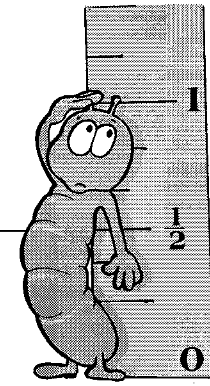
Equipment, Procedures, and Safety

Section 1.1
Length and Measurement



Pre-View 1.1

- **Ruler** or **meter stick** – equipment used in the laboratory to measure length in millimeters, centimeters, or meters
- **Meter** – metric unit for length
- **Accuracy** – the correctness of a measurement or how close the measurement is to the actual value
- **Precision** – the exactness of a measurement in terms of how many decimal places are used; determined by the smallness of the increments used in the measurement; can also be a measure of how reproducible or repeatable the data is

In general, biology is the scientific study of living things. Various types of equipment are used when studying biology, especially when conducting laboratory experiments. Biologists often use this equipment to make measurements. In your study of biology, it is important to know the names of some basic equipment and glassware and to understand when and how they are used. It is also important for you to know how to make meaningful measurements.

Measuring Length in a Laboratory

One of the most basic laboratory measurements is length. Just about everyone knows how to use a ruler to measure the length of an object, but scientists must measure length using metric units instead of feet and inches. A **ruler** or **meter stick** with metric units usually has several types of marks. The smallest marks indicate millimeters (mm). By the way, these marks are also called graduation marks or graduations. Graduation marks are found on many types of scientific equipment, so you will see this term again.

The centimeter ruler shown in figure 1-1 is drawn to scale. There are 1000 mm in one **meter**. The longer marks that are numbered show centimeters — 10 mm = 1 cm, and there are 100 cm in one meter. A man who is six feet tall is around 1.8 meters tall (or 1 meter, 80 centimeters). The ".8" means eight-tenths, and eight-tenths of a meter is 80 centimeters.

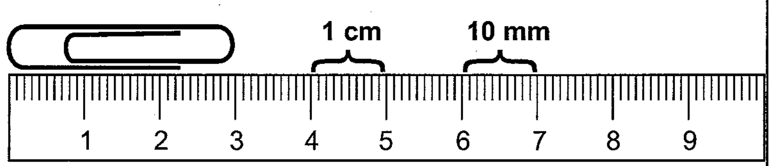


Fig. 1-1 Centimeter Ruler (To Scale)
A large paperclip is approximately 3 cm long.

Much longer lengths or distances are measured in kilometers (km), which are 1000 meters. One mile is about 1.6 kilometers.

Some scientific equipment is digital and gives a number on a readout. Other pieces of equipment, like rulers and meter sticks, require you to determine the measurement by manually reading a scale. In the real world, measurements rarely fall exactly at a graduation mark. Most of the time, the reading falls between two graduation marks. To get the reading, you simply estimate between the marks. Look at an example.

Example 1: The ruler shown in figure 1-2 is marked in centimeters and millimeters. Remember, ten millimeters are in one centimeter. What is the measurement of the object shown on this ruler?

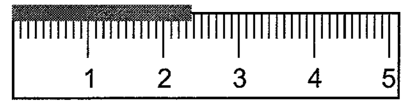


Fig. 1-2

It's easy to see that this object measures over 2 centimeters, but it falls between millimeter marks. It is somewhere between 2.3 centimeters and 2.4 centimeters (or between 23 millimeters and 24 millimeters). To record the measurement, estimate the distance between the marks. In this case, the object is a little more than half way to the next mark, so you might estimate this measurement to be approximately 2.37 centimeters (or 23.7 millimeters).

Precision and Accuracy of Measurements

When biologists make any kind of measurement, they always want it to be accurate, and they often want a precise measurement as well. ***Accuracy*** and ***precision*** are not the same thing. An accurate measurement is a correct measurement. Precision, on the other hand, is defined by how many decimal places are in a measurement. For example, a measurement of 3.2 cm is more precise than a measurement of 3 cm. The smaller the increment used to measure, the more precise the measurement can be. In other words, a ruler that is marked in millimeters will give a more precise measurement than a ruler that is marked only to the nearest centimeter. Precision can also refer to how reproducible data is, but for now, let's concentrate on the first definition.

