GUIDED INQUIRY EXPERIMENTS

INTRODUCTION

This manual contains experiments that cover some of the main areas of chemistry students will encounter in the lecture part of **CHEM101.** Unlike some traditional laboratory approaches, the students are not expected to know anything about the subject being considered before you go to the lab. These are Guided Inquiry Experiments. The design and purpose of the experiments is to introduce the students the subject area and give a concrete experience with the concepts before they are are discussed in a more abstract way in the lecture. Students will be often exposed to certain concepts and ideas for the first time during the lab which will help them their understanding of the concepts.

Since the experiments are designed to help learn some of the laboratory techniques and procedures that the **Scientists** investigate in nature, they also introduce some of the basic concepts of chemistry. During the experiments students will encounter a question that asks them to draw pictures, a Mental Model, to show their understanding at the atomic / molecular level which they are studying. In these guided enquiry experiments, students will be given specific instructions as to what to conduct and answer questions about the data collected.

CONTENTS:

1. Measurements and Acid-Base Classification
2. Determination of the concentration of an acid (two- parts)
3. Dissolution Reactions: Heats of Dissociation
4. Chemistry Model Kit System: Chemical Bonding & Molecular Structures

SAFETY IN THE LABORATORY

Almost all chemical laboratories by its very nature have several potential hazards which can cause injuries such as chemical burns, fire burns, poisoning and cuts. However, serious injuries rarely occur in student labs when safety rules such as the following are thoughtfully and strictly observed.

SAFETY PRECAUTIONS

WEAR SAFETY GOGGLES AT ALL TIMES. Injury to the eyes can easily cause a lifetime of blindness. Safety goggles offer excellent protection against such injury. These must be worn over the eyes (not on your forehead!) at all times that anyone in the lab has an experiment going on.

WEAR PROPER CLOTHING. To protect the feet and legs from chemical spills, wear shoes (not sandals) and full-length, loose-fitting pants in the lab. Also it is advised that old clothes be worn as minor chemical spotting will occur from time to time. Tie back long hair so that it does not fall into flames or chemicals.

DO NOT TOUCH TASTE OR SMELL LAB CHEMICALS. Use the proper equipment (spatulas, pipets, beakers—see Appendix B) to handle chemicals. Tasting of lab chemicals is strictly forbidden, as is eating or drinking normal foods in the lab. Any of these can easily lead to poisoning. If you must smell a chemical, use an indirect wafting technique.

DO NOT USE CRACKED OR CHIPPED GLASSWARE. Replace such glassware or fire polish chips at the direction of your instructor.

DISPOSE OF CHEMICALS AS DIRECTED. Do not put lab chemicals into waste baskets or directly down a sink drain. Waste chemicals should be placed in crocks or disposal containers as directed by the instructor. (Occasionally, the instructor may allow you to wash soluble, harmless chemicals down the drain.)

KNOW THE LOCATION AND USE OF SAFETY EQUIPMENT. Your lab will be equipped with safety equipment. Talk to your instructor about how and when they are to be used. Find at least two ways to exit the lab.

NEVER LEAVE A BURNER FLAME OR REACTION UNATTENDED.

WHAT TO DO IN CASE OF ACCIDENTS

SKIN CONTACT WITH CHEMICALS. This is the most common form of accident, usually affecting the hands and forearms. The key word for treatment is water, large volumes of it. Immediately wash the affected area with large volumes of water. Do these even if no sensations of burning is felt, since many chemicals are slow acting. Use a faucet for the arms and hands. For the face, use an eye-wash fountain. Keep your goggles in place for the beginning of the wash so as not to wash the chemical into your eyes. For the torso or legs go to the restroom, disrobe as needed, and wash the affected area with large amounts of water. Also rinse the affected clothing before using it again. If an immediate, heavy burning sensation is felt on the torso or legs, use the safety shower. Report the accident to the instructor.

CHEMICAL SPILLS. Any spills, no matter how small, on the bench or floor must be taken care of immediately to prevent others from unknowingly getting injured by them. Check with the instructor for clean-up procedures. Usually a spill can be handled by wiping it up with a wet cloth or sponge. The spot should then be washed twice more with fresh water and wiped dry.

HEAT BURNS. These come from the momentary touching of hot pieces of metal or glass. Hold the burned area under a stream of cold water or pack it with ice. Report the injury to the instructor.

CUTS. For small cuts, wash them with water and secure a dressing from the instructor.

SMALL FIRES. These can usually be extinguished by smothering with a double thickness of toweling.

THINK, THEN ACT. Most injuries occur from reacting too fast to a situation; i.e., an overflowing reaction, a falling beaker. (Trying to catch a beaker of corrosive chemical is tricky, to say the least.) The best thing to do in such a situation is to shout a warning, back away, and let the accident happen. Then think a few seconds about what you can safely do to rectify the sitzatian—and do it. Normally, this will simply be to get the instructor.

SERIOUS ACCIDENTS

You be the judge of what is serious. Remember it is better to be slightly embarrassed than to let a situation worsen. Your immediate reaction should be to:

1. Back away from the danger area.
2. Shout for help.
3. Try not to panic; stay as calm as possible. The instructor will know what to do.

If you are not involved in the accident, you may be called on to lend your instructor some assistance. Primarily this assistance will take the form of getting a person under the safety shower to extinguish flames or to wash off a serious spill.

COMMON PROCEDURES AND EQUIPMENT

BALANCES

The weighing (or massing) of chemicals is one of the most used and potentially most precise measurements employed by chemists. The measurement is done by counterbalancing the substance of unknown mass against objects of known mass. This balancing act is accomplished by means of a delicate pivot point called a knife edge. Thus the measuring instruments used are called balances.

