Herrin Science

Laboratory & Safety Skills

Name:______________________________________

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INTRODUCTION===

Science is the body of information including all the hypotheses and experiments that tell us about our environment. All people involved in scientific work use similar methods of gaining information. One important scientific skill is the ability to obtain data directly from the environment. Observations must be based on what actually happens in the environment. Equally important is the ability to organize this data into a form from which valid conclusions can be drawn. The conclusions must be such that other scientists can achieve the same results.

INTERNATIONAL SYSTEM OF UNITS ==

The international System (SI) of Measurements is accepted as the standard for measurement throughout most of the world. Three base units in SI are the meter, kilogram, and second. Frequently used SI units are listed below.

TABLE 1

	Frequently sued SI units
Length	1 millimeter (mm) = 1000 micrometers or microns (μm) 1 centimeter (cm) – 10 millimeters (mm) 1 meter (m) = 100 centimeters (cm) 1 kilometer (km) = 1000 meters (m) 1 light-year = 9 460 000 000 000 kilometers (km)
Area	1 square meter (m^2) = 10 000 square centimeters (cm^2) 1 square kilometer (km^2) = 1 000 000 square meters (m^2)
Volume	1 milliliter (mL) = 1 cubic centimeters (cc) (cm^3) 1 liter (L) = 1000 milliliters (mL)
Mass	1 gram (g) = 1000 milligrams (mg) 1 kilogram (kg) = 1000 grams (g) 1 metric ton = 1000 kilograms (kg)
Time	1 second = 1 s 1 minute (min) = 60 seconds (s)

Temperature measurements in SI are often made in degrees Celsius. Celsius temperature is a supplementary unit derived from the base unit Kelvin. The Celsius scale (°C) has 100 equal graduations between the freezing temperature (0°C) and the boiling temperature of water (100°C). The following relationship exists between the Celsius and Kelvin temperature scales:

$$K = °C + 273$$

Several other supplementary SI units are listed below.

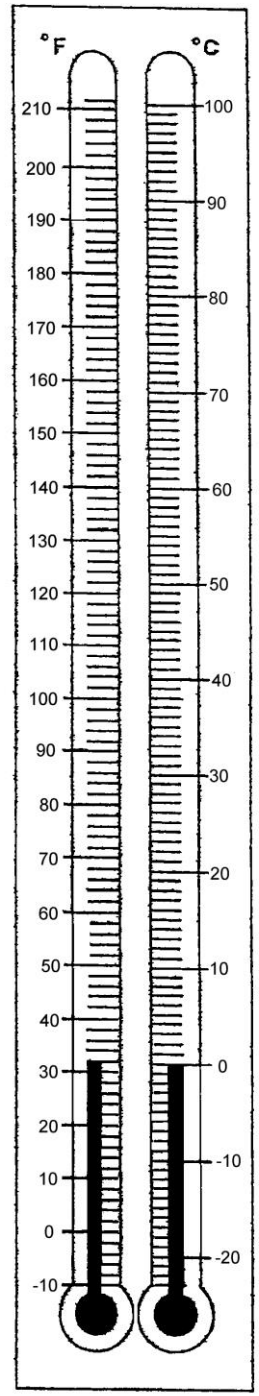
TABLE 2

Supplementary SI units			
Measurement	Unit	Symbol	Expressed in base units
Energy	joule	J	Kg • m^2/s^2
Force	newton	N	kg • m/s^2
Power	watt	W	kg • m^2/s^3 or J/s
Pressure	pascal	Pa	kg/m • s^2 or N • m

TABLE 3

SI/Metric to English conversions			
	When you want to convert:	Multiply by:	To find:
Length	inches	2.54	centimeters
	centimeters	0.39	inches
	feet	0.30	meters
	meters	3.28	feet
	yards	0.91	meters
	meters	1.09	yards
	miles	1.61	kilometers
	kilometers	0.62	miles
Mass and weight*	ounces	28.35	grams
	grams	0.04	ounces
	pounds	0.45	kilograms
	kilograms	2.20	pounds
	tons	0.91	tonnes (metric tons)
	tonnes	1.10	tons
	pounds	4.45	newtons
	newtons	0.23	pounds
Volume	cubic inches	16.39	cubic centimeters
	cubic centimeters	0.06	cubic inches
	cubic feet	0.03	cubic meters
	cubic meters	35.31	cubic feet
	liters	1.06	quarts
	liters	0.26	gallons
	gallons	3.78	liters
Area	square inches	6.45	square centimeters
	square centimeters	0.16	square inches
	square feet	0.09	square meters
	square meters	10.76	square feet
	square miles	2.59	square kilometers
	square kilometers	2.47	square miles
	hectares	0.40	acres
	acres		hectares
Temperature	Farhenheit	5/9 (°F – 32)	Celsius
	Celsius	9/5 (°C + 32)	Farhenheit

*** Weight as measured in standard Earth gravity**



	DISPOSAL ALERT This symbol appears when care must be taken to dispose of materials properly.		ANIMAL SAFETY This symbol appears whenever live animals are studied and the safety of the animals and the student must be ensured.
	BIOLOGICAL HAZARD This symbol appears when there is danger involving bacteria, fungi, or protists.		RADIOACTIVE SAFETY This symbol appears when radioactive materials are used.
	OPEN FLAME ALERT This symbol appears when use of an open flame could cause a fire or an explosion.		CLOTHING PROTECTION SAFETY This symbol appears when substances used could stain or burn clothing.
	THERMAL SAFETY This symbol appears as a reminder to use caution when handling hot objects.		FIRE SAFETY This symbol appears when care should be taken around open flames.
	SHARP OBJECT SAFETY This symbol appears when a danger of cuts or punctures caused by the use of sharp objects exists.		EXPLOSION SAFETY This symbol appears when the misuse of chemicals could cause an explosion.
	FUME SAFETY This symbol appears when chemicals or chemical reactions could cause dangerous fumes.		EYE SAFETY This symbol appears when a danger to the eyes exists. Safety goggles should be worn when this symbol appears.
	ELECTRICAL SAFETY This symbol appears when care should be taken when using electrical equipment.		POISON SAFETY This symbol appears when poisonous substances are used.
	PLANT SAFETY This symbol appears when poisonous plants or plants with thorns are handled.		CHEMICAL SAFETY This symbol appears when chemicals used can cause burns or are poisonous if absorbed through the skin.

SAFETY RULES ==

1. Always obtain your teacher's permission before beginning an activity.
2. Study the procedure. If you have questions, ask your teacher. Be sure you understand any safety symbols shown on the page.
3. Use the safety equipment provided for you. Goggles should be worn when any activity calls for using chemicals.
4. Always slant test tubes away from yourself and others when heating them.
5. Never eat or drink in the lab, and never use lab glassware as food or drink containers. Never inhale chemicals. Do not taste any substance or draw any material into a tube with your mouth.
6. If you spill any chemical, wash it off immediately with water. Report the spill immediately to your teacher.
7. Know the location and proper use of the fire extinguisher, safety shower, first aid kit, and fire alarm.
8. Keep all materials away from open flames. Tie back long hair and loose clothing.
9. If a fire should break out in the classroom or laboratory, or if your clothing should catch fire, smother it using the fire extinguisher or get under a safety shower. **NEVER RUN.**
10. Report any accident or injury, no matter how small, to your teacher.

Follow these procedures as you clean up your work area.