Example 2: Look at the two rulers on the right in figure1-3. Ruler 1 is marked to the nearest half a centimeter. Ruler 2 is marked to the nearest millimeter.

The actual diameter of a nickel is 21.2 millimeters. A student measured the diameter of a nickel on each ruler. On ruler 1, the student records the diameter as 2.1 centimeters (or 21 millimeters). On ruler 2, the student records the diameter as 21.1 millimeters. Which measurement is more accurate? Which measurement is more precise?

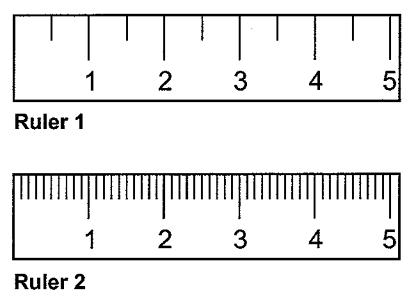


Fig. 1-3

Both measurements are very close to being completely accurate. If the actual diameter of a nickel is 21.2 millimeters, the first measurement is off by 0.2 millimeters (21.2 – 21 = 0.2), and the second measurement is off by only 0.1 millimeters (21.2 – 21.1 = 0.1). The measurement made on ruler 2 is a little more accurate because it comes closer to the actual diameter.

The measurement on ruler 2 is also more precise because the ruler is marked in smaller increments. The best measurement that can be made on ruler 1 is to the estimated closest tenth of a centimeter (or in other words, to the closest millimeter). On ruler 2, a measurement can be estimated to the closest tenth of a millimeter.

Problems Affecting Accuracy

What kinds of things would affect the accuracy of a scientific measurement? Two main problems can affect accuracy:

Problem 1, Operator Error: The first problem might be called "operator error." If you don't use the equipment correctly or if you don't carefully determine an instrument's reading, your measurement will be less accurate. For example, if the student measuring the nickel in Example 2 hadn't aligned the nickel to the end of the ruler, the measurement would be inaccurate.

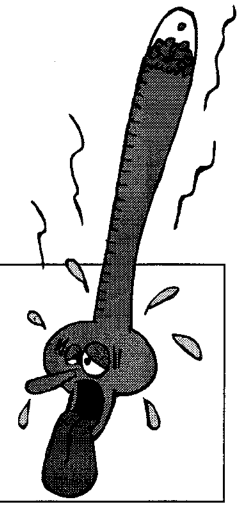
Problem 2, Equipment Error: The second problem can occur with the equipment itself. What would happen to the accuracy of a measurement if someone sands or cuts off the end of a ruler so that the first increment is short? The measurement is going to be less accurate. Although there aren't too many things that can go wrong with a ruler, other types of equipment can have problems that affect the accuracy. We'll look at those later.

Problems Affecting Precision

What affects the precision of a scientific measurement? Precision, in this case, is determined by the instrument itself. A ruler marked in centimeters can be used to measure to the nearest estimated millimeter. To get a more precise measurement, a ruler marked in smaller increments would have to be used. For example, a ruler marked in millimeters is precise to the nearest estimated tenth of a millimeter.

Equipment, Procedures, and Safety

Section 1.2
Temperature



Pre-View 1.2

- **Thermometer** – equipment commonly used in the laboratory to find temperature
- **Celsius** – the temperature scale that is based on zero degrees being the freezing point of water and 100 degrees as being the boiling point of water

Determining Temperature

Temperature measures how hot or cold an object is, and temperature is determined by how fast or slow the molecules of the object are moving. The faster the molecules are moving, the higher the temperature. In this way, temperature can be defined as the average kinetic energy of molecules in an object. (Kinetic energy is energy of motion.) Laboratory **thermometers** measure temperature in **degrees Celsius (°C)**. Celsius is much easier to use than Fahrenheit. On the Celsius scale, the boiling point of water is 100°C, and the freezing point of water is 0°C; on the Fahrenheit scale, the freezing point is 32°, and the boiling point is 212°.

