the pipet against the side of the target container for several seconds in order to facilitate complete drainage of the pipet.

Erlenmeyer flasks

Erlenmeyer flasks are also very common in chemistry labs. The narrow neck allows for storage of solutions using a stopper, and slows evaporation of the liquid better than a beaker. The angled sides make for much easier mixing of solutions by swirling or stirring, reducing the possibility of splashing the solution. The volumes marked on the sides of most Erlenmeyer flasks are usually only within 5%, so they are not used for making standards of a specific volume. FYI: The Erlenmeyer flask is named for the German chemist Emil Erlenmeyer who invented it in 1861.

Erlenmeyer flasks are available from the Analytical/Physical Chemistry Teaching Stockroom in the following sizes: 25 mL, 50 mL, 125 mL, 250 mL, 500 mL, 1000 mL, 2000 mL and 4000 mL.

Graduated cylinders

Graduated cylinders are just that – cylinders with graduations marked on the side. They are very useful for delivering approximate volumes of liquids and have smaller tolerances than beakers or Erlenmeyer flasks, but are not nearly as accurate as volumetric flasks or volumetric pipets. Graduated cylinders are available from the Analytical/Physical Chemistry Teaching Stockroom in the following sizes: 10 mL, 50 mL, 100 mL and 1000 mL.

Small plastic (disposable) pipets

Just a quick note about these incredibly useful items: many of them have marks indicating APPROXIMATE volumes. These are NO substitute for pipetters or volumetric pipets.

Equipment and Instrumentation

The majority of equipment and instrumentation you may need for your inquiry is contained in the UTeach inventory as described below. Most other items that you may need, such as standard apparatus and consumables are available in your research methods lab. Some of these standard items are described below. If you can't locate something, ask your mentor, TA, a student worker (if you are in PAI 4.14), or someone in the Analytical/Physical Chemistry Teaching Stockroom (if you are in WEL 5.132). If we can't locate what you need, we may be able to order it for you if it is not too expensive.

UTeach Inventory

The UTeach inventory <<https://uteach.utexas.edu/direct/>> can be used to search for and reserve scientific equipment and instruments. It lists items available from UTeach (listed as located on the fourth floor of PAI) and from FRI research labs (all other locations). FRI items are generally available for use in the FRI lab only. Your TA or instructor will have to coordinate with the relevant FRI Research Educator to arrange access. Unless listed on the inventory as not available for checked out, UTeach items may be checked out for one 24 hour period at a time from any UTeach student worker, whenever PAI 4.14 is open. (M–Th 8 am – 9 pm; Sat noon – 5 pm; Sun 1 – 6 pm). To return equipment, you must check it back in with a UTeach student worker.

Manuals are available for download through the inventory. It will save you time if you browse the manual and have an idea how to use the equipment before actually checking it out for your experiment. Depending on your instructor, you may be required to complete an *Equipment Familiarization* form before taking the equipment out of the lab.

Pipetters

Pipetters are often used in place of volumetric pipets. When used correctly, a pipetter will deliver the indicated volume within the specified tolerances of the pipet. Pipetters are NOT, however, a universal replacement for volumetric pipets; check with your TA if there is any question about which one you should use. Pipetters are available from the Analytical/Physical Chemistry Teaching Stockroom in the following sizes: 0.5-10 μL , 5-50 μL , 20-200 μL , 100-1000 μL , 1-5 mL, and 2-10 mL.

To use a pipetter:

- If you are using an adjustable volume pipetter, adjust the pipetter to the desired volume by turning the knob at the top. If you are using a fixed volume pipetter,

- skip this step.
- Place a new tip on the end of the pipetter (Always use a new tip every time you use the pipetter).
 - Depress the plunger until the first stop is felt.
 - Place the clean tip in the solution to be dispensed.
 - SLOWLY release the plunger (this draws the desired amount into the tip).
 - Hold the pipetter over the target container and depress the plunger to the first stop, wait 2-3 seconds, and finish depressing the plunger as far as possible. Note: Depressing the plunger past the initial stop blows out whatever is left in the tip, which is a good thing.

