PROPER USE OF LAB EQUIPMENT and DATA ANALYSIS SKILLS

Introduction: A good scientist must be able to use scientific tools to make accurate observations. While studying science in this class, you will be required to use many pieces of lab equipment to help you collect data and to make observations. It is essential that you be able to use each piece of equipment accurately and safely. You must also have the skills to record and analyze the data that you collect while using these pieces of equipment. The best way to become familiar with the tools used by scientists is to handle them yourself. In this lab, you will learn to use basic pieces of lab equipment and the methods of data recording (using the metric system) and analysis.

Purpose:
1. To learn to use the following pieces of equipment safely and accurately: Celsius thermometer, meter stick, triple beam balance, graduated cylinder, beaker, electric balance, and a microscope.
2. To learn to organize data in a data table.
3. To learn to graphically represent data in a bar graph, line graph and circle graph.

Materials:

<table>
<thead>
<tr>
<th>Thermometers</th>
<th>Beakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduated Cylinder</td>
<td>3 objects for massing (stopper, coin, 50 mL beaker)</td>
</tr>
<tr>
<td>Triple Beam Balance</td>
<td>Meter stick</td>
</tr>
<tr>
<td>Microscope</td>
<td>Electric balance</td>
</tr>
<tr>
<td>Ruler</td>
<td>Graph paper (optional)</td>
</tr>
</tbody>
</table>

Safety Precautions:
1. Safety goggles should be worn at all times.
2. Only sneakers or close toed shoes shall be worn in the lab. No sandals or flip flops.
3. Use caution when handling any type of glassware, as it can break easily and cut you.
4. Handle the microscopes with care.

Part I: The Celsius Thermometer

Thermometers are very fragile and must be handled with care. Read the following rules for the proper use of a thermometer.

1. Never "shake down" a thermometer to reset it.
2. Never use a thermometer to stir a liquid.
3. Never allow a thermometer to touch the bottom of a container that is being heated.

Read the following directions for using and reading a thermometer.

1. Place the bulb end of the thermometer into the object with an unknown temperature.
2. Wait several minutes for the thermometer to adjust to the temperature of the object.
3. Without removing the thermometer from the object, note the number nearest the top of the column of liquid in the thermometer.
Answer the following questions on the worksheet provided. Make sure to label every measurement with the correct unit.

1. What are the temperatures shown by these thermometers in Celsius?

2. What is the temp of beaker A? Beaker B?
3. Do you have a mercury thermometer or some other kind of thermometer?
4. Why must one be especially careful when dealing with a mercury thermometer?
5. Why must you read the temperature without removing the thermometer from the solution?
6. Why should the thermometer never be used to stir a liquid?
7. Why should the thermometer never touch the bottom of a container that is being heated?
Part II: The Graduated Cylinder

Read the following directions for using and reading a graduated cylinder:
1. Place the cylinder on a flat surface.
2. Look at the cylinder from the side at eye level. The top of the liquid should be at eye level. The view of the surface of the liquid will be curved. This curved surface is called the “meniscus”.
3. Read the graduated cylinder at the bottom of the meniscus.

Answer the following on the worksheet provided.
1. How much liquid is contained in each of the following graduated cylinders?

   a) 
   b) 
   c) 

At this station you will notice three beakers that are labeled “A”, “B” and “C”. Use your graduated cylinder correctly to complete the following:
2. Measure the amount of water in each of the three beakers on your table. What is the amount of water in beaker A? Beaker B? Beaker C?
3. What is the largest volume of liquid your graduated cylinder can measure?
4. What is the smallest volume of liquid your graduated cylinder can measure?

Part III: The Triple-Beam Balance

Balances are sensitive equipment and must be handled with care. If the balance isn’t zeroed prior to using, please contact the instructor for assistance.

Read the following rules for the proper use of a balance.
1. Never place a powder or liquid directly on the pan. Powders should be placed on weighing paper and liquids should be in a container.
2. Place all objects on the pan gently.
3. The adjustment knob is used to zero the balance.
Read the following directions for using and reading a balance.

1. Move all of the riders as far as they will go to the left. The pointer should now be in line with the zero marking. If not, move the adjustment knob very slowly until the pointer is in line with the zero marking. If you are confused, please ask the instructor.
2. Place an object on the pan. The pointer will swing up. Move the riders, starting with the back beam, until the pointer returns to the zero mark.
3. Total the masses indicated by each rider to find the mass of the object. Record.
4. Move the riders to the left again and remove the object.

Answer the following on the worksheet provided.

1. Study the triple and quadruple beam balance diagrams below. What are the masses of the objects indicated by these balances?

   a)

   b)

   c)
2. Use the balance on your table to determine the mass of these objects: a rubber stopper, a coin, a 50 mL beaker.
3. What place value is represented by each of the four beams?
4. What is the largest mass that this balance can measure?
5. What is the smallest mass that this balance can measure?