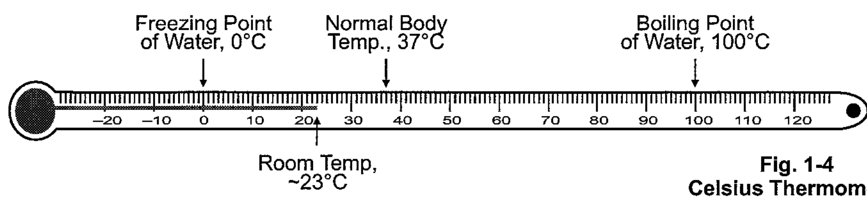


Fig. 1-4
Celsius Thermometer

Accuracy in Temperature Readings

Accuracy can be affected by "operator error" and by equipment (or calibration) error. Keep the following in mind to ensure accurate temperature readings using a thermometer.

- Read the thermometer at <u>eye level</u>. Otherwise the temperature will appear higher or lower than it actually is.
- Thermometer <u>placement</u> is important. For example, in liquids, the thermometer bulb should be completely submerged so that it isn't too close to the surface of the liquid. Also keep the thermometer away from the sides of the container.
- Give the thermometer enough <u>time to adjust</u> to the surrounding temperature. Thermometers rarely give instantaneous readings, so be sure the temperature reading is stable before recording it.
- The <u>calibration</u> of thermometers must be checked periodically. A Celsius thermometer in an ice bath should read 0° and in boiling water should read 100°. If it does not, it is not calibrated correctly, and all readings will be inaccurate.

Precision in Temperature Readings

A thermometer marked in degrees will give a more precise temperature measurement than a thermometer marked every two degrees or every five degrees. Remember, the smaller the increment marked on the equipment, the greater the precision.

Also remember that precision can refer to how reproducible data is. Let's say three different students measure the temperature of the same solution and record temperatures of 32.2°C, 32.7°C, and 33.4°C. Another three students take the same measurements and record 33.2°C, 33.1°C, and 33.3°C. Which three students had the more precise measurements? The second group's measurements are more precise because their numbers were closer together than the first group's.

Equipment, Procedures, and Safety

Section 1.3
Liquid Measurement and Handling

Pre-View 1.3

- **Graduated cylinder** – glassware used to *accurately* measure liquid volume in milliliters
- **Meniscus** – the curve at the surface of a liquid
- **Pipette, burette,** and **syringe** – pieces of glassware used to dispense measured amounts of liquids
- **Dropper**– piece of equipment used to dispense small amounts of liquids (in drops at a time)
- **Test tube** – glassware used for holding, mixing, and storing small amounts of liquids
- **Beaker** and **Erlenmeyer flask** – glassware used for holding and storing larger amounts of liquids; used only for *approximate* (not exact) measurements
- **Petri dish** – glassware commonly used to grow and observe bacteria cultures

Glassware for Measuring and Dispensing Liquids

Various kinds of glassware are used for storing and handling of liquids, but only a few are used for measuring.

A **graduated cylinder** (figure 1-5) is used to accurately measure the volume of liquids. The most common measurement for volume in a laboratory is milliliters. A milliliter is a thousandth of a liter and is abbreviated mL. To get the most precise and accurate measurement, you would use a graduated cylinder with the smallest marks, or graduations. Usually a smaller graduated cylinder is more precise than a larger one. Look at the following example.

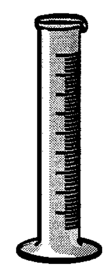
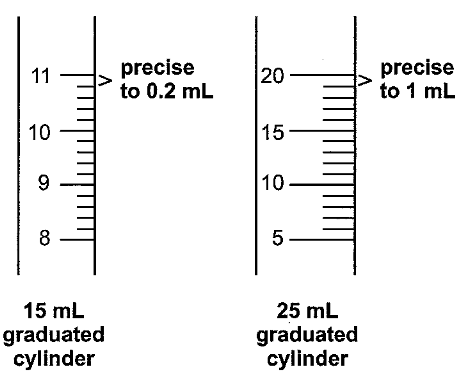


Fig. 1-5

Example: You are given two graduated cylinders. The first graduated cylinder holds 15 mL. Between each long mL mark are 4 shorter marks representing 0.2 mL each. The second graduated cylinder holds 25 mL. Each large mark represents 5 mL, and each smaller mark represents 1 mL. Which could be used to accurately measure 10 mL of liquid? Which graduated cylinder is more precise?

Either one could be used to accurately measure 10 mL of liquid, but the 15 mL graduated cylinder is more precise. It is marked in smaller increments of 0.2 mL instead of the 1 mL marks on the 25 mL graduated cylinder.



