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Summary: A check of chemistry laboratory manuals was conducted to determine what the authors considered important and essential to the development of good laboratory techniques. An effort was made to correlate the different techniques considered to be of the greatest importance. These were listed under different headings. These essential headings were: Personal, laboratory rules, safety precautions, obtaining and handling of chemicals, heating of objects, correct laboratory procedure and Miscellaneous. Two different check sheets were developed to aid the instructor in evaluating the students laboratory techniques. The short check sheet does not contain as many violations as the long form. These check sheets make a record of individual experiments and individual students that may be consulted at any time. They will also serve as a guide sheet to spot chronic carelessness and as an aid to grade determination.

THESIS ADVISOR James H. Zant

# DEVELOPMENT OF A LABORATORY TECHNIQUE CHECK SHEET FOR CHEMISTRY

By

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DEVELOPMENT OF A LABORATORY

TECHNIQUE CHECK SHEET

FOR CHEMISTRY

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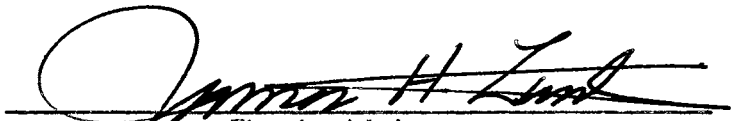

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# PREFACE

I am indebted to many individuals for their co-operation in the preparation of this report. I deeply appreciate the suggestions made by Dr. H. P. Johnston to guide me in the preparation of this report. Appreciation is also expressed for the helpful suggestions received from Dr. James H. Zant. I also gratefully acknowledge the help of Mrs. Peggy Kilian, Dr. Otto M. Smith and Dr. C. M. Baker.

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# CHAPTER I

# INTRODUCTION

## Statement of the Problem

Every teacher should have some method of evaluating the laboratory technique of the student as well as his ability to find the correct solution to the questions listed with the experiment.

This report includes a study of correct laboratory techniques as well as the development of a "Laboratory Technique Check Sheet". The check sheet is a quantitative method of evaluating techniques of the students. Since safety and proper laboratory techniques go together as does Bunsen and burner, to insist upon and to encourage safety is to promote good laboratory techniques.

Limitations: This report was prepared for use in the chemistry class. The application of this report to any of the other sciences is limited without some changes being made. Some parts, however, could be used in the other sciences. This would be determined by the instructors ability to apply them.

The report was prepared for the high school chemistry class. Its application to the college chemistry courses could be limited to the first two courses. Even with this limited application, some changes would be necessary to fit this report to such usage.

The biggest limitation to the application of this report is the ability of the instructor to apply it to his particular class or group.

This report was not prepared for use as a test at the end of a set period such as mid-semester or semester. The only testing that this report can accomplish is from day to day. It will let the student know that he is being evaluated (tested) every day, at all times and in several areas.

## Procedure Followed in Preparing this Report

A list of correct laboratory techniques or procedures was prepared from the information given in a number of laboratory manuals. As this report is concerned mainly with chemistry, only these manuals were consulted. Most of the techniques used in this report were obtained from the list of approximately 80 techniques that were compiled. Other techniques were added from a list of procedures mentioned in different science articles and recommended by different high school and college chemistry teachers. The various techniques were then divided into specific categories. Some of the techniques occur in more than one category. This was due to the type of technique that was considered and the importance it had in the particular category.

The first check sheet contained approximately 90 parts crowded on one page for easy handling. This appeared to be too complicated and was then trimmed to the size shown in this report. The abbreviations have no particular source and were made for the sake of brevity.

The information sheet was developed last. It indicated the manner in which the check sheet should be used in evaluating the individual as well as the evaluation of the class.

## Justification of this Report

The chemistry laboratory is one place where students quickly learn that work habits are consistently right, or dangerously wrong. You are not half-right when the glass tubing you have been trying to force through a rubber stopper suddenly breaks in your hand. And you are not half-right when a caustic chemical is spilled on the skin and necessitates the care of a doctor.

It is probably safe to say that most students who are beginning high school science have had limited experience in the laboratory. They have not been personally involved in performing laboratory experiments. Instead, they have been accustomed to the teacher performing all experiments before the class. The technique of the teacher, either good or bad, was of secondary importance to the student. He was more interested, if he had an interest, in the results that were obtained. Sometimes the "show" completely lost all continuity and meaning for which the experiment was intended. As a result, most students have had no opportunity to develop a laboratory technique.

