Safety in Your Laboratory

Risk Assessment

MAKING YOUR LABORATORY A SAFE PLACE TO WORK AND LEARN

Concern for safety must begin before any activity in the classroom and before students enter the lab. A careful review of the facilities should be a basic part of preparation for each school term. You should investigate the physical environment, identify any safety risks, and inspect your work areas for compliance with safety regulations.

The review of the lab should be thorough, and all safety issues must be addressed immediately. Keep a file of your review, and add to the list each year. This will allow you to continue to raise the standard of safety in your lab and classroom.

Many classroom experiments, demonstrations, and other activities are classics that have been used for years. This familiarity may lead to a comfort that can obscure inherent safety concerns. Review all experiments, demonstrations, and activities for safety concerns before presenting them to the class. Identify and eliminate potential safety hazards.

1. **Identify the Risks**
   Before introducing any activity, demonstration, or experiment to the class, analyze it and consider what could possibly go wrong. Carefully review the list of materials to make sure they are safe. Inspect the equipment in your lab or classroom to make sure it is in good working order. Read the procedures to make sure they are safe. Record any hazards or concerns you identify.

2. **Evaluate the Risks**
   Minimize the risks you identified in the last step without sacrificing learning. Remember that no activity you can perform in the lab or classroom is worth risking injury. Thus, extremely hazardous activities, or those that violate your school's policies, must be eliminated. For activities that present smaller risks, analyze each risk carefully to determine its likelihood. If the pedagogical value of the activity does not outweigh the risks, the activity must be eliminated.

3. **Select Controls to Address Risks**
   Even low-risk activities require controls to eliminate or minimize the risks. Make sure that in devising controls you do not substitute an equally or more hazardous alternative. Some control methods include the following:

   - Explicit verbal and written warnings may be added or posted.
   - Equipment may be rebuilt or relocated, parts may be replaced, or the equipment may be replaced entirely by safer alternatives.
   - Risky procedures may be eliminated.
   - Activities may be changed from student activities to teacher demonstrations.

4. **Implement and Review Selected Controls**
   Controls do not help if they are forgotten or not enforced. The implementation and review of controls should be as systematic and thorough as the initial analysis of safety concerns in the lab and laboratory activities.

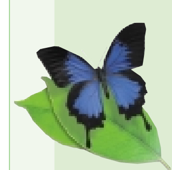
SAFETY RISKS AND PREVENTATIVE CONTROLS

This chart describes several possible safety hazards and controls that can be implemented to resolve them. This chart is not complete, but it can be used as a starting point to identify hazards in your laboratory.

Identified risk	Preventative control
Facilities and Equipment	
Lab tables are in disrepair, room is poorly lighted and poorly ventilated, faucets and electrical outlets do not work or are difficult to use because of their location.	Work surfaces should be level and stable. There should be adequate lighting and ventilation. Water supplies, drains, and electrical outlets should be in good working order. Any equipment in a dangerous location should not be used; it should be relocated or rendered inoperable.
Wiring, plumbing, and air circulation systems do not work or do not meet current specifications.	Specifications should be kept on file. Conduct a periodic review of all equipment, and document compliance. Damaged fixtures must be labeled as such and must be repaired as soon as possible.
Eyewash fountains and safety showers are present, but no one knows anything about their specifications.	Ensure that eyewash fountains and safety showers meet the requirements of the ANSI standard (Z358.1).
Eyewash fountains are checked and cleaned once at the beginning of each school year. No records are kept of routine checks and maintenance on the safety showers and eyewash fountains.	Flush eyewash fountains for 5 minutes every month to remove any bacteria or other organisms from pipes. Test safety showers (measure flow in gallons per min) and eyewash fountains every 6 months and keep records of the test results.
Labs are conducted in multipurpose rooms, and equipment from other courses remains accessible.	Only the items necessary for a given activity should be available to students. All equipment should be locked away when not in use.
Students are permitted to enter or work in the lab without teacher supervision.	Lock all laboratory rooms whenever a teacher is not present. Supervising teachers must be trained in lab safety and emergency procedures.
Safety equipment and emergency procedures	
Fire and other emergency drills are infrequent, and no records or measurements are made of the results of the drills.	Always carry out critical reviews of fire or other emergency drills. Be sure that plans include alternate routes. Don't wait until an emergency to find the flaws in your plans.
Emergency evacuation plans do not include instructions for securing the lab in the event of an evacuation during a lab activity.	Plan actions in case of emergency: establish what devices should be turned off, which escape route to use, where to meet outside the building.
Fire extinguishers are in out-of-the-way locations, not on the escape route.	Place fire extinguishers near escape routes so that they will be of use during an emergency.
Fire extinguishers are not maintained. Teachers are not trained to use them.	Document regular maintenance of fire extinguishers. Train supervisory personnel in the proper use of extinguishers. Instruct students not to use an extinguisher but to call for a teacher.