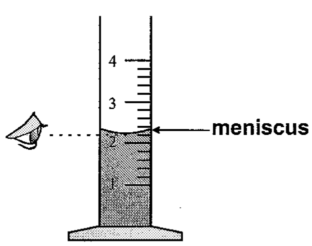


Fig. 1-6

When liquid is put into a glass container, the surface of the liquid will curve. This curve in the liquid is called the **meniscus**, and for most liquids, the meniscus curves downward. Mercury is one of the few exceptions because its meniscus curves up. To get an accurate measurement, read the meniscus at eye level and read the liquid level at the bottom of the meniscus curve (assuming the meniscus is curving downward). Figure 1-6 shows the correct way to read a graduated cylinder.

Section 1.3, continued

Liquid Measurement and Handling

Graduated cylinders are not the only pieces of glassware used for measurements. For very small liquid measurements, scientists may use a **pipette** (figure 1-7), a **burette** (figure 1-8), or a **syringe** (figure 1-9). These pieces of equipment are also used for dispensing liquids in measured amounts.

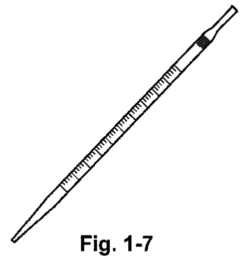


Fig. 1-7

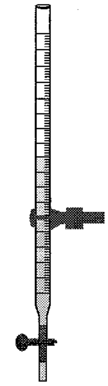


Fig. 1-8

Fig. 1-9

Making Accurate Liquid Measurements

- Use a graduated cylinder, pipette, burette, or syringe designed for accurate liquid measurement.
- Read the *bottom* of the meniscus at *eye level.*
- Be sure the graduated cylinder or other measuring container is clean, dry, and free of any debris. Debris particles or liquid will displace the measured liquid volume and cause the reading to be inaccurate.

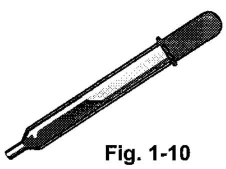


Fig. 1-10

Droppers similar to the one in figure 1-10 are sometimes used for dispensing and measuring small amounts of liquids. Droppers must be used carefully to make sure that the drops are the same size. As a general rule of thumb, 20 drops equal 1 mL. A dropper would not be used to measure or dispense a precise amount of liquid.

Glassware for Storage, Handling, and Observations

Not all glassware is used for measuring and dispensing liquids. Some types are used for holding, mixing, or storing liquid.

For small amounts of liquids, **test tubes** (figure 1-11) can be used for mixing and handling. Some test tubes have caps that allow them to be used for storage as well.

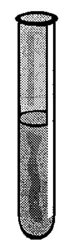


Fig. 1-11

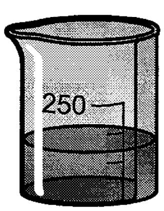


Fig. 1-12

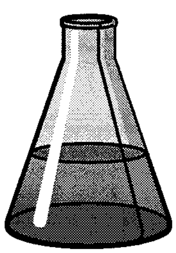


Fig. 1-13

Beakers (figure 1-12) and **Erlenmeyer flasks** (figure 1-13) are commonly used for storing and mixing liquids. Some have measurement markings, but these containers ***do not*** give accurate measurements. A 250 mL beaker or Erlenmeyer flask will hold 250 milliliters of liquid, but you wouldn't use the beaker or the flask to accurately measure 250 mL.

A **petri dish** (figure 1-14) has several uses. It is commonly filled with an agar and nutrient solution and then used to grow and observe bacteria cultures. A petri dish can also be used by itself to observe seed germination or small animal behaviors.