Over a period of years, teachers of the laboratory courses have observed that students will follow certain procedures or work habits more often than others. The correct work habits are just as easily learned as the incorrect.

The college chemistry laboratory can correct some of the incorrect laboratory techniques, but why wait until the student has developed the incorrect procedures to the point of being a habit? Why not train him in the correct techniques at the start and help him develop them? If a person is to understand science fully and continue the study of it, he

must be familiar with the correct methods and techniques of the scientific laboratory. A scientist must be able to manipulate his hands as well as his mind. In many cases it is desired that he show manual skill, dexterity, ingenuity and resourcefulness.

Observations in commercial laboratories have indicated time and time again that the careless technician, the routine chemist or research helper who has poor laboratory training finds it extremely difficult to climb the ladder of success in the chemical industry.

Carelessness should neither be tolerated nor ignored. Slovenly habits in doing the experiments will produce at best, below average experimentalists.

## CHAPTER II

## CORRECT TECHNIQUES

The vital question that faces (or should face) the chemistry or science teacher is: How is the student best helped to acquire these qualities of correct techniques, procedures, and actions?

One of the most effective ways of impressing on the student the correct procedure is to demonstrate the correct versus the incorrect laboratory techniques. This should be repeated at various times during the year to correct and bring to the student's attention the incorrect procedures that have reappeared. The check sheet will indicate to the teacher the most frequent discrepancies. Any serious incorrect work habits that are noted should be brought to the attention of the student at the time they occur.

The method of evaluation that is developed in this report is such that the chemistry teacher can better understand the strong and weak points of his students as concerned with the correct laboratory techniques. When the strengths and weaknesses are known, the teacher can take steps to improve on the weaker areas.

The following headings should be duplicated and given to each chemistry student. The different laboratory techniques are grouped under seven separate headings. Each heading contains the most important <u>correct</u> techniques. Some of the techniques overlap and will be found in more than one area.

## Personal

Apron on: Do not forget to put on your apron. Some students will become so interested in starting the experiment or in other things, that they will forget.

Apron on correctly: The bib of the apron should be up under your chin. This is made possible by putting one apron string through the neck string and pulling it up snugly until it fits under the chin.

Unnecessary talking: The laboratory is not to be used as a place to visit. All necessary conversations should be made in a moderate tone.

Ignored instructions: Follow directions carefully. Do not add to or delete from, the assigned experiment. Do not attempt to perform any experiments that have not been assigned unless you have secured permission from the instructor.

Ignored instructor: The instructor must always be present when you work in the laboratory. No practical joking will be tolerated. It involves too much danger for your neighbors. Listen for instructions concerning a change in the experiment, such as the substitution of certain equipment or chemicals for the ones in the experiment.

Experiment read: Assignments of experiments will be made in advance. Carefully read over the directions in the laboratory manual before you come to the laboratory.

Experiment understood: Observe closely what happens, record this in your notes, and be sure you understand what has gone on.

Dry run: Do not pretend to be doing the experiment and plan on getting the answers from another student. Do not attempt to answer the questions without first doing the experiment.

Laboratory desks: Good housekeeping is a prerequisite for safe and accurate experimentation. Keep your desk clean and tidy at all times. Do not place articles of clothing, books, or extraneous materials on the desk. At the end of each period, clean the apparatus you have used and place it in order in your locker. Wash off the top of your desk, and clean off any material you may have spilled on the front of the desk. Lock your locker before leaving the laboratory after each period.

## Laboratory Rules

Equipment clean: All glass equipment should be clean inside and out. All other equipment must be clean and free of foreign matter.

Equipment dry: This applies to all equipment, but particularly to glass. Wet glass equipment will sometimes break when heat is applied. Any wet glass container will hinder the pouring of powders. The wrong reaction could be caused by wet equipment. Wet equipment is also troublesome to handle.

Work area clean: Keep the work area free of all excess materials. Keep the work area dry.

Work area arrangement: Set up and arrange the equipment as the experiment or instructor suggests. Arrange the equipment to minimumize such accidents as knocking over equipment and getting a serious burn.