Identified risk	Preventative control
Safety equipment and emergency procedures, *continued*	
Teachers in labs and neighboring classrooms are not trained in CPR or first aid.	Teachers should receive training from the local chapter of the American Red Cross. Certifications should be kept current with frequent refresher courses.
Teachers are not aware of their legal responsibilities in case of an injury or accident.	Review your faculty handbook for your responsibilities regarding safety in the classroom and laboratory. Contact the legal counsel for your school district to find out the extent of their support and any rules, regulations, or procedures you must follow.
Emergency procedures are not posted. Emergency numbers are kept only at the switchboard or main office. Instructions are given verbally only at the beginning of the year.	Emergency procedures should be posted at all exits and near all safety equipment. Emergency numbers should be posted at all phones, and a script should be provided for the caller to use. Emergency procedures must be reviewed periodically, and students should be reminded of them at the beginning of each activity.
Spills are handled on a case-by-case basis and are cleaned up with whatever materials happen to be on hand.	Have the appropriate equipment and materials available for cleaning up; replace them before expiration dates. Make sure students know to alert you to spilled chemicals, blood, and broken glass.
Work habits and environment	
Safety wear is only used for activities involving chemicals or hot plates.	Aprons and goggles should be worn in the lab at all times. Long hair, loose clothing, and loose jewelry should be secured.
There is no dress code established for the laboratory; students are allowed to wear sandals or open-toed shoes.	Open-toed shoes should never be worn in the laboratory. Do not allow any footwear in the lab that does not cover feet completely.
Students are required to wear safety gear but teachers and visitors are not.	Always wear safety gear in the lab. Keep extra equipment on hand for visitors.
Safety is emphasized at the beginning of the term but is not mentioned later in the year.	Safety must be the first priority in all lab work. Students should be warned of risks and instructed in emergency procedures for each activity.
There is no assessment of students' knowledge and attitudes regarding safety.	Conduct frequent safety quizzes. Only students with perfect scores should be allowed to work in the lab.
You work alone during your preparation period to organize the day's labs.	Never work alone in a science laboratory or a storage area.
Safety inspections are conducted irregularly and are not documented. Teachers and administrators are unaware of what documentation will be necessary in case of a lawsuit.	Safety reviews should be frequent and regular. All reviews should be documented, and improvements must be implemented immediately. Contact legal counsel for your district to make sure your procedures will protect you in case of a lawsuit.