1. Turn off the water and gas. Disconnect electrical devices.
2. Return all materials to their proper places.
3. Dispose of chemicals and other materials as directed by your teacher. Place broken glass and solid substances in the proper containers. **Deposit materials in the sink only when instructed to do so.**
4. Clean your work area.
5. Wash your hands thoroughly after working in the laboratory.

First aid	
Injury	**Safe response**
Burns	Apply cold water. Call your teacher immediately.
Cuts and bruises	Stop any bleeding by applying direct pressure. Cover cuts with a clean dressing. Apply cold compresses to bruises. Call your teacher immediately.
Fainting	Leave the person lying down. Loosed any tight clothing and keep crowds away. Call your teacher immediately.
Foreign matter in eye	Flush with plenty of water. Use eyewash bottle or fountain.
Poisoning	Note the suspected poisoning agent and call your teacher immediately.
Any spills on skin	Flush with large amounts of water or use safety shower. Call your teacher immediately.

✂--

Parents or Guardians and Students: Please read the above safety rules and First aid responses.

I, ___________________________________, have read and understand the safety rules and first aid information listed above. I recognize my responsibility and pledge to observe all safety rules in the science classroom and laboratory at all times.
Please cut along the dotted line above to detach bottom portion. Return this portion with your signature and date.

____________________________ Student Signature

______________ Date

1 Lighting a Laboratory Burner

Most laboratory burners are constructed similarly. There is an inlet for gas and a vent or valve for the adjustment of air, which is mixed with the gas, as shown in Figure 1. For maximum heat, the air-gas mixture must be correct and the object to be heated should be placed just above the pale blue part of the flame.

1. To light the burner, hold a lighted match or a gas lighter next to the barrel of the burner and then turn on the gas.
2. After lightning the burner, adjust the flame from the gas inlet. If the flame rises from the burner or appears to “blow out” after lighting, reduce the supply of gas. Adjust the air vent until a light blue cone appears in the center of the flame. If the flame is yellow, open the air vent.

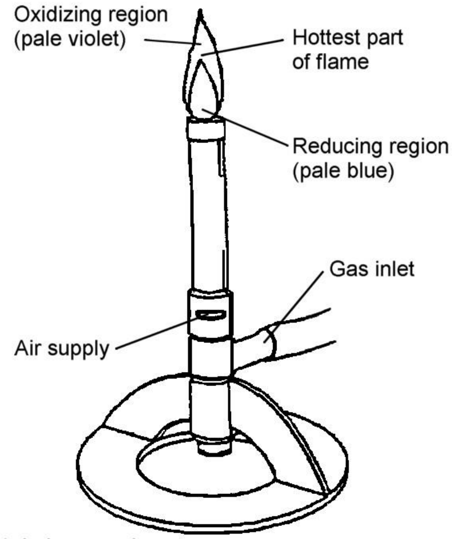


FIGURE 1. Laboratory burner

2 Decanting and Filtering

It’s often necessary to separate a precipitate from a liquid. The most common process of separation used in laboratories is filtration.

1. The major portion of the liquid is decanted, or separated from the precipitate, by carefully pouring off the liquid, leaving the solid material. To avoid splashing and to maintain control, the liquid is poured down a stirring rod, as shown in FIGURE 2.
2. Fold the filter paper as shown in FIGURE 3.
3. Filter the solution by pouring it through filter paper that catches any remaining precipitates, as shown in FIGURE 4.
4. Rinse the solid with distilled water to remove any solvent particles. The rinse water should be decanted and filtered.

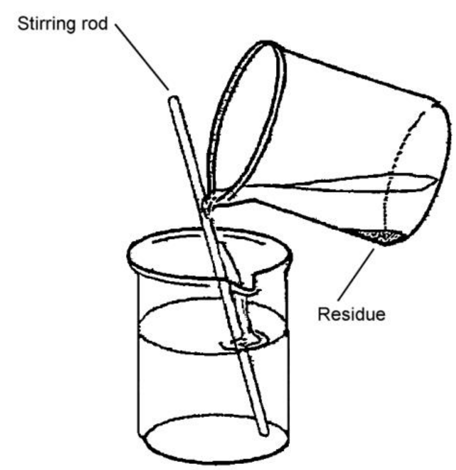


FIGURE 2. Decanting a liquid

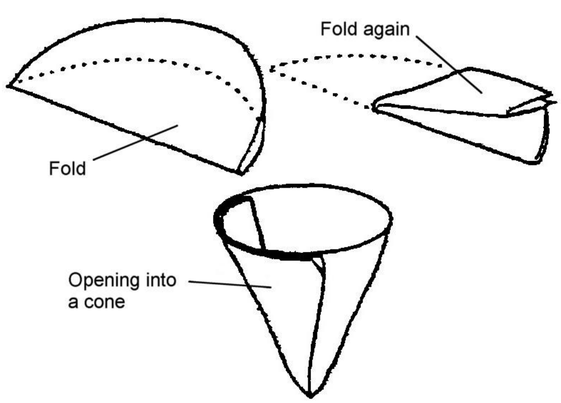


FIGURE 3. Folding a piece of filter paper

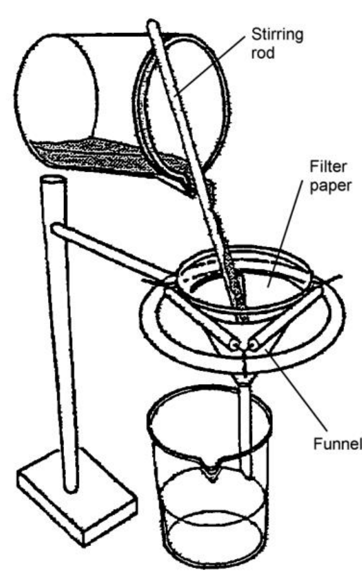


FIGURE 4. Filtering

3 Using the Balance

Although the balance you use may look somewhat different from the balance pictured In FIGURE 5, all beam balances require similar steps to find an unknown mass.

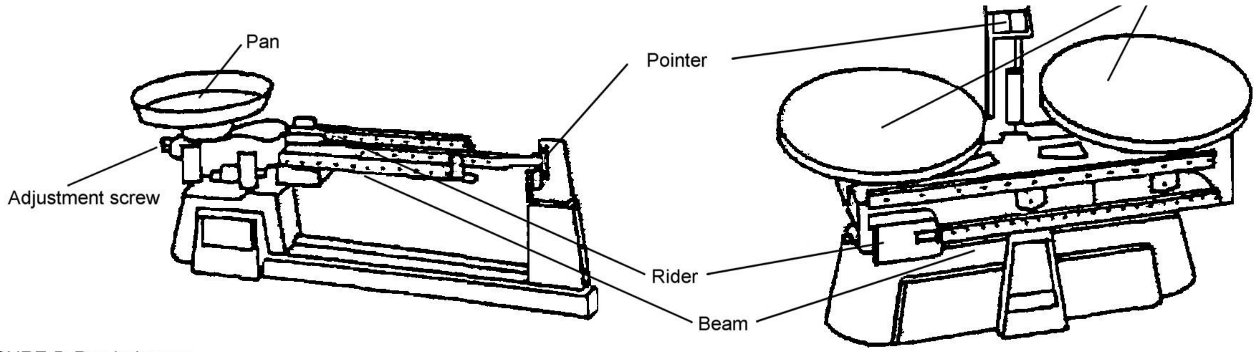


FIGURE 5. Pan balances

Follow these steps when using a beam balance.