Disposing of liquids: Wash all liquids down the sink drain with plenty of water. Never pour the liquids into the waste jar or into the waste basket.

Disposing of gases: Place the gases in the hood and let them evaporate. If no hood is available, dilute with water and treat as a liquid.

Disposing of hot or burning materials: Let the material cool or burn out. In some cases water may be added to cool or extinguish the flame. Use caution; not all burning can be extinguished with water. After the materials have cooled, dispose of them as a solid or liquid.

Replacement of reagents: Do not take the reagent bottles to your desk. Other members of the class need the same reagents. When the reagents are used, return them to the exact place where found. Check to see that all caps are on and stoppers are in correctly. Do not leave excess chemicals on the outside of the bottle. Clean with a paper towel.

Replacement of equipment: Each student will put away the equipment that he has finished using. Return all extra and borrowed equipment after it has been cleaned and dried. Be sure to return all special equipment to the correct place of storage.

Chemicals wrong: Carefully read the labels on the container. Read the label just before obtaining the chemicals and again before replacing the container in its original place.

Chemicals unused: The experiment usually tells you the amounts of chemicals you need. Avoid using too much. Do not return excess chemicals to the stock bottles. It is easy to make an error and contaminate stock chemicals. If a mistake is made, consult the instructor.

Solution from bottles: Never dip a stirring rod, pipette or medicine dropper into the reagent bottle. Pour a small quantity of the reagent into a test tube or beaker, and dip the stirring rod into that. Handle stoppers so that they remain clean. Be sure to replace them in the correct bottle. Take the stopper from the bottle by turning the palm upward and holding the stopper between two fingers. Hold the stopper in the fingers until through using the bottle, then replace in the bottle.

Wash and save chemicals: Save all natural solids such as zinc mossy and calcium carbonate.

## Safety Precautions

Glass equipment into stoppers: There is some danger in the simple operation of inserting a glass tube, thermometer, thistle tube or funnel into a cork or rubber stopper. The part of the glass equipment which you hold in your hand should be wrapped in a cloth towel. Wet the end of the equipment to be inserted; then, with gentle pressure and steady rotation of the equipment, work it through the hole in the stopper. Do not try to force it through rapidly. Bad cuts are often caused by careless handling of glass equipment. In some cases it is wise to enlarge the hole in the stopper with a cork borer or to wet the glass equipment with ethyl alcohol. The ethyl alcohol is better than glycerin and not as messy. Always remove stoppers from tubes and thermometers before putting away the equipment; otherwise the stopper may stick or "freeze" to the glass. The cork borer may be used to remove stoppers from the glass equipment when other methods of removal fail.

Acid into water: Always add the acid to the water when making up a dilute solution of acids. This will also apply to the addition of acid to an experiment reaction. Pour carefully and with constant stirring.

Smelling gases: Be cautious about smelling chemicals. A good procedure is to fan the vapor gently toward your nose with your hand. Be careful of the eyes during such procedure.

Tasting chemicals: Do not taste chemicals unless you are specifically directed to do so. All chemicals, mixtures and solutions are to be considered poisonous unless you are instructed otherwise. If any chemical is accidently swallowed, see your instructor at once.

Correct precaution for spilled liquids: If you spill acids, alkalis, or other corrosive materials on your skin, flush them off as quickly as possible with large quantities of water and get help from the instructor. If the liquids are spilled on the desk, clean up at once with paper towels or flushed into the sink with water. Always be sure to neutralize the acids and bases. Use the prepared solutions that are made for this purpose. Solid sodium bicarbonate may be used to neutralize large amounts of acids or bases.

Holding of equipment: When you heat substances in test tubes, avoid pointing the test tube at your neighbor. Never look directly down into a beaker or crucible or into the mouth of a flask or test tube which is being heated. Place all hot objects upon an asbestos sheet until they are cool. Pick up hot objects with the forceps or tongs.

Accidents: Report immediately to the instructor if you have an accident. Be sure to have all cuts and burns treated promptly so that infection is prevented.

Equipment: It is wise to wear safety glasses in the performing of some of the experiments.

Generators: Wrap a cloth towel around the hydrogen generator. Keep heat or flames away from all generators unless instructed otherwise. Most generators can be stopped or neutralized by the addition of excess water.