Identified risk	Preventative control
Purchasing, storing, and using chemicals	
The storeroom is too crowded, so you decide to keep some equipment on the lab benches.	Do not store reagents or equipment on lab benches. Keep shelves organized. Never place reactive chemicals (in bottles, beakers, flasks, wash bottles, etc.) near the edges of a lab bench.
You prepare solutions from concentrated stock to save money.	Reduce risks by ordering diluted instead of concentrated substances.
You purchase plenty of chemicals to be sure that you won't run out or to save money.	Purchase chemicals in class-size quantities. Do not purchase or have on hand more than one year's supply of each chemical.
You don't generally read labels on chemicals when preparing solutions for a lab, because you already know about a chemical.	Read each label to be sure it states the hazards and describes the precautions and first aid procedures (when appropriate) that apply to the contents in case someone else has to deal with that chemical in an emergency.
You never read the Material Safety Data Sheets (MSDSs) that come with your chemicals.	Always read the Material Safety Data Sheet (MSDS) for a chemical before using it. Follow the precautions described in that MSDS. File and organize MSDSs for all chemicals where they can be found easily in case of an emergency.
The main stockroom contains chemicals that haven't been used for years.	Do not leave bottles of chemicals unused on the shelves of the lab for more than one week or unused in the main stockroom for more than one year. Dispose of or use up any leftover chemicals.
No extra precautions are taken when flammable liquids are dispensed from their containers.	When transferring flammable liquids from bulk containers, ground the container; before transferring flammable liquids to a smaller metal container, ground both containers.
Students are told to put their broken glass and solid chemical wastes in the trash can.	Have separate containers for trash, for broken glass, and for different categories of hazardous chemical wastes.
You store chemicals alphabetically instead of by hazard class. Chemicals are stored without consideration of possible emergencies (fire, earthquake, flood, etc.), which could compound the hazard.	Use MSDSs to determine which chemicals are incompatible. Store chemicals by the hazard class indicated on the MSDS. Store chemicals that are incompatible with common fire-fighting media like water (such as alkali metals) or carbon dioxide (such as alkali and alkaline-earth metals) under conditions that eliminate the possibility of a reaction with water or carbon dioxide if it is necessary to fight a fire in the storage area.
Corrosives are kept above eye level, out of reach from any unauthorized person.	Always store corrosive chemicals on shelves below eye level. Remember, fumes from many corrosives can destroy metal cabinets and shelving.
Chemicals are kept on the stockroom floor on the days that they will be used so that they are easy to find.	Never store chemicals or other materials on floors or in the aisles of the laboratory or storeroom, even for a few minutes.



Name ______________________ Class ______________ Date ____________

Safety Symbols

The following safety symbols will appear in the instructions for experiments and activities to emphasize important notes of caution. Learn what they represent so that you can take the appropriate precautions. Remember that the safety symbols represent hazards that apply to a specific activity, but the numbered rules given on the previous pages always apply to all laboratory work.

- Never put broken glass or ceramics in a regular waste container. Use a dustpan, brush, and heavy gloves to carefully pick up broken pieces and dispose of them in a container specifically provided for this purpose.
- Dispose of chemicals as instructed by your teacher. Never pour hazardous chemicals into a regular waste container. Never pour radioactive materials down the drain.

- When using a burner or hot plate, always wear goggles and an apron to protect your eyes and clothing. Tie back long hair, secure loose clothing, and remove loose jewelry.
- Never leave a hot plate unattended while it is on.
- Wire coils may heat up rapidly during this experiment. If heating occurs, open the switch immediately and handle the equipment with a mitt.
- Allow all equipment to cool before storing it.
- If your clothing catches on fire, walk to the emergency lab shower and use the shower to put out the fire.

- Perform this experiment in a clear area. Attach masses securely. Falling, dropped, or swinging dropped objects can cause serious injury.
- Use a mitt to handle resistors, light sources, and other equipment that may be hot. Allow all pieces of equipment to cool before storing them.

- If a thermometer breaks, notify the teacher **immediately.**
- Do not heat glassware that is broken, chipped, or cracked. Use tongs or a mitt to handle heated glassware and other equipment because it does not always look hot when it is heated. Allow all pieces of equipment to cool before storing them.
- If a bulb breaks, notify your teacher immediately. Do not remove broken bulbs from sockets.