Part IV: The Compound Microscope

"Micro" refers to tiny, "scope" refers to view or look at. Microscopes are tools used to enlarge images of small objects so as they can be studied. The compound light microscope is an instrument containing **two lenses**, which magnifies, and a variety of **knobs to resolve** (focus) the picture. Because it uses more than one lens, it is sometimes called the compound microscope in addition to being referred to as being a light microscope. In this section of the lab, you will learn about the proper use and handling of the microscope ([www.biologyjunction.com](http://www.biologyjunction.com)).

I. Microscope Handling

1. **Carry the microscope with both hands** --- one on the arm and the other under the base of the microscope.
2. One person from each group will now go over to the microscope storage area and properly **transport one microscope to your working area**.
3. The other person in the group will **pick up a pair of scissors, newsprint, a slide, and a cover slip**.
4. **Remove the dust cover** and store it properly. Plug in the scope. Do not turn it on until told to do so.
5. **Examine the microscope and label all parts, as well as give the function of each part**.

II. Making a wet mount of the letter "e".

1. With your scissors cut out the letter "e" from the newspaper and place it on the glass slide, to look like (e).

2. Place one drop of water directly over the “e.” Don’t put too much water because the cover slip will float away.

This lab has been modified by S Bailey
3. Place the cover slip at a 45 degree angle with one edge touching the water drop, and then gently let go. You may want to use the forceps to assist with proper placing. See the figure below.
4. Place the slide on the stage. Turn on the microscope. Always start with the scanning objective and use the coarse adjustment knob to focus. You may need to move the slide around until you see the object.
5. Once you have the specimen focused, switch to low power and refocus using the coarse adjustment knob.
6. Switch to high power and use the fine adjustment knob to focus the sample.
7. If the specimen is too light or too dark, try adjusting the diaphragm.
8. Draw what you see on the data collection sheet.

![Technique for Adding a Stain when making a Wet Mount](image)

**Staining a Slide**

1. Stain = methylene blue.
2. Using the eye dropper, place one drop of methylene blue on the edge of the cover slip.
3. Place the flat edge of a piece of paper towel on the opposite side of the cover slip. The paper towel will draw the water out from under the cover slip, and the cohesion of water will draw out the stain under the slide.
4. When the stain covers the entire area of the specimen, you are done. Wipe up any excess stain.

**Part V: The Metric Ruler**

All of our measurements will be made using the metric system. The meter stick on your table is (obviously) one meter long. Study your meter stick to observe the following: (1) a meter consists of a 100 centimeters, and (2) a meter consists of 1000 millimeters. Notice that you will find a note card and a sheet of white, computer paper at this station.

**Answer the following on the worksheet provided.**

1. How long is the meter stick in inches?
2. How many feet are in a meter?
3. What is the length of the note card in meters, centimeters, and millimeters?
4. What is the width of the computer paper in meters, centimeters, and millimeters?
5. What is the width of the lab table in meters, centimeters, and millimeters?
Part VI: Tabling, Graphing and Analyzing Data
A. Making a Table

Any time data is collected in an experiment, it is most often presented in a table. The data table must have a title, rows, columns, and heads. The title should be placed at the top and tells the observer what information is contained in the table. At the top of each column should be a “head” that tells you what information is in the column.

Read the paragraph below. Use the information to complete a table.

An experiment was conducted to measure the amount of oxygen consumed during cellular respiration by germinating seeds at two different temperatures. Measurements were taken every two minutes for 10 minutes. The first set of seeds was kept in a cold environment in which the temperature was maintained at 10°C. The measurements (showing cumulative oxygen consumption) obtained at 2-minute intervals were: 1 mL, 1.8 mL, 2.7 mL, 3.6 mL, and 4.5 mL. The second set of seeds was kept in a warm environment in which the temperature was maintained at 24°C. The measurements (showing cumulative oxygen consumption) obtained at 2-minute intervals were: 2 mL, 3.1 mL, 4.3 mL, 5.6 mL, and 6.5 mL.

B. Making a Line Graph

Line graphs show data plotted as points that are connected by a line. Line graphs are often used to show change over time and can be used to compare two or more sets of data.

Before a line graph can be constructed, you must identify the two variables that will serve as x and y coordinates on the graph. These are called the “independent variable” and the “dependent variable”.

The independent variable is the one being manipulated or changed during the experiment. It is always placed on the x-axis or horizontal axis. The dependent variable is the observed result of the independent variable being changed. The dependent variable is always placed on the y-axis or vertical axis. An easy way to remember this is to ask yourself the questions, “What did I know before I did the experiment?” (independent variable) and “What did I learn by doing the experiment?” (dependent variable)

Using a piece of graph paper, or the student worksheet if one was provided by your teacher, graph the information that you placed in your newly constructed data table in Part A. Remember: Since you were comparing seeds at two different temperatures, there should be two different lines plotted on your graph.