1. Slide all riders back to the zero point. Check to see that the pointer swings freely along the scale. The beam should swing an equal distance above and below the zero point. Use the adjustment screw to obtain an equal swing of the beams. You should "zero" the balance each time you use it.
2. Never put a hot object directly on the pan. Air currents developing around the hot object may cause massing errors.
3. Never pour chemicals directly on the balance pan. Dry chemicals should be placed on paper or in a glass container. Liquid chemicals should be massed in glass containers.
4. Place the object to be massed on the pan and move the riders along the beams, beginning with the largest mass first. If the beams are notched, make sure all riders are in a notch before you take a reading. Remember, the swing should be an equal distance above and below the zero point on the scale.
5. The mass of the object will be the sum of the masses indicated on the beams, as shown in FIGURE 6 and 7. Subtract the mass of the container from the total mass reading, if necessary.

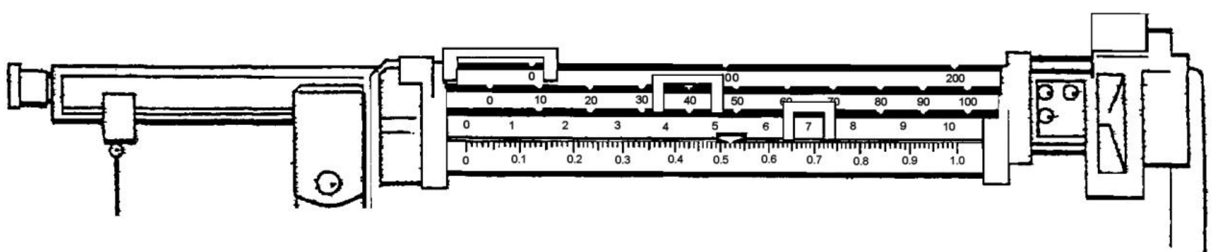


FIGURE 6. The mass of the object would be read as 47.52 grams.

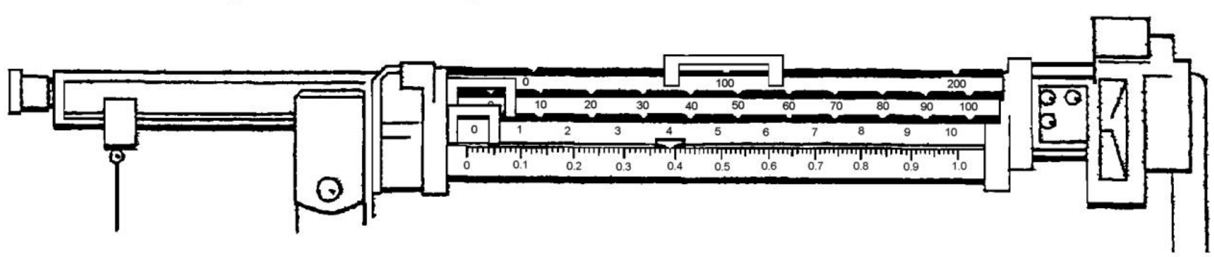


FIGURE 7. The mass of the object would be read as 100.39 grams.

4 Measuring Temperature

1. When the temperature of a liquid is measured with a thermometer, the bulb of the thermometer should be in the center of liquid. Do not allow the bulb to touch the bottom or sides of the container. When the thermometer is removed from the liquid,

The column in the thermometer will soon show air temperature. For this reason, take temperature readings while the thermometer is in the liquid.

2. When measuring the temperature of hot or boiling liquids, be sure to use a thermometer that is calibrated for high temperatures.
3. Never “shake down” a thermometer to reset it.
4. Never use a thermometer to stir a liquid.

5 Measuring Volume

1. The surface of liquids in glass cylinders is often curved. This curved surface is called the meniscus. Most of the liquids you will measure will have a concave meniscus. View the meniscus along the horizontal line of sight. See FIGURE 8. Do not try to make a reading looking up or down at the meniscus.
2. Always read a concave meniscus from the low point of the curve. This gives the most precise volume in a glass container.
3. Liquids in many plastic cylinders will not form a meniscus. In these containers, read the volume from the level of the liquid.

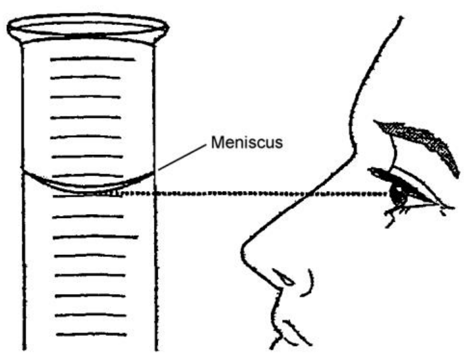


FIGURE 8. Reading liquid volume

6 Transferring Chemicals from Reagent Bottles

CAUTION: ***Never touch chemicals with your hands.***

Many chemicals are corrosive and irritating to the skin. Goggles and aprons must be worn when transferring chemicals from one container to another. To avoid contaminating stock chemicals, do not return unused chemicals to the stock bottle.

Solids

1. Solids are generally kept in wide mouth bottles. Use a clean spoon or spatula to remove the solid material from its container as shown in Step 1 of FIGURE 9. Or, rotate the bottle back and forth to shake out the solid.
2. Place the solid material on a piece of creased, waxed paper and add the solid very carefully to your container (Step 2 of FIGURE 9). Transfer the solid to a test tube by folding the paper as shown in Step 3 of FIGURE 9.
3. If the solid is to be massed, remember to use waxed paper or a container. Do not place the solid directly on the balance pan.

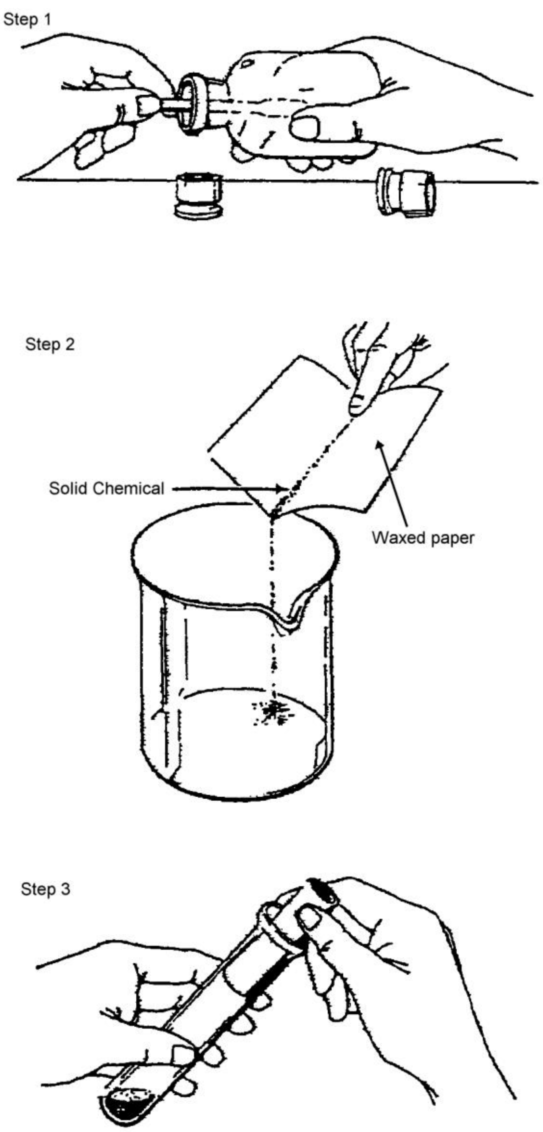


FIGURE 9. Transferring a solid

Liquids

1. Grasp the stopper between your fingers as shown in FIGURE 10 and remove the stopper from the reagent bottle. Do not put the stopper on the table; keep it between your fingers.
2. Wearing goggles, hold the test tube or graduated cylinder at eye level and pour the liquid slowly until the desired volume has been transferred. Read the volume as described above.
3. Replace the stopper in the reagent bottle. If any liquid runs down the outside of the bottle, rinse it with water before with a damp paper towel if the liquid is an acid.