- Never close a circuit until the setup has been approved by your teacher. Never rewire or adjust any element of a closed circuit.
- Never work with electricity near water; be sure the floor and all work surfaces are dry.
- If the pointer on any kind of meter moves off scale, open the circuit immediately by opening the switch.
- Do not work with any batteries, electrical devices, or magnets other than those provided by your teacher.

- Do not eat or drink anything in the laboratory. Never taste chemicals or allow them to come into contact with your skin or eyes.
- If a chemical gets on your skin, on your clothing, or in your eyes, rinse it off immediately and alert your teacher.
- Do not allow radioactive materials to come in contact with your skin, hair, clothing, or personal belongings. Although the materials used in this program are not hazardous when used properly, radioactive materials can cause serious illness when used improperly.

- Tie back long hair, secure loose clothing, and remove loose jewelry to prevent them from getting caught in moving or rotating parts or from coming in contact with hazardous chemicals.

- Wear eye protection, and perform experiments in a clear area. Swinging objects can cause serious injury.
- Avoid looking directly at a light source. Looking directly at a light source may cause permanent eye damage.
- Use knives and other sharp instruments with extreme care.

- Always obtain permission before bringing any animal to school.
- Handle animals carefully and respectfully.
- Wear disposable polyethylene gloves when handling any wild plant.
- Do not eat any part of a plant or plant seed used in the lab.
- Wash hands thoroughly after handling plants or animals.

Safety with Microbes

WHAT YOU CAN'T SEE *CAN* HURT YOU

Pathogenic (disease-causing) microorganisms are not appropriate investigation tools in the high school laboratory and should never be used.

Consult with the school nurse to screen students whose immune system may be compromised by illness or who may be receiving immunosuppressive drug therapy. Such individuals are extraordinarily sensitive to potential infection from generally harmless microorganisms and should not participate in laboratory activities unless permitted to do so by a physician. Do not allow students who have any open cuts, abrasions, or open sores to work with microorganisms.

HOW TO USE ASEPTIC TECHNIQUE

- Demonstrate correct aseptic technique to students *prior* to conducting a lab activity. Never pipet liquid media by mouth. When possible, use sterile cotton applicator sticks instead of inoculating loops and Bunsen burner flames for culture inoculation. Remember to use appropriate precautions when disposing of cotton applicator sticks: they should be autoclaved or sterilized before disposal.
- Treat *all* microbes as pathogenic. Seal with tape all petri dishes containing bacterial cultures. Do not use blood agar plates, and never attempt to cultivate microbes from a human or animal source.
- Never dispose of microbe cultures without sterilizing them first. Autoclave or steam-sterilize at 120°C and 15 psi for 15 to 20 minutes all used cultures and any materials that have come in contact with them. If these devices are not available, flood or immerse these articles in full-strength household bleach for 30 minutes, and then discard. Use the autoclave or steam sterilizer yourself; do not allow students to use these devices.
- Wash all lab surfaces with a disinfectant solution before and after handling bacterial cultures.

HOW TO HANDLE BACTERIOLOGICAL SPILLS

- Never allow students to clean up bacteriological spills. Keep on hand a spill kit containing 500 mL of full-strength household bleach, biohazard bags (autoclavable), forceps, and paper towels.
- In the event of a bacterial spill, cover the area with a layer of paper towels. Wet the paper towels with bleach, and allow them to stand for 15 to 20 minutes. Wearing gloves and using forceps, place the residue in the biohazard bag. If broken glass is present, use a brush and dustpan to collect material, and place it in a suitably marked container.

Name ______________________ Class ______________ Date ____________

Safety in the Field

Activities conducted outdoors require some advance planning to ensure a safe environment. The following general guidelines should be followed for fieldwork.