Hood or ventilation: Use the hood or be sure of very good ventilation when performing any experiment that might produce poisonous or objectional gases or vapors.

## Obtaining and Handling of Chemicals

Transporting powders: Carry all powders on a creased filter paper. Use care and do not spill the powder or allow it to be blown off of the paper. The air movement may be due to cross ventilation or to the too rapid movement of the student carrying the powder.

Transporting solids: Carry solids on a clean watch glass, filter paper or sheets of paper that are provided for that purpose.

Transporting liquids: Carry all liquids in clean test tubes, beakers, flasks or your graduated cylinder.

Pouring powders: Rotate the bottle containing the powder when pouring from it. This will keep an excess amount from gushing out. Never try to "pour" a powder or solid from a bottle into a test tube. A folded strip of heavy paper may be used to transfer the materials from the stock bottle to a test tube. This method may also be used to place the materials at the bottom of the test tube and keep the side of the test tube clean. Hold the test tube in an oblique position when attempting this maneuver. A clean spatula may be used to transfer some of the powders.

Pouring solids: Tilt and roll the bottle containing the solid until some of the contents enter inside the stopper (hollow) or lid. Carefully remove the stopper so that some of the contents will remain in the top. Tap the stopper with a pencil until the desired amount falls out. If the cap is not hollow, shovel out a small amount on a clean spatula. Tap the spatula until the correct amount falls off. If a spatula is used, try to take the desired amount as the excess should not be returned to the container. In some cases the clean forceps may be used to pick up a piece of the solid.

Pouring liquids: Stop and think before removing the cap from any container of liquids. Does it contain a volatile or corrosive chemical? A moistened neck and lip prevents the first drops from gushing out. Pour down a glass rod when possible as this will prevent the spattering of the liquid. When pouring from a bottle into a test tube, place the lip of the bottle inside the test tube. It is not necessary to use a funnel. When pouring from a bottle, catch the last drop of the liquid on the stopper. Use an acid pump whenever it is possible. After the bottles are obtained from storage, clean them before attempting to remove any liquid. Watch out for the spewing of corrosive liquids. If in doubt, wrap a cloth around the cap or stopper before loosening the cap. A straight glass tube may be used to transfer liquids by the drop. A pipette or dropper is the best for transfering liquids by the drop. Be sure that the pipette, dropper or glass tubing is not contaminated by another chemical.

Mortar and pestle: Before using a mortar and pestle be sure it is clean and free of other chemicals. A violent reaction could be caused by a small amount of foreign matter. Grind each solid separately. Do not grind too violently and grind small amounts at a time. Use care and do not spill.

## Heating of Objects

Bunsen burner use: When evaporating equipment to dryness, remove the flame just before the last of the water disappears. Keep the flame below the level of the liquid in the vessel which is being heated.

Bunsen burner lighting: When about to light a burner, light the match before turning on the gas. Keep the burner in front of you and always

hold your face well away from it when lighting. To correct the striking back of a burner, extinguish and relight. Turn the burner off when not in use.

Bunsen burner flame: A blue flame about two inches high with two distinct cones is the correct flame to use for practically all laboratory work. Use the non-luminous flame for all heating purposes except reduction and annealing. Do not allow the burner flame to make a roaring sound.

Flame use: Move the flame around when applying heat to a glass vessel. Gradually apply the heat to any glass container. Dry all glass equipment on the outside before applying heat.

Test tube containing solids: When heating a solid in a test tube, hold the tube in almost horizontal position, with the mouth slightly lower than the closed end. Use the test tube holder when heating a test tube.

Test tube containing liquids: Heat slowly and gradually move the flame from the open end to the closed end. Use extreme care in heating a test tube containing a volatile liquid. Adjust the heat so that the test tube will not boil over or the liquid be forced from it.

Deflagrating spoon: Always use a deflagrating spoon for lowering a burning substance into a container that has a narrow mouth.

Wrong objects: Never heat a graduated cylinder or a bottle. Always use a pyrex test tube for heating.

Crystallization: Always use the watch glass for crystallization. Improvise a steam or water bath from a beaker or small pan. Never apply heat directly to a watch glass as the chemicals might ignite or the glass may break.