Three types of balances are available: the triple beam balance, the top loading electronic balance and the analytical electronic balance. Your instructor will give you specific instructions for the type of balance you will use; however, it is strongly suggested that you study the comments below before doing any balance work.

CARE OF THE BALANCE

Because balances are very delicate and fairly expensive instruments, the following rules must be followed.

Do not attempt to repair a balance that is malfunctioning. Inform your instructor about the problem.

Never place chemicals directly on the balance pans, as this will lead to corrosion and eventual malfunctioning. Beakers, paper "boats," etc., should be used to hold the chemical being weighed.

Never remove chemicals from a container while it is on the balance pan. This might put too much pressure on the pan. Always remove the container completely from the balance before removing chemicals.

Add chemicals to a container on a balance pan carefully, to prevent spills. If a spill does occur, use a balance brush to gently sweep it away. (Be sure the electronic balance is shut off before you start cleaning up.) If the spill involves more than a few grains of material or involves a highly corrosive chemical, see your instructor for clean-up instructions.

Do not movea balance**.** This will upset its leveling and can cause the machinery to jam.

USE OF THE TOP LOADING ELECTRONIC BALANCE

(The balance discussed below is the newest, totally electronic version.)

This instrument uses a pressure sensitive strain gauge to determine mass. The mass of the object affects the electronic signal passing through the gauge; this signal gets displayed as a digital readout of grams. The instrument can be as precise as many analytical balance (± 0.001 g) and is easier to use. Such top loading balances are becoming the instrument of choice for routine lab work. However, they are delicate and expensive to repair. Thus they must also be used thoughtfully and carefully. The controls will be explained by your instructor but, in general, they are as follows:

1. on-off button
2. calibration button
3. tare button

WEIGHING

1. Turn the instrument on using the on-off button.
2. Push the calibration button. The readout will rapidly run through a series of displays as the electronics are calibrated. When the display settles on 0.00 g, the calibration is complete.
3. Place the object to be weighed on the pan, wait a few seconds for the display to settle down, then read the gram mass of the object.
4. Your instructor will tell you either to turn off the balance after you complete your weighing or to leave it on. Follow these directions.

TARING

The tare button allows you to reset the display to 0.000 g even with an object on the balance pan. It is used when you only need the mass of the chemical and not the mass of the chemical and container. Use the tare feature only when you are absolutely sure you will never need to know the mass of the container. If you are unsure, ignore the tare button and record all masses.

1. Weigh the container as described above. After the display settles down, push the tare button. The display should now read 0.000 g.
2. Add the desired chemical to the container. The display now shows the weight of only the added chemical.

TIPS ON PRECISE WEIGHING

To obtain the most precise (reproducible) results from your weighing, the following procedures should be observed. These are particularly important when using the high-precision analytical balance.

1. Check the leveling bulb on the instrument. If it is not dead center, have your instructor make the needed adjustments.
2. Always use the same balance in weighing for a particular experiment. This will allow any small constant error in the balance to be canceled out in your final calculations.
3. Recheck the zero adjustment of the balance occasionally.
4. Be sure the balance and the area around it are kept spotlessly clean.
5. Never use your fingers to directly handle a container you are weighing. Fingerprints weigh a few mg each and slowly evaporate. Handle your containers with tongs or with a paper band as shown.

USING STOCK REAGENT BOTTLES

All the chemicals you will use will be available in stock reagent bottles on the laboratory reagent shelf. The standard procedures for getting what you need from these bottles are described below. These procedures are to be used for two reasons:

To prevent contamination of the chemicals. Impure chemicals can give improper experimental results. To prevent excessive wasting of chemicals. Most of the reagents are quite expensive, thus overuse of them is economically unsound. In dealing with solid chemicals be sure the contents of the bottle are loose and in small pieces before you make a transfer. Often the chemical can be loosened by tapping the closed bottle against the palm of your hand. If this doesn't work, consult your instructor. Three methods of transferring solids are shown in the figures. The "hollow stopper" method and the direct pouring method are preferred. If you must use a spatula to scoop out the chemical be sure it is clean and dry. Do not go from one reagent bottle to the next without thoroughly cleaning and drying the spatula.

Transferring liquids is much simpler because of their fluidity. The preferred technique is shown in the figure, gentle pouring with the lip of the reagent bottle resting on the lip of the beaker. This technique prevents splashing and allows you to control the amount transferred. When you are pouring, hold onto the beaker to prevent it from tipping. If you need both hands to control the reagent bottle, have your partner hold the beaker. To prevent spills always use a receptacle whose opening is much larger than that of the reagent bottle. Thus you should not pour liquids from a

reagent bottle directly into a test tube, nor should you pour from a one gallon reagent bottle into a 50 mL beaker.

OTHER RULES THAT SHOULD BE FOLLOWED ARE:

1. Wipe up any spills immediately. If liquid runs down the side of a reagent bottle, wipe the bottle with a damp cloth.
2. Do not contaminate the reagent bottle lids. Handle the lids only by the finger grips provided. If the lid has a flat top, set it upside-down on the bench. If the top is not flat, do not set it on the bench, hold the lid while making the transfer. Always replace the lid immediately after using the reagent bottle,
3. Take only what you need. A useful guide is to assume 1 gm of chemical is about 1 cm3. One cm3 is about the volume of the exposed eraser on a new pencil. (Also 1 cm3 is about 1/4 the volume of the last joint on the little finger.)
4. Don't return unused chemical to a reagent bottle. Dispose of unused chemicals as directed by your instructor.
5. Never remove a reagent bottle from the reagent shelf. This is discourteous to others who need the chemical.
6. Label the receptacle so that you will know later which chemical it contains. Most glassware has white, etched glass spots for labelling. Pencil marks work beat on these since the marks can be easily erased.