FIGURE 10. Removing a stopper from a reagent bottle

7 Working with Chemicals

1. When smelling a substance, use a fanning motion to direct the vapor toward you. Never smell a substance directly. The proper technique is shown in FIGURE 11.
2. Always point the mouth of the test tube away from yourself and others when you heat the test tube. Move the tube constantly for even heating. See FIGURE 12.
3. Diluting acids
   a. The acid is added to the water, and never in the reverse.
   b. The acid should be poured slowly down the stirring rod and the solution continually stirred as shown in FIGURE 13. Diluting an acid produces heat. Therefore, it is important to add the acid slowly and to stir the solution.

FIGURE 11. Smelling a substance

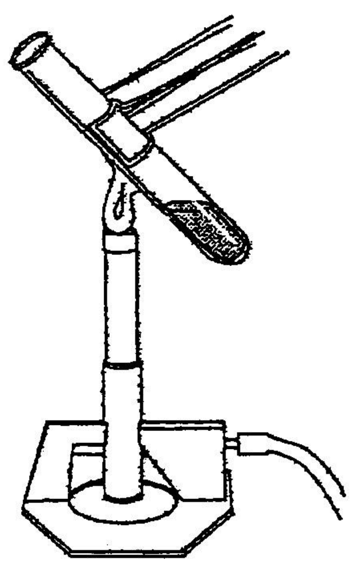


FIGURE 12. Heating a test tube

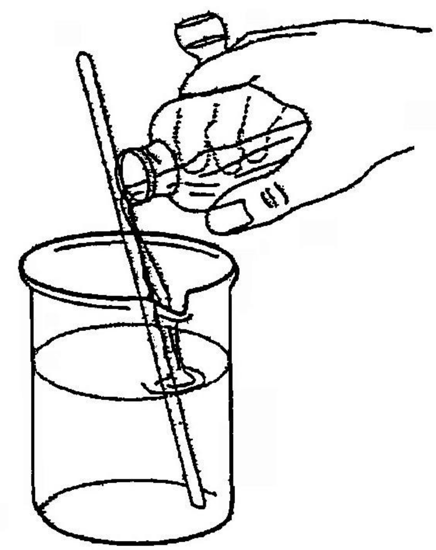


FIGURE 13. Diluting an acid

8 Inserting Glass Tubing into a Rubber Stopper

1. Begin by lubricating the tip of the glass tubing and the rubber stopper with soapy water, glycerol, or some other suitable substance.
2. Protect your hands with a cloth towel. Be sure that the ends of the tubing are directed away from the palms of your hands. Never force the tubing into the stopper. Ease it in with a gentle twisting motion. **CAUTION:** *Excessive hand pressure on the tubing will cause it to break. Sever injury can occur.*
3. The end of the glass tubing should protrude from the stopper.

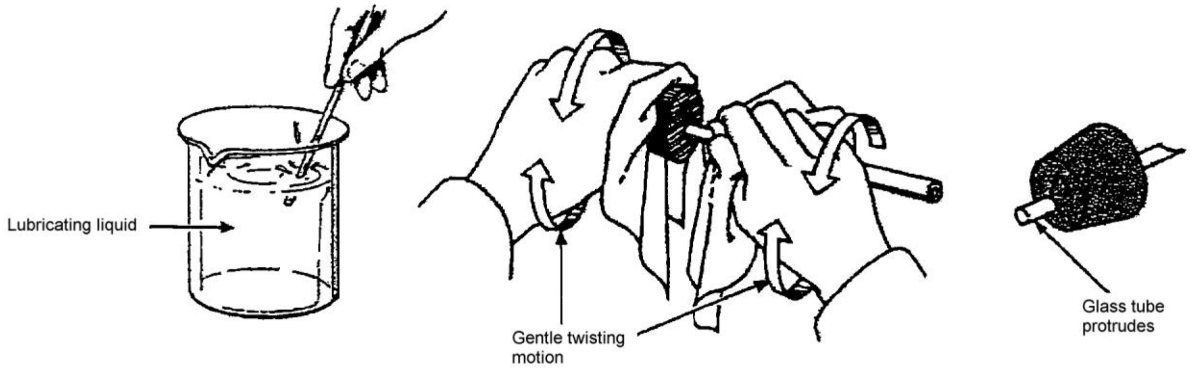


FIGURE 14. Inserting glass tubing into a rubber stopper

9 Microchemistry

Microchemistry uses smaller amounts of chemicals than do other chemistry methods. The hazards of glass have been minimized by the use of plastic lab ware and hot water provides heat rather than open flames or burners.

1. Reactions occur in a plastic tray called a microplate. The tray has shallow wells arranged in Rows (running across) and Columns (running up and down). These wells are used instead of test tubes, flasks and beakers. Some microplates have 96 wells, arranged as in Rows A-D in FIGURE 15. Other microplates have 24 larger wells, as shown in the bottom two rows of FIGURE 15.

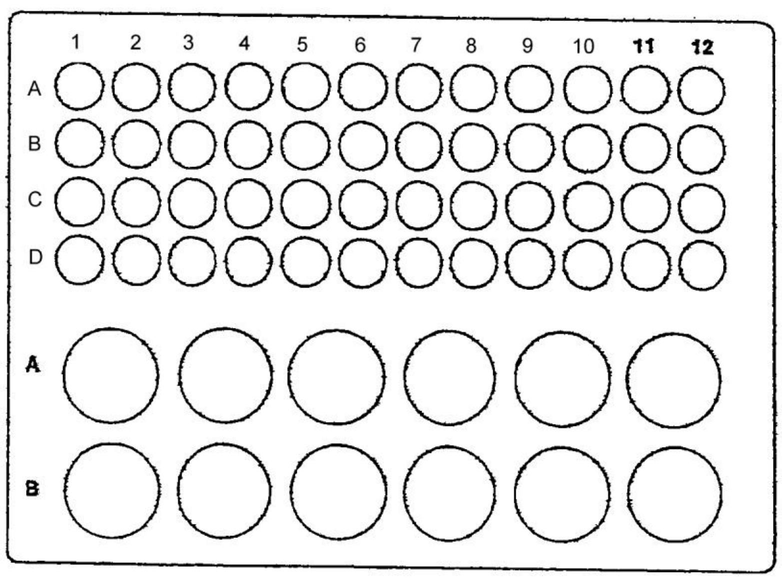


FIGURE 15. Microplate

2. Liquids are transferred in Microchemistry using a soft, very flexible plastic pipet. See FIGURE 16. The stem of the pipet can be stretched into a thin tube. If the stem is stretched and then cut with scissors (FIGURE 17), the small tip will deliver a tiny drop of chemical. You may also use a pipet called a Microtip pipet which has been pre-stretched at the factory. It is not necessary to stretch a Microtip pipet. The plastic pipet can be used over and over again simply by rinsing the stem and bulb between chemicals.