Balances

Balances are an important part of any chemistry lab, and they are available in many styles and capacities. Top-loading balances may be available in the lab as well as analytical balances complete with doors on the side to prevent drafts from affecting measurements. When using a balance, keep in mind that chemicals should NEVER be weighed directly on the balance pan. Some sort of containment must always be used, such as a weigh boat, weigh bottle or weighing paper. Also be aware that temperature can affect what is being weighed. If the item(s) being weighed are warmer than room temperature, the apparent weight will be lower than it would be if it were room temperature. The simplest solution to avoid this problem is to make sure all warm objects are cooled to room temperature before being weighed. Finally, even though most analytical balances go out to four decimal places (0.1 mg), you should never try to weigh less than 20 mg of something because the relative error introduced becomes quite large compared to the amount being weighed.

Dataloggers and probes

Many inquiries will require the use of a datalogger and a probe. The probes do not plug directly into a computer; they require the use of a datalogger as well, and are requested separately. Many of the probes require calibration; there are instructions for this in the manual which accompanies the probe. Some of the probes also require special storage conditions (for example: some of the probes must stay upright); this information will also be in the manual accompanying the equipment. READ THE MANUAL ACCOMPANYING THE EQUIPMENT. It will save you much time and frustration, and perhaps even some money because you will be much less likely to break the equipment.

Basic chemical procedures

Making solutions

A simple solution is made up of a solute dissolved in a solvent. Most commonly, the solvent is a liquid and the solute may be a liquid or a solid. Determine the total quantity of the solution you will need. Round up to the closest size of volumetric flask we have that is larger than the quantity you want to make. (The following sizes are available in the A/P stockroom: 1 mL, 2 mL, 5 mL, 10 mL, 25 mL, 50 mL, 100 mL, 200 mL, 250 mL, 500 mL, 1000 mL and 2000 mL.). Find out the number of moles n of solute needed for that volume of solvent (in L), to make the concentration in M (= moles/L) you need, using this formula:

$$\text{Number of moles (moles)} = \text{Concentration (M)} \times \text{Volume (L)}$$

Then use the molecular weight of the solute to convert number of moles to mass (in g):

$$\text{Mass of solute (g)} = \text{Molecular weight (g/mol)} \times \text{Number of moles (moles)}$$

If the solute is a liquid, then you have one more step, using the density of the liquid to convert mass (g) to volume (in mL):

$$\text{Volume of solute (mL)} = \frac{\text{Density (g/mL)}}{\text{Mass of solute (g)}}$$

Go and measure the correct mass of solid solute using a balance, or the correct volume of liquid solute using a volumetric pipette. For liquids, measure the closest volume you can to that calculated, and then use that volume to calculate the actual concentration of the solution that you make.

Put the correct amount of solute into a volumetric flask that is the correct size to make the total quantity of solution you used in the calculation. Follow the instructions of how to use a volumetric flask to dissolve the solute in the solvent and then fill it carefully up to the mark.

Dilution

If you need a series of the same solution covering a range of concentrations, perhaps to make a calibration curve, then rather than making each solution separately, you would make a single solution of the highest concentration needed, and then make a set of dilutions of that concentrated solution. When making a dilution, adding more of a solvent to a solution decreases the concentration of the solution without changing the number of moles of solute in the solution; i.e.,

$$M_i V_i = M_f V_f$$

where M_i and M_f are the initial and final concentrations of the solution and V_i and V_f are the initial and final volumes of the solution.

Here is an example of how to make a solution that is one-quarter the concentration of the original concentrated stock solution:

- Use a volumetric pipette to transfer 25 mL of the original stock solution into a 100 mL volumetric flask.
- Add some solvent and swirl to mix.
- Use more solvent to fill the flask up to the mark. You now have a solution that 25 mL of original solution in a total of 100 mL, i.e., 25/100 or $\frac{1}{4}$ the concentration of the original solution.
- You could repeat this putting 2, 5, and 10 mL of the original solution into three separate 100 mL volumetric flasks and diluting to the mark to make solutions that were $\frac{1}{50}$, $\frac{1}{20}$ and $\frac{1}{10}$ the original concentration, for example.

Safety

Being safe in a lab is not negotiable. There are safety rules in effect for any lab, and they are not in place for the amusement of the lab directors. Any time you are in a lab setting you must wear the appropriate personal protective equipment, even if you personally are not doing something hazardous. Other people work in the lab, and they may be doing something hazardous or something may have been unintentionally left in a dangerous state. Never eat, drink or chew gum in a lab.

Personal safety

Eye protection

Eye protection must be worn in the labs at all times. When you enter a lab, your eye protection needs to be covering your eyes (not on top of your head, where it is protecting your head; or around your neck, where it is protecting your neck - neither of which are protecting your eyes!).