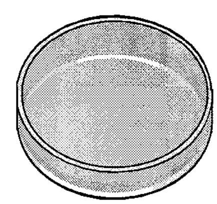
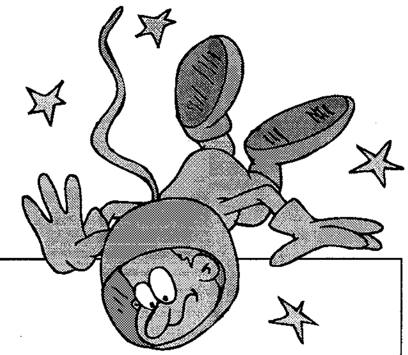


Fig. 1-14

Equipment, Procedures, and Safety

Section 1.4
Mass and Weight Measurements



Pre-View 1.4

- **Mass** – the measure of how much matter is in an object
- **Gram** – the metric unit for mass
- **Triple beam balance** – a type of balance scale commonly used in high school laboratories
- **Weight** – the measurement of *force* exerted by gravity on an object
- **Newton** – the metric unit for force (and weight)
- **Spring scale** – equipment used to find force or weight

Many times the terms ***mass*** and ***weight*** are used interchangeably, but they are not the same. Mass is the measurement of how much matter is in an object, and it is measured in grams using a balance scale, such as a **triple beam balance**. Weight is a measurement of the force of gravity on an object, and it is measured in Newtons using a **spring scale.** If you went to the moon, your mass would not change since your body would contain the same amount of matter, but your weight would be less on the moon than on earth because the force of gravity on the moon is only about 20% of that on earth.

Measuring Mass

To find the mass of an object, a scale balance is used. The most common types of scale balances are the **triple beam balance** (figure 1-15) and the electronic balance (figure 1-16). Both types of balances measure mass in grams. The triple beam balance is commonly found in high school laboratories, but you may also have an electronic balance. Getting a measurement on an electronic balance is fairly easy. Getting a measurement on a triple beam balance takes a little work, so review the following steps.

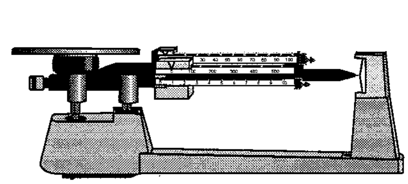


Fig. 1-15 Triple Beam Balance

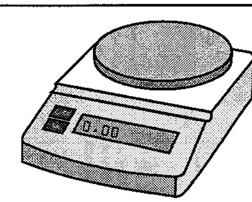


Fig. 1-16 Electronic Balance

Using a Triple Beam Balance

Remember, a triple beam balance is used to find mass, not weight. It measures mass in grams.

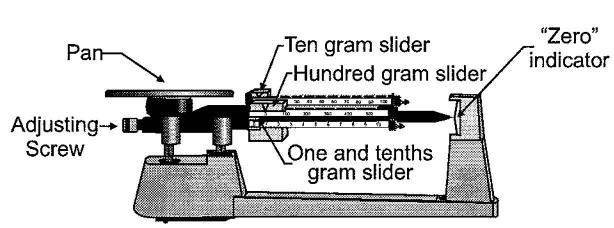


Fig. 1-17 Triple Beam Balance

Step 1

To use a triple beam balance like the one in figure 1-17, you must first be sure that it is on a level surface. Before you put anything on the pan, move the three sliders as far left as they will go. The indicator on the right should be in line with the zero mark. If not, calibrate the balance by turning the screw under the pan until it is in line.

Step 2

Place the object you are measuring on the pan and move the 100 gram slider on the beam until the indicator drops below the mark. Be sure it "clicks" into place. The number *to the left* of this point will show the number of hundreds of grams in the object. Move the slider back one notch to the left so that the indicator is once again above or equal to the zero mark. The slider should now point to the number of hundreds of grams in the object.

Step 3

Next, move the 10 gram slider along its beam until the indicator drops below zero. Be sure the slider clicks into place. Once again the number to the left of this point will tell you how many tens of grams are in the object. Move the slider back one notch to the left so that the indicator is above or equal to the zero mark. This slider will now point to the number of tens of grams in the object.

Step 4

The one gram slider is not notched, so you can move it anywhere on the beam. The numbers marked on this beam are grams, and the marks between are tenths of a gram. Move this last slider until the indicator exactly lines up with the zero mark. The object's mass now "balances" the mass on the beams. By adding the numbers together, you can find the mass of the object. Notice that the mass shown in figure 1-18 is 278.4 grams.

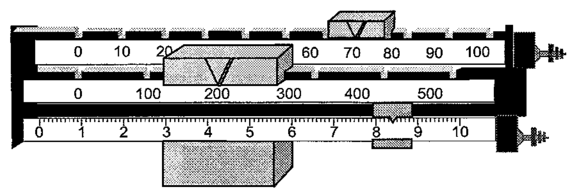


Fig. 1-18
278.4 grams

Accuracy in Mass Measurements

To get an accurate mass using a triple beam balance, be sure the balance is calibrated correctly. As a quick check, the mass should be exactly zero when there is nothing in the pan. Use the adjusting screw as shown in figure 1-17 to calibrate the balance to zero.