- **Know your mission.** Your teacher will tell you the goal of the field trip in advance. Be sure to have your permission slip approved before the trip, and check to be sure that you have all necessary supplies for the day's activity.
- **Find out about on-site hazards before setting out.** Determine whether poisonous plants or dangerous animals are likely to be present where you are going. Know how to identify these hazards. Find out about other hazards, such as steep or slippery terrain.
- **Wear protective clothing.** Dress in a manner that will keep you warm, comfortable, and dry. Decide in advance whether you will need sunglasses, a hat, gloves, boots, or rain gear to suit the terrain and local weather conditions.
- **Do not approach or touch wild animals.** If you see a threatening animal, call your teacher immediately. Avoid any living thing that may sting, bite, scratch, or otherwise cause injury.
- **Do not touch wild plants or pick wildflowers unless specifically instructed to do so by your teacher.** Many wild plants can be irritating or toxic. Never taste any wild plant.
- **Do not wander away from others.** Travel with a partner at all times. Stay within an area where you can be seen or heard in case you run into trouble.
- **Report all hazards or accidents to your teacher immediately.** Even if the incident seems unimportant, let your teacher know what happened.
- **Maintain the safety of the environment.** Do not remove anything from the field site without your teacher's permission. Stay on trails, when possible, to avoid trampling delicate vegetation. Never leave garbage behind at a field site. Leave natural areas as you found them.

Name ________________ Class ________ Date ________

Laboratory Techniques

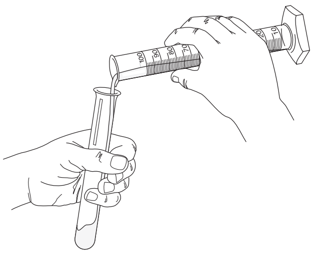


FIGURE A

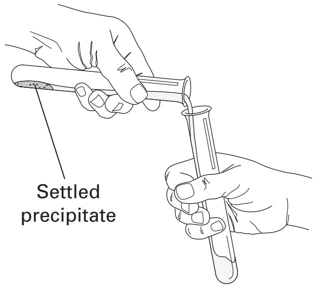


FIGURE B

FIGURE C

HOW TO DECANT AND TRANSFER LIQUIDS

1. The safest way to transfer a liquid from a graduated cylinder to a test tube is shown in Figure A. The liquid is transferred at arm's length, with the elbows slightly bent. This position enables you to see what you are doing while maintaining steady control of the equipment.

2. Sometimes, liquids contain particles of insoluble solids that sink to the bottom of a test tube or beaker. Use one of the methods shown above to separate a supernatant (the clear fluid) from insoluble solids.

a. Figure B shows the proper method of decanting a supernatant liquid from a test tube.

b. Figure C shows the proper method of decanting a supernatant liquid from a beaker by using a stirring rod. The rod should touch the wall of the receiving container. Hold the stirring rod against the lip of the beaker containing the supernatant. As you pour, the liquid will run down the rod and fall into the beaker resting below. When you use this method, the liquid will not run down the side of the beaker from which you are pouring.

HOW TO HEAT SUBSTANCES AND EVAPORATE SOLUTIONS

1. Use care in selecting glassware for high-temperature heating. The glassware should be heat resistant.

2. When heating glassware by using a gas flame, use a ceramic-centered wire gauze to protect glassware from direct contact with the flame. Wire gauzes can withstand extremely high temperatures and will help prevent glassware from breaking. Figure D shows the proper setup for evaporating a solution over a water bath.

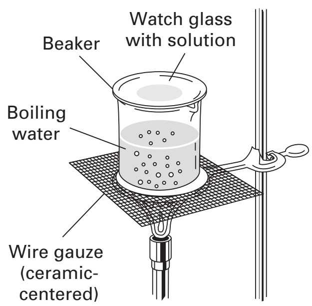


FIGURE D

3. In some experiments, you are required to heat a substance to high temperatures in a porcelain crucible. Figure E shows the proper apparatus setup used to accomplish this task.

4. Figure F shows the proper setup for evaporating a solution in a porcelain evaporating dish with a watch glass cover that prevents spattering.