Clothing

Clothing must be appropriate for the lab as well. Leg covering should come to the knee. Shorts, skirt, kilt - it doesn't matter, but whatever you are wearing, it needs to come to the knee. Shirts should have some sort of sleeve and cover the waist while moving around. If, while reaching for something, the tummy is exposed then that shirt is not appropriate to wear in the lab. Shoes should enclose the foot. Flip flops and sandals are obviously unacceptable, but so are the ballet flats which leave the almost the entire top of the foot exposed. Tie back long hair, and don't wear dangling jewelry in the lab.

Gloves

Gloves are a powerful tool to protect you from chemical exposure, but they can also create some very dangerous situations if not worn appropriately. So, about wearing gloves...

Use gloves appropriate to the task at hand. Gloves can be made from a variety of materials, and the gloves you choose will depend upon what you are using.

Change your gloves often. Once a chemical comes into contact with your glove, it will start to permeate the glove. Given enough time, the chemical will completely permeate the glove and then become trapped against your skin.

Be aware of what you are touching with your gloved hands, and do not wear gloves outside of the lab. Anything on your gloves will track to anything you touch; this includes the pen you use to record your data, the water fountain in the hall outside the lab or the keyboard of your computer.

Lab safety

Familiarize yourself with the safety features of the lab BEFORE you start doing an experiment. Standing a few inches from the blazing fire is not the time to try and figure out where the fire extinguisher is located. You should be able to find any of the following at a moment's notice:

Use hoods when appropriate.

If you are given something and told to keep it in a hood, please do so. Sometimes it is just a matter of an unpleasant odor, but sometimes it is a matter of toxicity or some other hazard.

Safety shower

The safety showers are generally located near the entrances to the lab. When the handle is pulled, a valve is opened and a large volume of water is dispensed. Be aware that this may make a rather large mess, and will probably activate an evacuation alarm in part (if not all) of the building. If you have an incident that requires you to get in the shower, then by all means do so. Be aware; however, that a small chemical exposure may just as easily be addressed in the sink or in the eyewash (which generates a large volume of water but has a relatively gentle flow). You must also remove your clothing if you need to get in the shower. Modesty aside, it can mean the difference between a relatively small exposure requiring minimal further attention to extensive injury requiring lengthy medical treatments.

Eye wash

If you need to use an eyewash, you need to know two things. First, you will need to physically hold your eyes open with your fingers. When something gets in your eyes, it is painful and your tendency is to squeeze them shut. However, if your eyes are closed you will not flush the irritant away. Hold your eyes open. Second, you need to stay in the eyewash for at least 15 minutes. This is to ensure that all of the irritant is flushed away. It will be the longest 15 minutes of your life, but do it anyway.

Fire extinguisher

When using a fire extinguisher, remember the acronym PASS:

1. **P**ull the pin on the handle of the extinguisher. The pin serves to keep the extinguisher from discharging accidentally.
2. **A**im the nozzle at the base of the fire, not at the top of the flames.
3. **S**queeze the handle of the fire extinguisher in order to release the extinguishing medium.
4. **S**weep the nozzle of the extinguisher slowly back and forth across the base of the fire.

First aid kit

The first aid kit in the lab should contain anything needed to address a small cut or burn, or other minor personal injury. If an incident like this occurs, notify your TA. (Perhaps the chemical exposure from whatever was on the pipet before it went through your hand needs to be addressed before the cut itself.)

Spill kit or spill pillow

A spill kit should contain anything needed to neutralize and clean up a small spill in the lab. Typically, a spill kit will contain sodium bicarbonate to neutralize acid spills, citric acid to neutralize base spills, vermiculite to absorb any solvent spills, gloves, a broom and dustpan, and plastic garbage bags for disposal of the residual cleanup mess. A spill pillow can be used in place of a spill kit to absorb whatever spill has occurred. Do NOT dispose of a spent spill pillow or any residue from a spill cleanup in the trash; see your TA for the proper disposal method.

Evacuation route and designated gathering area

Make a note of the appropriate evacuation route and gathering area for your lab, and STAY THERE. Someone will come to check and see if everyone has made it out of the building. If you disappear to get a soda or something and we don't know that you have made it out of the building, we will assume that you are stuck somewhere inside and start sending people back into the building to look for you.