FIGURE 16. Plastic pipet


FIGURE 17. Cutting a pipet

10 Identifying Parts of a Microscope

Most microscopes have the parts shown in FIGURE 18.

a. Eyepiece
b. Body tube
c. Revolving nosepiece
d. Low-power objective lens
e. High-power objective lens
f. Stage
g. Stage clips
h. Base
i. Mirror
j. Diaphragm
k. Arm
l. Fine adjustment knob
m. Coarse adjustment knob

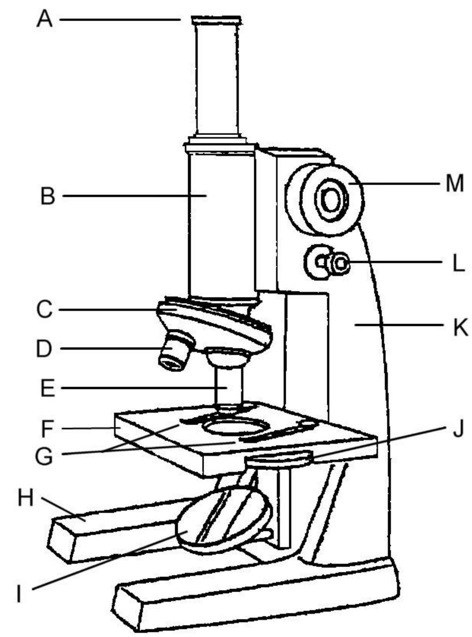


FIGURE 18. Microscope

11 Using a Microscope

Microscopes should be stored in a safe place where storage and retrieval can be supervised. If not kept in a cabinet, a microscope should be protected from dust with a cloth or plastic cover.

1. Always carry a microscope upright with two hands, one hand holding the arm and one hand supporting the base.
2. Store the microscope with the low-power objective in position.
3. Always bring a specimen into focus with the low-power objective first.
4. Never use the coarse adjustment to focus the high-power objective.
5. When using the coarse adjustment to lower the low-power objective, always look at the microscope from the side. If you look through the eyepiece, you may accidentally force the objective into the coverslip.
6. Do not allow direct sunlight to shine on the mirror and reflect up into the eye.
7. Clean lenses only with lens paper. Moisten the lens paper with a drop of water or alcohol if the lens does not wipe clean with dry lens paper.
8. Be careful when using coverslips and microscope slides because they may crack or shatter when dropped.

12 Using Preserved and Live Animals

1. Use extreme caution when dissecting preserved specimens. Dissecting tools are very sharp. Always use a dissecting pan to support your specimen to dissect it.
2. Many laboratories contain live animals. Always wear heavy gloves when handling animals. If you are bitten, report the bite at once. Do not destroy the animal that has bitten you. Instead, call the local department of health for further instructions.

13 Testing for the Hardness of a Mineral

Hardness is the resistance of a mineral to being scratched. When testing for hardness, one mineral is harder than another if the first mineral can scratch the second.

1. Test a mineral for hardness by scratching the mineral against a mineral with a known hardness. See FIGURE 19.
2. Reverse the minerals and scratch again to confirm your results. If the minerals are nearly the same hardness, a scratch may be difficult to see.
3. Use a set of Mohs' minerals to determine the hardness of unknown minerals. If Mohs' minerals are not available, you may substitute common objects. If a mineral can be scratched by a fingernail, it has a hardness of about 2; a copper penny, a hardness of 3; a nail, a hardness of 5 to 6; a knife blade, a hardness of 6; and a piece of glass, a hardness of 6 to 7.

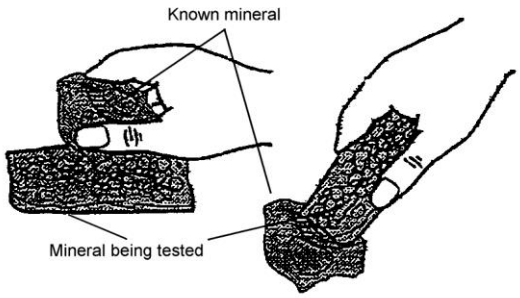


FIGURE 19. Testing for hardness

14 Testing for Streak

1. Streak is the color of the powdered mineral that is left when the mineral is drawn across a nonglazed porcelain plate called a streak plate. FIGURE 20.
2. The streak is often not the same color as the mineral sample.

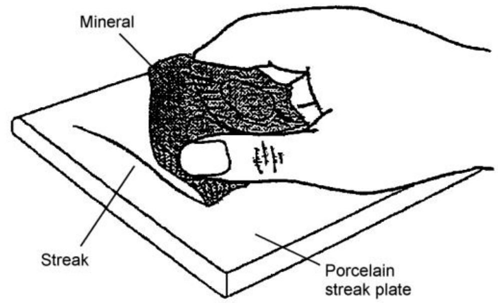


FIGURE 20. Testing for streak

15 Testing for Magnetism

Very few minerals are magnetic.

1. To test a mineral for magnetism, break it in small pieces and test the pieces with a magnet as shown in FIGURE 21.
2. Some minerals become magnetic only if they are heated. Hold a small piece of the mineral in a flame with tongs. Be sure to wear goggles and use a thermal mitt.
3. Repeat the test with the heated mineral and magnet.

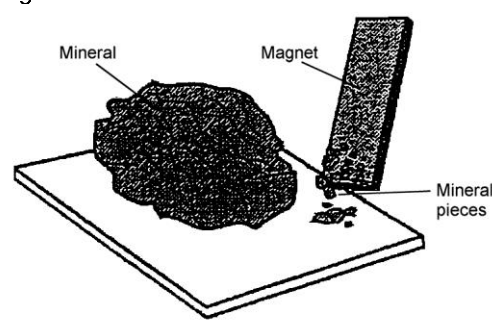


FIGURE 21. Testing for magnification

16 Testing for Cleavage and Fracture

A mineral has cleavage if it breaks under stress to form smooth, flat reflective faces. Minerals may cleave along different planes that form parallel cleavage surfaces.

1. A test for cleavage is shown in FIGURE 22.
2. If the mineral breaks or does not break parallel to the chisel, turn the mineral and repeat the process until you have checked for cleavage in all directions.
3. A mineral that does not cleave is said to fracture or break along irregular surfaces.

FIGURE 22. Testing for mineral cleavage

Scientific Methods

All scientists have special interests. Scientists are interested in the world around them. This curiosity leads them to investigate things and events. Scientists use their senses to observe as they investigate. They use many methods in seeking answers to problems. Scientists use scientific problem solving. One scientific problem-solving technique has six steps:

1. State the problem.
2. Gather information about the problem.
3. Form a hypothesis.
4. Test the hypothesis.
5. Accept or reject the hypothesis.
6. Do something with the results.

Using Scientific Methods

Scientists observed that white mice that were fed seeds appeared to grow more than mice given leafy green and yellow vegetables. The scientists hypothesized that the protein in the seed was responsible for the growth. They designed an experiment to test this hypothesis. They divided 200 mice of the same age, size, health, and sex into two groups of 100 mice each. The mice were kept under identical conditions for fourteen days. One group was given a diet low in protein. The other group was given a normal protein diet. The mass of each mouse was recorded daily for fourteen days.