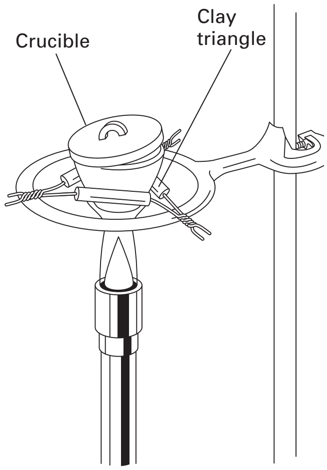


FIGURE E

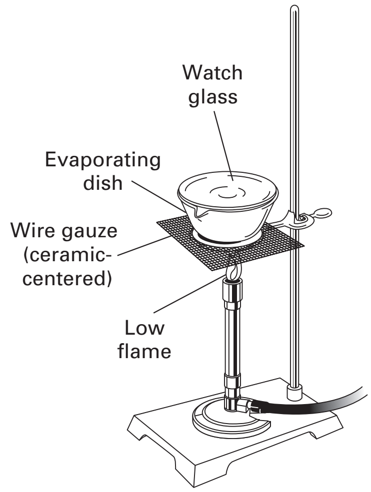


FIGURE F

5. Glassware, porcelain, and iron rings that have been heated may *look* cool after they are removed from a heat source, but these items can still burn your skin even after several minutes of cooling. Use tongs, test-tube holders, or heat-resistant mitts and pads whenever you handle these pieces of apparatus.
6. You can test the temperature of beakers, ring stands, wire gauzes, or other pieces of apparatus that have been heated by holding the back of your hand close to their surfaces before grasping them. You will be able to feel any energy as heat generated from the hot surfaces. DO NOT TOUCH THE APPARATUS. Allow plenty of time for the apparatus to cool before handling.

HOW TO POUR LIQUID FROM A REAGENT BOTTLE

1. Read the label at least three times before using the contents of a reagent bottle.
2. Never lay the stopper of a reagent bottle on the lab table.
3. When pouring a caustic or corrosive liquid into a beaker, use a stirring rod to avoid drips and spills. Hold the stirring rod against the lip of the reagent bottle. Estimate the amount of liquid you need, and pour this amount along the rod, into the beaker. See Figure G.

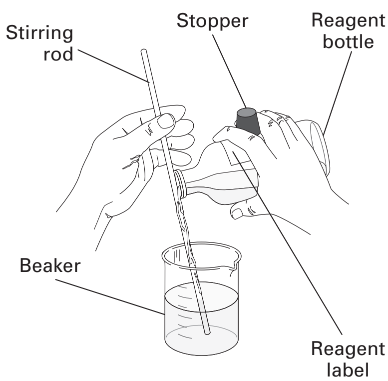


FIGURE G

4. Extra precaution should be taken when handling a bottle of acid. Remember the following important rules: Never add water to any concentrated acid, particularly sulfuric acid, because the mixture can splash and will generate a lot of energy as heat. To dilute any acid, add the acid to water in small quantities while stirring slowly. Remember the “triple A’s”—*Always Add Acid* to water.

5. Examine the outside of the reagent bottle for any liquid that has dripped down the bottle or spilled on the counter top. Your teacher will show you the proper procedures for cleaning up a chemical spill.
6. Never pour reagents back into stock bottles. At the end of the experiment, your teacher will tell you how to dispose of any excess chemicals.

HOW TO HEAT MATERIAL IN A TEST TUBE

1. Check to see that the test tube is heat resistant.
2. Always use a test tube holder or clamp when heating a test tube.
3. Never point a heated test tube at anyone, because the liquid may splash out of the test tube.
4. Never look down into the test tube while heating it.
5. Heat the test tube from the upper portions of the tube downward, and continuously move the test tube, as shown in Figure H. Do not heat any one spot on the test tube. Otherwise, a pressure buildup may cause the bottom of the tube to blow out.

HOW TO USE A MORTAR AND PESTLE

1. A mortar and pestle should be used for grinding only one substance at a time. See Figure I.
2. Never use a mortar and pestle for simultaneously mixing different substances.
3. Place the substance to be broken up into the mortar.
4. Pound the substance with the pestle, and grind to pulverize.
5. Remove the powdered substance with a porcelain spoon.