Sublimation: Place the material to be sublimed in a beaker and set an evaporating dish over it. Place water or ice in the evaporating dish

and heat the beaker gently. Always sublime small amounts. A funnel with a cotton plug in the neck may be inverted over the beaker in place of the evaporating dish.

Even heat: Place a wire gauze or asbestos sheet under beakers or flasks when heating them to spread the heat. Heat crucibles in a pipe-steam triangle that is placed on a support. Be sure that the crucible sets half-way down into the pipesteam triangle.

Thermometers: Always use the correct thermometer for the experiment. Do not apply heat directly to the thermometer or place it on the bottom of the container being heated. Never use the thermometer for stirring.

## Correct Laboratory Procedure

Generators: The thistle tube must have its lower end below the surface of the liquid in the generator. When an acid is to be added to a generator, add a little at a time, allowing the reaction to reach a maximum before successive proportions are added. Avoid the "sucking back" of a delivery tube by disconnecting, or by taking the end from the water as soon as heating is completed. Always place a cloth towel around the hydrogen generator. Keep flames away from the generator or delivery tube. After completing the collection of the gas, add water to the contents of the generator and empty into the receptacle provided by the instructor.

Gas collection: When a gas, lighter than air and insoluble in water is collected, collect by the displacement of water in an inverted bottle of water. Insert the delivery tube beneath an inverted bottle of water without admitting air. Use a pneumatic trough to hold the inverted bottles of water. When a dry gas, lighter than air but soluble in water is to be collected, collect in an upright bottle of air. If the

gas is heavier than air, but soluble in water, collect in an upright bottle of air.

Filtration: Fold the filter paper in the shape of a smooth cone to fit the funnel. Wet before using as this insures a snug fit of the filter paper in the funnel. Be sure that the stem of the funnel touches the side of the vessel into which the liquid is being filtered. Keep the liquid in the funnel below the edge of the filter paper.

Platform balances: The object to be weighed is placed on the left-hand pan; the weights are placed on the right-hand pan. Do not place chemicals directly on the pan. Most dry materials may be weighed on filter paper. Use one filter paper on each pan. Handle the analytical weights with clean forceps. Read the balance to the nearest tenth of a gram. Always handle the balance with its center support when moving from one area to another.

Measurements: When the volume of a liquid must be known fairly accurately, a graduated cylinder is used. The eye must be kept on a horizontal line with the bottom of the concave surface. For mercury the eye must be kept on a horizontal line with the top of the convex surface.

Glass tubing: To cut into the desired lengths, lay the piece of glass tubing flat on the table, and with a file, scratch it at the point where you wish to cut it. Hold the tubing in both hands with the scratch turned away from you and between your index fingers. Push slightly with your thumbs, give the two ends a quick pull. "Fire polish" all fresh breaks by holding the end of the rough tube in the upper part of the non-luminous flame, rotating the tube slowly, until the edge has been made smooth by the melting of the glass. In making

all bends, place a wing top on the burner. Roll the glass tubing back and forth over the wing top until it becomes quite soft. Remove from the flame, hesitate, then quickly bend to the desired shape. To make a pipette or dropper, roll the tube over the burner without the flame spreader. Allow the walls to thicken to about twice their original size, remove from the flame, hesitate, pull apart until the softened region is as small as desired. Cut to the desired lengths and fire glaze the tip. The glass tube may be sealed by continuining the "fire polish" method until it is closed. Handle hot glass cautiously. Hot glass tubing gives no visible evidence of being hot. To cool it, lean it up against something; do not lay it flat on the table. It may be placed on an asbestos sheet.

Cork borer: When using the cork borer, select a size smaller than the hole desired. Bore almost through from one side and then remove and bore from the other side. The borer may be used to remove a thermometer or glass tube from the stopper. Select the size of borer that fits the equipment as snugly as possible and bore as mentioned before.

Distillation: Use a minimum amount of rubber tubing or rubber stoppers to connect the boiler to the distillation tube. This will keep the distillate from being contaminated. Place the distillation tube at an oblique angle so that the condensed liquid will flow from the force of gravity. The cooling liquid should be forced in at the bottom of the distillation tube.

Drying tube: Place a small piece of cotton over the narrow opening before adding the drying agent. The drying agent must fill the tube to capacity and make a snug fit. Insert cotton over the agent and place the stopper into the tube.