1. Which group of mice served as a control? ____

2. What was the independent variable? ____

3. What effect of the protein diet was tested? (dependent variable) ____________________________

4. What other effects of a protein diet could have been tested? ______________________________

   ____

5. Why were larger numbers of mice used in this experiment? ________________________________

   ____

6. If the results of the experiment did not show a marked change between the two groups, what should the scientists do next? ____

7. What are the parts of an experiment? ____

   ____

Tables and Graphs

A. Making Tables

As you study science, you will find that often information is presented in a table. You will organize data and observations in tables. You will be asked to use information given in tables. Knowing how to make and use tables is an important skill.

Tables have a title, rows, columns, and heads. The title is found at the top of the table. The title tells you what information is contained in the table. Columns are the sections that run up and down. At the top of each column is a head that tells you what information is in the column. Rows are sections that run from one side to another on the table.

Use the information in this paragraph to complete the table below. When you complete a table, you must record the information in the proper column and row. There are 5000 species in Phylum Porifera, 11 000 species in Phylum Coelenterata, 26 000 species in the three phyla of worms, 80 000 species in Phylum Mollusca, 826 000 species in Phylum Arthropoda, 47 000 species in Phylum Chordata, and 5000 species in Phylum Echinodermata.

Number of animal species	
Phylum	**Number**

B. Making Graphs

A graph is a picture that shows data in a way that helps you understand the information. There are several different types of graphs. Line graphs show data plotted as points that are connected by a line. Line graphs often are used to show change. The graph in FIGURE 1 shows the phase changes of hydrogen peroxide as it is heated over time.

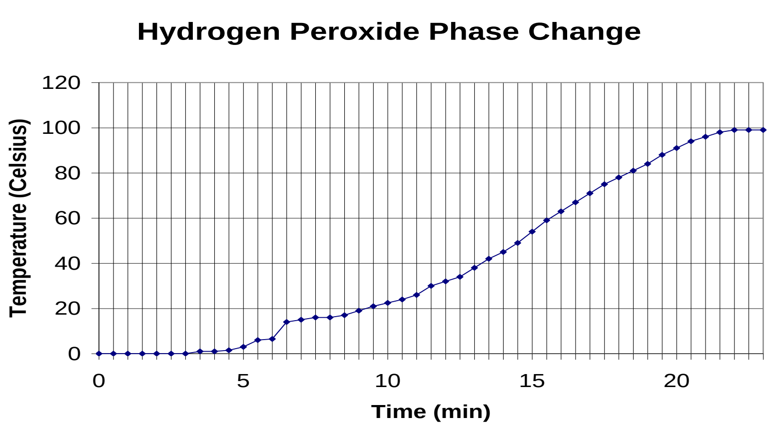
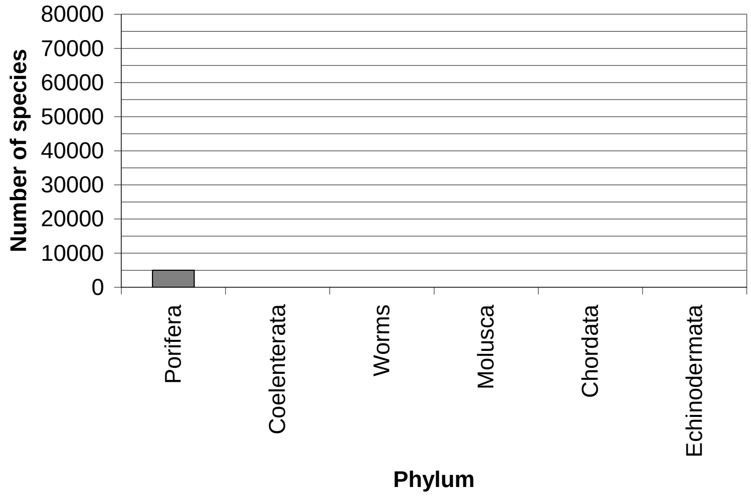


FIGURE 1

A bar graph always has two axes, a horizontal and a vertical, and these axes are labeled and divided. On the bar graph in FIGURE 2, the vertical axis is labeled and divided into ten thousands. The horizontal axis is labeled "Phylum" and divided by different animal phyla. Indicate the number of species in each phylum given by shading in bars on the graph. The column for Phylum Porifera has been done for you.



Pie graphs are circular graphs that show how each part is related to the total. Use the data from the table below to make a pie graph. Calculate the fractional amount of time for each of the sections. The total circle will represent 4.5 billion years. To find the fraction for each section, divide the time length of that section by 4 500 000 000. Then multiply the fraction by 360 degrees to determine the angle for the section. The calculation for the Cenozoic Era is given.

$$65\,000\,000 \text{ years} / 4\,500\,000\,000 \text{ years} = 0.0144 \bullet 360° = 5.18°$$

Round the final answer to the nearest whole degree. Use this procedure to complete the table. Then, use a protractor and the data from the table to construct a circular graph in FIGURE 3. Label all parts of the graph.

Era	Number of years	Number of degrees
Cenozoic	65 000 000	
Mesozoic	160 000 000	
Paleozoic	345 000 000	
Precambrian	3 930 000 000	

Use a protractor and the data to construct a circular graph in FIGURE 3. Label all parts of the graph.

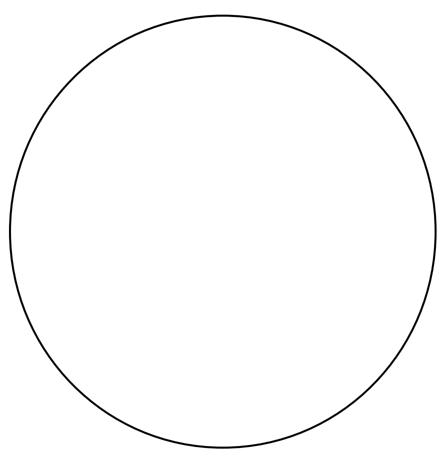


FIGURE 3

A. Developing Safety Policies

Several statements are printed in Column 1 concerning students' activities and attitudes in the laboratory. Think about each statement and formulate a safety rule or procedure related to each statement. Write one or two clear, concise sentences in Column II that can serve as safety policy for your science classroom.

Column I	Column II
1. Peter says that his teacher is solely responsible for preventing laboratory accidents.	1. ______________________
2. Alex started the lab activity before reading it through completely.	2. ______________________
3. Ricardo decided to do a lab activity that he read in a library book before the teacher came into the room.	3. ______________________
4. Stephanie says that the lab aprons are unattractive and that the safety goggles mess up her hair. She refuses to wear them.	4. ______________________

B. Using Safety Devices Correctly

Describe the location and purpose of having each of the following devices in your science laboratory. Write your answers in the spaces provided. (Locations will vary according to your laboratory design.)