HOW TO DETECT ODORS SAFELY

1. Test for the odor of gases by wafting your hand over the test tube and cautiously sniffing the fumes as shown in Figure J.
2. Do not inhale any fumes directly.
3. Use a fume hood whenever poisonous or irritating fumes are present. DO NOT waft and sniff poisonous or irritating fumes.

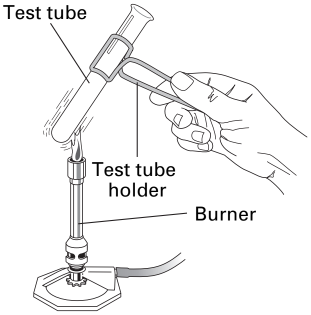


FIGURE H

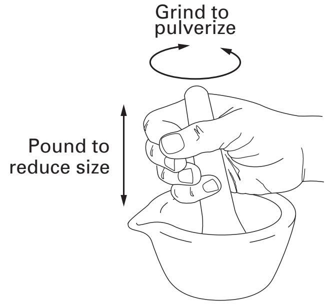


FIGURE I

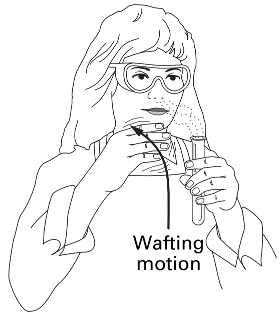


FIGURE J

Using Calculator-Based Labs

Download science lab software for FREE from Vernier Software & Technology or Holt, Rinehart and Winston to perform Calculator-Based Labs.

The procedures for the experiments labeled CBL™ Probeware (Calculator-Based Labs) are written for Calculator-Based Laboratory (CBL) Systems. There are a variety of systems currently available (such as CBL 1, CBL 2, and LabPro), and new products will continue to be developed (such as handheld devices that can be used with probes and sensors). Your equipment supplier is the best source of information regarding product updates or upgrades.

CBL Probeware experiments also require software programs by Vernier Software & Technology. In each experiment, the step-by-step instructions refer specifically to the menus that will appear on your students' calculator screens as they use these programs.

Texas Instruments offers a variety of graphing calculators that can be used with the CBL System. A list of these calculators is shown below. Although the instructions given in the experiments were written to work for all TI calculators, some minor adaptations may need to be made, depending on which calculators your students use.

- TI-73
- TI-82
- TI-83
- TI-83 Plus
- TI-86
- TI-89
- TI-92
- TI-92 Plus

Getting Started

SYSTEM REQUIREMENTS

You will need TI-GRAPH LINK™ software and a TI-GRAPH LINK computer-interface cable to get started using the PHYSCI programs with your TI graphing calculator and CBL. These products are available from CENCO, from Vernier Software, or from educational- and office-supply companies.

DOWNLOADING THE PROGRAMS FROM THE WEB TO YOUR COMPUTER

Use the following Web site to download the software programs you will need to complete Calculator-Based Labs.

internetconnect

go.hrw.com

Go to: go.hrw.com
Keyword: HN4 VERNIER

At this site, you can download the lab software to your computer's hard drive. All download instructions are found on the Web site. After you download the software, open and read the text file. It contains more detailed information about the program by Vernier Software and Technology. You might want to print a copy of this file for reference throughout the school year.

You may also want to refer to the CBL Made Easy! Booklet that comes with your purchase of the CBL system. The most up-to-date version of the text file and this booklet can be found on the Vernier Web site at www.vernier.com.