Material Safety Data Sheets (MSDS)

One of the most dangerous things you can do in a lab is be unfamiliar with the chemicals with which you are working. If you review the hazards of the materials you are using, you are well prepared in the event of an incident. If not, then you are quite likely to react in a way that will only make the situation worse. For any chemical you want to use, you should first review the MSDS for that chemical. For both storage and safety reasons, you need to be aware of the physical characteristics and hazards of each chemical that you are using. An MSDS (materials safety datasheet) is available for every chemical. You can find links to searchable MSDS databases here:

<<http://www.utexas.edu/safety/ehs/msds/>>. An MSDS has a lot of information in it, but there is no single format they have to follow, making it hard to tell you exactly where to find which pieces of information. Here are some things given in an MSDS that can be useful to you:

CAS Number

see Page 3

Molecular weight

You may need this for calculations, such as determining concentration.

Physical data

Information such as pH, whether it dissolves in water, density, etc. can be very useful.

Fire and explosion hazards

It is important to note the flashpoint (temperature above which the chemical will burn in air) and whether your chemical is flammable (and under what conditions).

Reactivity

This section contains information on other chemicals with which your chemical is particularly reactive. Keep them apart.

Health Hazards data

This section lists all the possible hazards of your chemical through acute and chronic exposure, inhalation, skin contact and ingestion, etc. An approach of healthy respect for chemical hazards is more appropriate than either blatant disregard or abject terror.

Safe handling precautions

While this information may not have this specific section heading, there should be a section summarizing how to store, use and dispose of your chemical safely.

Room Access

You may not work in a lab unsupervised. When working outside the lab, we trust you will use appropriate good sense with respect to health, safety, and legal issues in all of your data acquisition efforts. You must start your experiment while being supervised by your instructor, TA, or mentor. After observing you work, they may tell you that you seem to be confident and competent enough to work on that inquiry with minimal supervision. The times you can work in the lab depend upon whether you need full or minimal supervision. Your TA or instructor will make that decision.

Information on how to arrange full or minimal supervision access to the lab, outside your regularly scheduled lab time, will be available soon.

Waste Disposal

You will probably generate waste during the execution of your inquiry. Safe disposal of that waste is an important part of your inquiry. Disposing of waste in an appropriate manner saves both money and the environment. Certain kinds of waste can be blended and burned as fuel, but not if the waste is contaminated with something that cannot be burned. A few milliliters of a non-blendable material added to the wrong container may require gallons of waste to be buried in a landfill, which is a much more expensive method of disposal than burning.

Minimize the amount of waste you generate.

Do not get more of a chemical than you need. Once a chemical is removed from the stock container, any that remains unused must be disposed of as waste (pouring chemicals back into the stock containers leads to contamination of the stock.

Categorize your waste

Our waste is divided into seven categories, and you must determine into which category your waste falls. There is a flow chart available that will help determine this. In rare instances, you may have a waste that should not be put in any of our categories; if this is the case, you will be informed of how to dispose of this waste when you are given the chemical. The flow chart is a series of yes or no questions; simply follow the arrows answering the questions until you ultimately come to the container into which you will put your waste.

If you are unsure as to how to answer any of the questions on the flow chart, ask your TA. Do NOT simply pick any container and hope it will work. Mixing incompatible wastes can lead to explosive or lethal (literally) situations.

If you have waste and you cannot determine what it is, let your TA know. Unknown waste is extremely expensive to dispose of as it must be analyzed prior to disposal. If you generated it, there are just a few things it could be and its identity can at least be narrowed to a comparatively small range of possibilities.

Dispose of your waste in the appropriate container.

For 2009 Research Methods, all waste disposal must be supervised by your instructor, TA, or mentor. Before you put any waste in the container, check to see if the container is full. If the container is full, your lab TA will be able to get a new container for you. If the container is not full, add your waste to the container.

If you put something in the wrong container, IMMEDIATELY let your TA know. It may be harmless, but it may be that you have mixed incompatible wastes and immediate steps may be necessitated in order to prevent the aforementioned explosive or lethal situations.

Record your waste disposal on the appropriate waste log form

Record what you put into the container on the associated waste log form. YOU MUST RECORD ALL WASTE ADDED TO THE WASTE CONTAINERS ON THE

FORM FOR THAT CONTAINER. This is the only way we can determine the contents of the containers, and that information is needed in order to determine the final disposition of the waste.

A note about solid waste

Items such as gloves, paper towels, kimwipes and the like are only considered solid waste if they are "grossly contaminated". Unless the contamination of the gloves or other like items is severe or the chemicals being used are particularly hazardous, gloves worn during the course of regular lab work will be disposed of in the regular trash cans.