Be sure to: (1) Label each axis appropriately, (2) Scale each axis appropriately, (3) Title your graph, (4) Label each of the two lines on your graph.
C. Making a Bar Graph

Bar graphs are useful for showing comparisons of data collected by counting. A bar graph has two axes, a horizontal axis and a vertical axis. Generally the horizontal axis is labeled and the vertical axis is divided. The data are not related so the bars do not touch.

Using the worksheet, make a bar graph of the following information:

Students were surveyed to determine what part of the school day was their favorite. Students could choose only one of the following categories as their favorite part of the school day:

<table>
<thead>
<tr>
<th>Part of the School Day</th>
<th># of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Class</td>
<td>15</td>
</tr>
<tr>
<td>Science Class</td>
<td>25</td>
</tr>
<tr>
<td>English Class</td>
<td>8</td>
</tr>
<tr>
<td>History Class</td>
<td>10</td>
</tr>
<tr>
<td>Gym</td>
<td>46</td>
</tr>
<tr>
<td>Lunchtime</td>
<td>73</td>
</tr>
</tbody>
</table>

D. Making a Circle Graph

A circle graph is used to show how a certain quantity is broken down into parts. The circle represents the whole, and the “slices of the pie” represent the portions of the whole. In a circle graph, be sure to label the sections so that the data is shown.

Using your notebook paper, or the student worksheet if one was provided by your teacher, make a circle graph of the following information:

People were surveyed to determine what color automobile they would prefer. The results were:

Grey – 50%
Red – 25%
White – 10%
Blue – 10%
Beige – 5%
PROPER USE OF LAB EQUIPMENT
and DATA ANALYSIS SKILLS
Student Answer Sheet

Part I: The Celsius Thermometer

1. What are the temperatures shown by these thermometers?
   
   __________ 1   __________ 2   __________ 3
   __________ 4   __________ 5   __________ 6

2. Temperature of beaker A? ____________
   Temperature of beaker B? ____________

3. Do you have a mercury thermometer or some other kind of thermometer?

4. Why must one be especially careful when dealing with a mercury thermometer?

5. Why must you read the temperature without removing the thermometer from the solution?

6. Why should the thermometer never be used to stir a liquid?

7. Why should the thermometer never touch the bottom of a container that is being heated?

Part II: The Graduated Cylinder

1. How much liquid is contained in each of the following graduated cylinders?

   a) __________  
   b) __________  
   c) __________  

This lab has been modified by S Bailey
2. What is the amount of water in beaker A? __________

What is the amount of water in beaker B? __________

What is the amount of water in beaker C? __________

3. What is the largest volume of liquid your graduated cylinder can measure? _______________________

4. What is the smallest volume of liquid your graduated cylinder can measure? _______________________

Part III: The Triple-Beam Balance

1. What are the masses of the objects indicated by these balances?
   a) __________ b) __________ c) __________ d) __________

2. Use the balance on your table to determine the mass of these objects:
   rubber stopper __________ coin __________ 50 mL beaker __________

3. What place value is represented by each of the three beams?

4. What is the largest mass that this balance can measure?

5. What is the smallest mass that this balance can measure?
Part IV: The Compound Microscope

Label the microscope.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyepiece / Ocular Lens</td>
<td></td>
</tr>
<tr>
<td>Body Tube</td>
<td></td>
</tr>
<tr>
<td>Arm</td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td></td>
</tr>
<tr>
<td>Coarse Adjustment Knob</td>
<td></td>
</tr>
<tr>
<td>Fine Adjustment Knob</td>
<td></td>
</tr>
<tr>
<td>Stage</td>
<td></td>
</tr>
<tr>
<td>Stage Clips</td>
<td></td>
</tr>
<tr>
<td>Diaphragm</td>
<td></td>
</tr>
<tr>
<td>Rotating Nosepiece</td>
<td></td>
</tr>
<tr>
<td>Scanning Objective</td>
<td>Low Power Objective</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>High Power Objective</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Mirror or Bulb</td>
<td></td>
</tr>
</tbody>
</table>

1. If the scanning objective is 4X, what is the total magnification? ________________
2. If the high power objective is 40X, what is the total magnification? ________________
3. If the low power objective is 10X, what is the total magnification? ________________
4. The ocular lens always has a magnification of ________________.
5. Look at the specimens under the microscope and draw what you see in the circles below.

Part V: The Metric Ruler

1. How long is the meter stick in inches? ______________
2. How long is one centimeter in inches? ______________
3. What is the length of the note card in:
   meters ___________ centimeters ___________ millimeters ___________
4. What is the width of the computer paper in:
   meters ___________ centimeters ___________ millimeters ___________
5. What is the width of the lab table in:
   meters ___________ centimeters ___________ millimeters ___________

This lab has been modified by S Bailey
Part VI: Tabling, Graphing and Analyzing Data

A. Making a Table – Make a table of the information in the space below.

B. Making a Line Graph – Make a line graph of the information on the grid below.
C. Making a Bar Graph – Make a bar graph of the information on the grid below.

D. Making a Circle Graph – Make a circle graph of the information.