## Miscellaneous

Burette clamps: Put paper into the jaws of the clamp to insure a snug fit. Clamp firmly, but without pressure, and use care as to not crush the equipment.

Test tube holder: Clamp the test tube firmly and remember that a pressure on the handle releases the tube. Always use a test tube holder when heating a test tube.

Ringstand: Always place a ringstand on a level spot without something under it. Always use the correct size that was made for the experiment.

Barometer: Use care in making all adjustments on the mercury barometer. Read the mercury barometer within one-tenth of a millimeter. Take the thermometer reading at the time of taking the barometer reading and use the correction factor for that temperature.

Hydrometers: Select the correct hydrometer for the liquid being tested. Be sure it is clean and dry before and after using.

Stoppers: Always use the correct size of stopper. Twist or screw the stopper into a test tube or mouth of a container.

Forceps: Use forceps to hold small objects that are being heated. They should be used to hold materials, such as litmus paper, in checking reactions. The tongs or forceps must be used to handle hot objects, such as the crucibles.

Chemicals: Use extreme caution and keep the manganese dioxide and carbon separated and well labeled. Never use a chemical that is without a label.

Water supply: Test the force of the water before putting a vessel beneath the water. Turn off the water faucet when through using the water. Use only the necessary amounts of distilled or pure water.

Collection bottles: Set up the bottles of gas, upright or inverted, as determined by the weight of the contained gas. A glass plate should be placed over or under the mouth of the bottle.

Care of equipment: When a funnel is to be placed on a laboratory table, stand it mouth down. Keep the rubber protectors on the graduated cylinders. Place all equipment in front of you and keep it there. Watch out for that misplaced elbow. All equipment must be cooled before returning it to the locker or storage area.

# CHAPTER III

## THE CHECK SHEET

If all or most of the preceding techniques have merit, the problem now arises to find some fairly comprehensive, yet convenient method of evaluating the individual student. The method suggested here for an appraisal of laboratory techniques is a check sheet that indicates the students mistakes.

The following pages will give the instructor a choice of two lists of common errors. Using one or the other, a teacher can indicate on the check sheet the error observed. This makes a record of individual experiments and individual students that may be consulted at any time. It may be used to give a complete grade on each experiment or as a guide sheet to indicate chronic carelessness. The most common errors will be noted and an effort made to correct them. If the incorrect procedures are numerous, evaluate them and indicate the correct technique to the class or to the chronic violator.

The first laboratory technique check sheet has the violations and the check sheet on the same page. The first page will not contain as many violations as the second page. It was developed in this form to enable the instructor to have all information on one page. It will be placed on the following page to give an indication of its appearance. Some of the abbreviations are not of a standard variety, but most are easily understood.

# LABORATORY TECHNIQUES
(SHORT FORM)

A. Personal

1. Apron on. (a) Corr. (b)
2. Unnecessary talking
3. Ign. instr. (a) Instru. (b)
4. Exp. read (a) Undstd. (b)
5. Dry run
6. Lab desks

B. Laboratory Rules

1. Equip. clean (a) Dry (b)
2. Wrk. ar. cln. (a) Arr. (b)
3. Disp. of chem.
4. Repl. equip.
5. Chem. wrng. (a) Unused (b)

C. Correct Laboratory Procedure

1. Gen. set up (a) Use (b)
2. Gas displ. of air (a) HOH (b)
3. Filtering
4. Balances
5. Meas: Bur. (a) Cyl. (b)

D. Safety Precautions

1. Gls. eq. into stop. Wet (a) Screw (b) Towel (c)
2. Testing chem.
3. Corr. prec. for spld. chem.
4. Holding of equip.

E. Heating of Objects

1. Bunsen burner
2. T.t cont. chem.
3. Wrong obj.

F. Obtaining and Handling of Chemicals

1. Hndl. powders
2. Hndl. solids
3. Hndl. liquids (acid in HOH)
4. Mortar and pestle

## CHECK SHEET

| Name | Date | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| John Doe | 1a | | 3 | 1c | | |

To indicate how the preceding sheet is used, a student named John Doe made the following mistakes. A-1a--Apron not on. C-2--Incorrect disposal of chemicals. D-1c--No towel was used in working with the glass equipment and rubber stopper. If more than one mistake was made under A, it may be indicated on the next line and ditto marks placed under the students name.