CO_2 fire extinguisher ______________________

____

goggles ______________________

eyewash station and safety shower ______________________

safety hood or vent ______________________

____

LABORATORY SKILLS ASSESSMENT
Using a Microscope

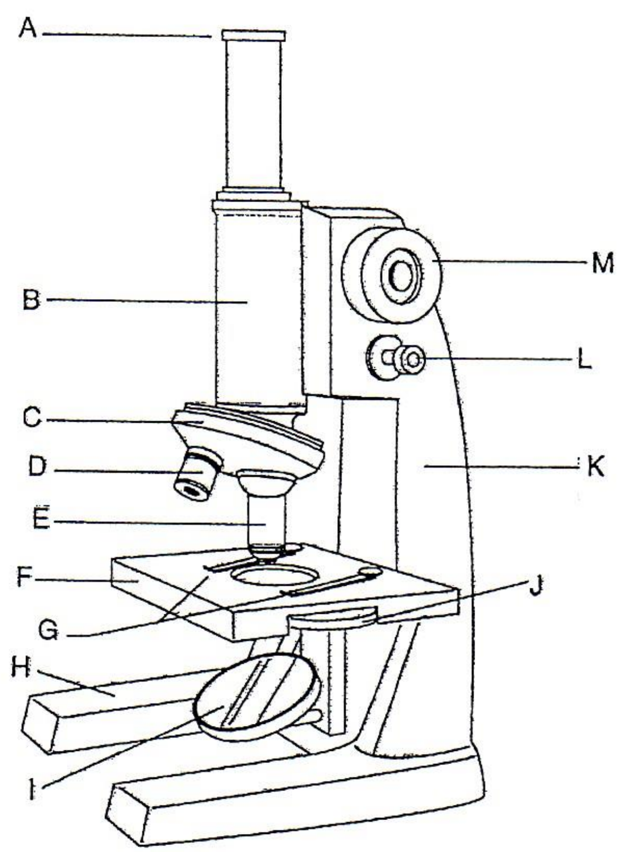
Microscopes are optical instruments, much like a pair of glasses. The purpose of the microscope is to help you see things that are very small. The microscope can introduce you to organisms that you would otherwise not see. Because it is a delicate instrument, a microscope requires careful handling.

Show that you are aware of how to handle a microscope correctly by completing the following statements.

1. Always carry a microscope with one hand on the __________________ and the other hand on the ______________.
2. A microscope should be stored with the _____________________ objective in place.
3. Always bring a specimen into focus using the ___________________ objective .
4. Never use the _________________ adjustment to focus the high-power objective.
5. Do not allow direct sunlight to fall on the __________________.
6. Use only the ___________________ adjustment when focusing with the high-power objective.
7. Lenses should be cleaned with __________________________.

Identify the parts of the microscope on the lines to the left.

A ____________________________________
B ____________________________________
C ____________________________________
D ____________________________________
E ____________________________________
F ____________________________________
G ____________________________________
H ____________________________________
I ____________________________________
J ____________________________________
K ____________________________________
L ____________________________________
M ____________________________________



Measuring with a Microscope

Scientists use microscopes to study things that are too small to be seen with the unaided eye. The size of microscopic organisms can be estimated using the method given here. The approximate size of the field of view seen under low power can be determined by actual measurement. A transparent millimeter ruler is placed across the field of view as shown in FIGURE 1.

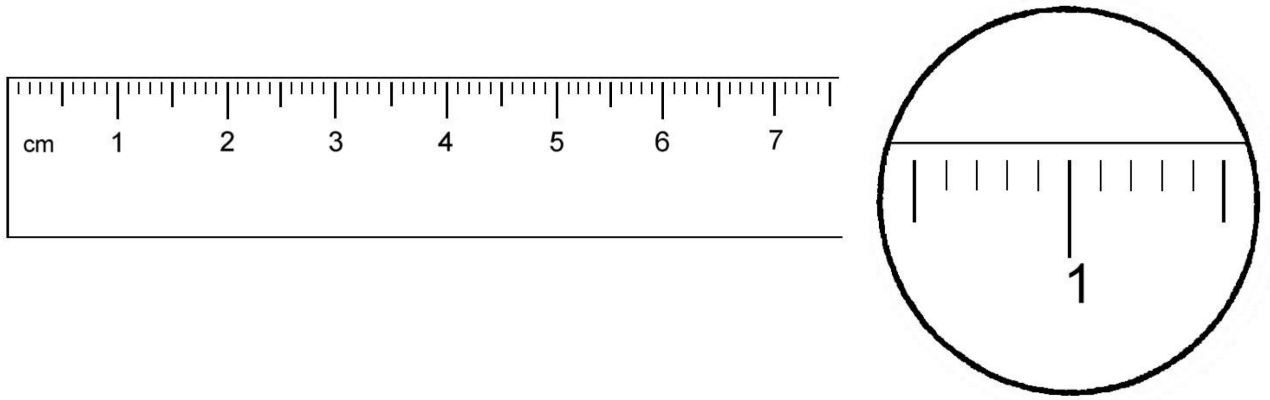


FIGURE 1

1. How many millimeters wide is the field of view shown? ____________________

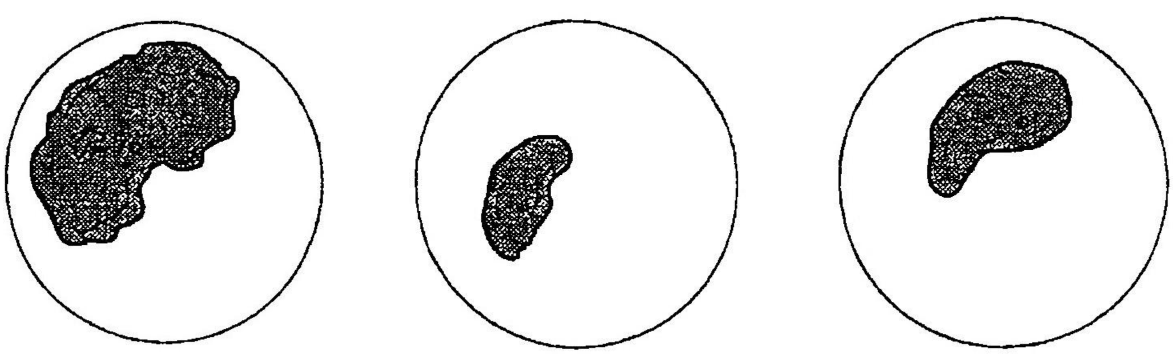
Objects examined under the microscope are quite small. Therefore, it is often convenient to use units of length smaller than the millimeter for microscopic measurement. One unit often used is the micron (μ). There are 1000 microns in one millimeter.

2. How many microns wide is the low-power field shown in FIGURE 1? ____________________

To measure the diameter of the high-power field of view, follow these steps. First divide the magnification number of the high-power objective by the magnification number of the low-power objective. Then divide the diameter of the low-power field of view by this number. For example, assume that a low-power objective is 10x, and the high-power objective is 40x. On the microscope, the diameter of the low-power field of view is 2000 microns.