DOWNLOADING LAB SOFTWARE TO A CALCULATOR

- Each experiment will tell you which program you will need for that experiment. To download that group file from your computer to your calculator, follow the directions in the manual that comes with the TI-GRAPH LINK cable.
  Note: Because the program may be large, it is recommended that all other programs be removed before loading the program onto a calculator.
- When the transfer is complete, a set of programs will appear on the calculator's screen. The set will include the program title and a list of related programs that are used by the main program.
- To distribute the programs to your students' calculators, use the link-to-link cable to copy the programs to each student's calculator.
- Students should keep all of the programs on their calculators so that they can use them throughout the year. Because these programs are locked, students will not be able to change the programs on their own calculators.

USING THE SOFTWARE

- To use a program, simply follow the instructions given in the lab procedure. The program can calibrate sensors, collect data, and perform data analysis. You can use the CBL to its full potential without writing your own programs or using many different interfaces.
- The programs are designed to be very flexible. There are a variety of data-collection modes and sensors available. You even have the capability of using more than one sensor at a time so that several different measurements can be made simultaneously.

More Information

Texas Instruments

www.ti.com

Technical support: 1-800-TI-CARES

Programming assistance: (972) 917-8324

E-mail: ti-cares@ti.com

Address: Texas Instruments
P.O. Box 650311, MS 3962
Dallas, TX 75265

Vernier Software & Technology

www.vernier.com

E-mail: info@vernier.com

Address: Vernier Software & Technology
13979 SW Millikan Way
Beaverton, OR 97005-2886

Name ______________________________ Class ______________ Date ____________

Writing a Lab Report

There is no universally accepted format for a lab report. Your teacher will specify how he or she wishes to evaluate your work in the lab. However, the purpose of any lab report should be to record your findings and communicate what you have learned. With these goals in mind, here are some typical guidelines for writing a lab report.

Get organized. A good lab notebook is your key to success in the lab. Record everything in this notebook, and use it as a reference when you write the report.

Take notes during any pre-lab discussion. Good notes will make writing the report go much faster. You will usually be given some clues as to what to observe or how to do the calculations.

Always record the units when collecting data. It's easy to forget a few days later the units you saw for the data you collected.

MODEL FORMAT

A good general, scientifically based model has the following parts:

1. **Title** The title should clearly describe the nature of the experiment. In some cases, you may be able to use the title of the lab your teacher provides. However, be sure that the title provides clear information. Don't forget to include your name, date, and the names of any lab partners with your title section.
2. **Abstract or Summary** Though this section appears second in the report, it is often written last. This section summarizes the purpose of the experiment and your findings. It gives the reader a quick overview of what you've done and what you've learned.
3. **Introduction** This section should describe the problem or hypothesis you are investigating. The introduction should include the reason you are studying the problem and any useful outside information related to the problem or hypothesis.
4. **Materials and Methods** This section describes your procedure, the materials you used, how you gathered and analyzed your data, and the controls in your experiment. This section should be written in the past tense and passive voice.

   For example:

   Three 50 mL beakers were each filled with 25 mL of water.

   Do not write:

   I filled three beakers with water.
5. **Results** In this section, you describe what you found out through the experiment. Results include your observations, measurement data, graphs, and tables. Calculations and answers to all lab questions should be included.

DATA TABLES AND CHARTS

Choose a title for your data table, and then make a list of the types of data to be collected. This list will become the headings for your data columns. For example, if you collected data on plant growth over time, you could record your data in a table like the one below.

PLANT GROWTH OVER TIME

Time (days)	Height of plant (cm)
1	10
3	12
5	15
7	18
9	20

GRAPHS

Choose the scale for each axis of your graph. The scale should take up as much of the paper as possible so that the results can be clearly seen. Then, choose the interval for the scale (the number of days represented by each block in the x-axis scale, for example). Remember, once you choose the interval for the scale, you cannot change it. If you change the interval of your scale, your graph will not accurately represent your data.

Mark the points for each pair of numbers. When all points are marked, draw the best straight or curved line between them. Remember that you do not "connect the dots" when you draw a graph. Instead, you should draw a "best fit" curve—a line or smooth curve that intersects or comes as close as possible to your set of data points.

Plant Growth