# LABORATORY TECHNIQUES
## (LONG FORM)

A. Personal

1. Apron on (a) Corr. (b)
2. Unnecessary talking
3. Ign. instr. (a) Inctru. (b)
4. Exp. read (a) Undstd. (b)
5. Dry run
6. Lab desks

B. Laboratory Rules

1. Equip. cln. (a) Dry (b)
2. Wrk. ar. cln. (a) Arr. (b)
3. Disp. of sol. (a) Liq. (b)
4. Disp. of hot (a) Burn. (b)
5. Repl. equip. (a) Reag. (b)
6. Chem wrng. (a) Unused (b)
7. Sol. from bottle
8. Wash (a) Save chem. (b)

C. Correct Laboratory Procedure

1. Gen. set up (a) This. tb (b) Acid add. (c)
2. Gas col. Hvy. (a) Lt. (b) Solub. (c) Insolub. (d) Disp. air (e) HOH (f)
3. Filtering: Paper (a) Funnel (b) Liq. (c)
4. Balances: Adj. (a) Locat. (b)
5. Meas: Bur. (a) Cyl. (b)
6. Gls. tub.: Brk. (a) Bnd. (b) Plsh. (c) Pnt. (d)
7. Cork Borer

D. Safety Precautions

1. Gls. eqp. into stopper Wet (a) Screw (b) Towel (c)
2. Acid into water
3. Sml. gas. (a) Tast. Chem. (b)
4. Correct precautions for spilled: Acids (a) Bases (b) Other (c)
5. Holding of equipment

E. Heating of Objects

1. Bunsen burner: Use (a) Flme. (b)
2. Flme. mvd. arnd. (a) Grad. appl. (b)
3. T.t cont. sol. (a) Liq. (b)
4. Defl. spoon
5. Wrng. obj. (a) Wtch. gls. (b)
6. Wire gze. (a) Pipestm.(b)
7. Thermometer
8. Boiler (a) Dist. tube (b)

F. Obtaining and Handling of Chemicals

1. Trans. pwd. (a) Liq. (b)
2. Forng. pwd. (a) Liq. (b)
3. Mortar and pestle Cln. (a) Grinding (b)
4. Use of hood

G. Miscellaneous

1. Bur. clmp. (a) T.t hldr. (b)
2. Water
3. Ringstand (a) Clamp (b)
4. Barometer (a) Hydrometer (b)
5. Stoppers (a) Forceps (b)

# CHAPTER IV

## GENERAL INFORMATION

A general criticism of the laboratory centers on the stero-typed experiments found that many laboratory manuals indicate very little correct techniques and allow the student to develop his own. In some cases the instructor has everything set up to the point that the experiment is nothing more than filling in the blanks, observing and very little handling of equipment. This type is worth little more than no laboratory exercises at all. Most of us know that a science course without a laboratory phase is not worthy of the name of science. The application of this report will be left up to the individual teacher. Its use will be determined by the laboratory equipment available and the class schedule of the instructor. This will vary from the extreme to the absurd and can be best evaluated by each individual teacher. It is suggested that the instructor practice the correct procedures and not make too many obvious mistakes in his presentation. Practice before presentation, is the best method to follow. Different models should be prepared in advance and passed out for the students to handle and see the correct results. The extra time allowed for the presentation, practice and the students participation will be well rewarded in the lack of accidents. One bad accident can ruin a year of study and destroy all of the good intentions of any science teacher. Beware of the dependent and independent student. These students are not

labeled, but will be found by observation. The independent student is the most dangerous as his mistakes will be of a serious nature. He will also be the hardest to spot as he is usually a good student and appears to follow instructions. This type will be the one who tries a new way of doing an experiment or performs an unauthorized experiment. The dependent student will be easy to notice as he will be continually consulting you about all phases of the experiment. He will not trust his own judgement and abilities. Do not ignore or give too much help to this type of student. The use of the instructors judgement will be governed by the student and the type of experiment he is attempting. One of the best laboratory rules is "If in doubt, don't". It is best to apply this rule to the extreme and avoid an accident.

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