3. What is the width of the high-power field of view? ____________________

4. What is the width of these organisms shown below? These organisms were viewed under high power.

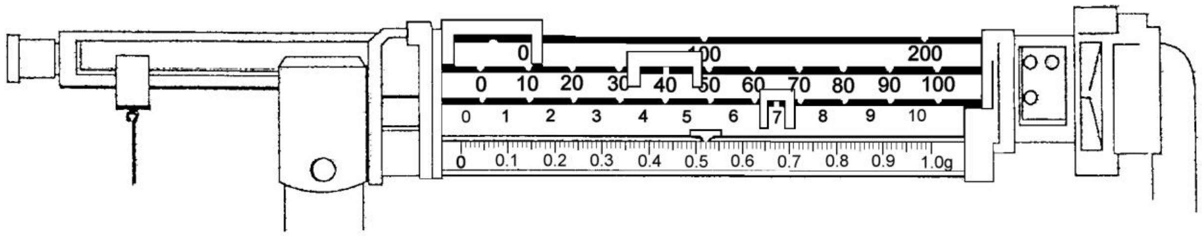


____________ ____________ ____________

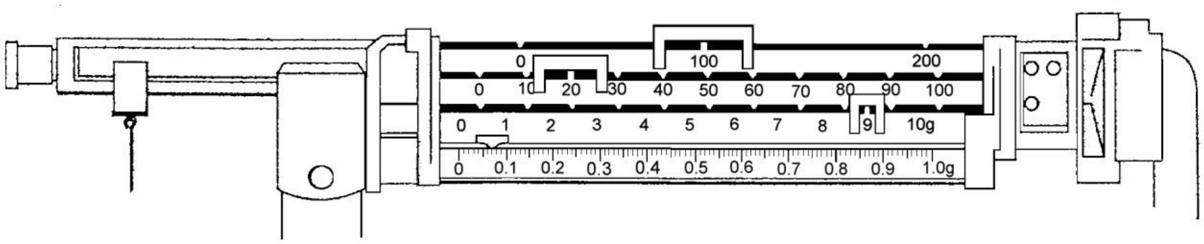
FIGURE 2

Balance: Determining Mass

1. What mass is shown on each of these balances? ***Units should be given in grams (g)***



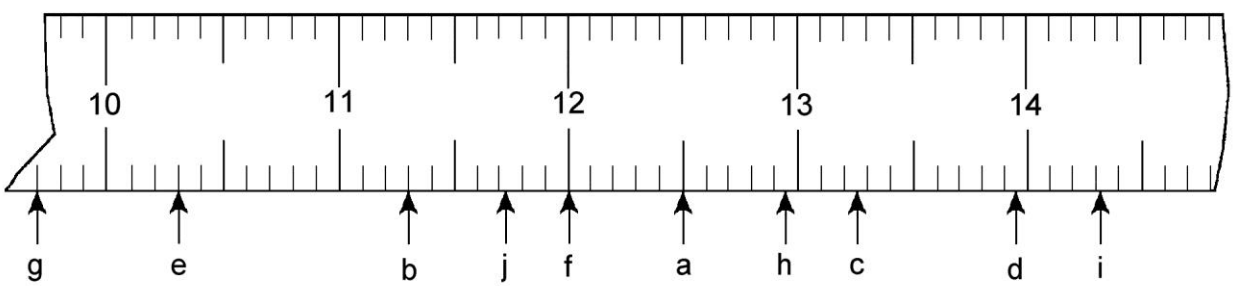
a. The mass of the object would read as ________________________.



b. The mass of the object would read as __________________________.

Metric Ruler: Determining Length

2. What lengths are indicted on this ruler? ***Units should be given in centimeters (cm)***



a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

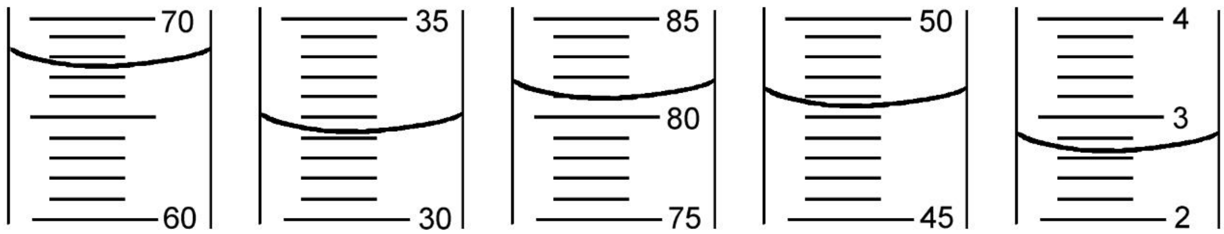
h. ______________________________

i. ______________________________

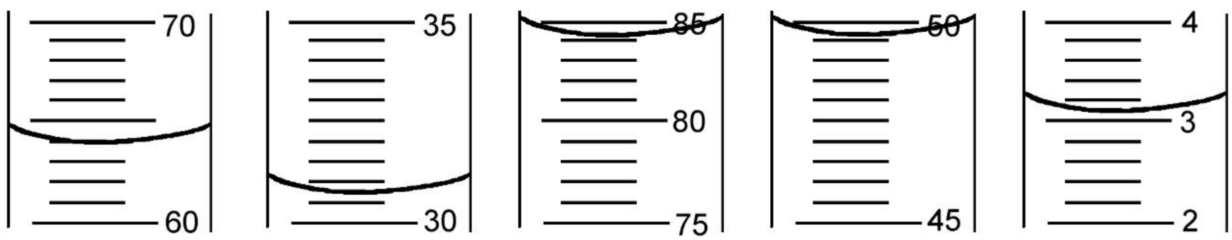
j. ______________________________

Graduated Cylinder: Measuring Liquid Volume

3. What volume is indicated on each of these graduated cylinders? ***Units should be given in millimeters (mL)***



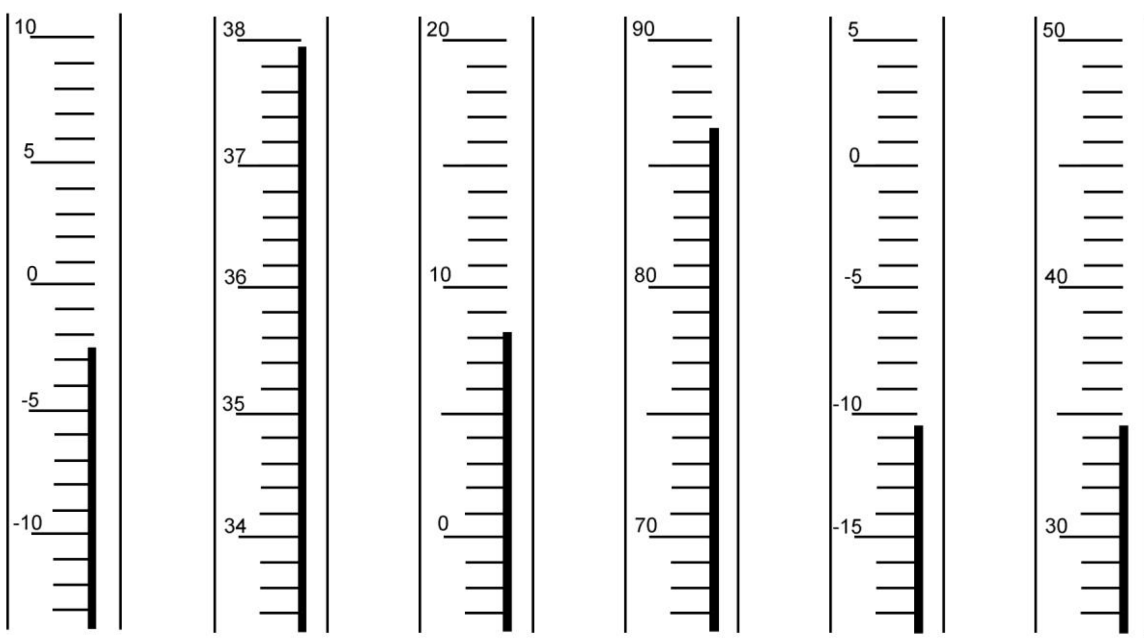
a. ___________ b. ___________ c. ___________ d. ___________ e. ___________



f. ____________ g. ____________ h. ____________ i. ____________ j. ____________

Thermometer: Measuring Temperature

4. What temperature is indicated on each of these thermometers? ***Units should be in degrees Celsius (°C)***



a. _________ b. _________ c. ________ d. _________ e. _________ f. _________