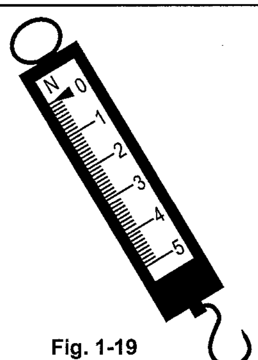


Fig. 1-19
Spring Scale

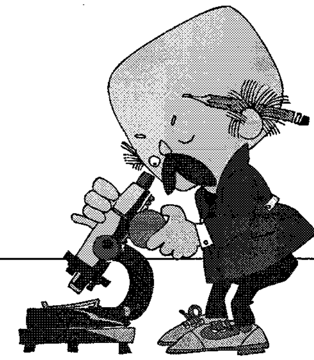
Measuring Weight

A spring scale measures weight. Weight is a force measured in Newtons. Remember, weight depends on gravity.

Your bathroom scale is a spring scale although it does not look like the one in Figure 1-19. Some scales have a dial readout, and others have a linear scale as shown in figure 1-19. To find the weight of an object using this spring scale, you would hold the scale up and attach the object to be weighed to the hook at the bottom. The spring will stretch, and the pointer will move along the scale and point to the number that shows the object's weight.

Equipment, Procedures, and Safety

Section 1.5
Microscopes



Pre-View 1.5

- **Light microscope** – a common type of microscope that focuses light rays through a specimen
- **Electron microscope** – a type of microscope that focuses beams of electrons instead of light rays
- **Resolution** – the ability of a microscope to see detail
- **Wet mount slide** – a temporary type of microscope slide created by using a drop of water

Types of Microscopes

Most people can't see details clearly on anything much smaller than 0.1 mm, so biologists may use a microscope to study smaller objects. The units of length usually used for microscopic measurements are the **micrometer, µm**, which is only one-thousandth (1/1,000) of a millimeter and the **nanometer, nm**, which is one-millionth (1/1,000,000) of a millimeter.

There are several types of microscopes, and two of the most common types are the light microscope and the electron microscope. Both produce magnified images, but they work in different ways. A **light microscope**, the most common type, focuses light rays that pass through the specimen to produce a magnified image. A light microscope can be used to view cells and some cell organelles. **Electron microscopes** focus beams of electrons instead of light rays. Electron microscopes have much better **resolution** — that is, they magnify objects more and get clearer details at higher magnification than light microscopes. They can be used to view objects as small as a strand of DNA, which cannot be viewed by a light microscope. Electron microscopes can't be used to view living objects though, so both types are important to biologists.

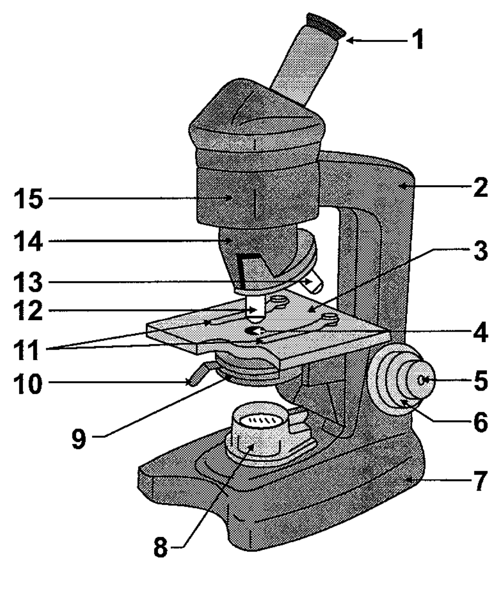
Light Microscope Versus Electron Microscope

Light Microscope	Electron Microscope
• can be used to view living objects	• objects cannot be alive
• natural color and movement can be observed	• black and white images with no movement
• poor resolution — 200 nm	• excellent resolution — 0.2 nm
• easy to use	• viewer must be highly trained
• fairly inexpensive	• very expensive

Parts of The Microscope

In order to use a light microscope, you need to study the diagram below so that you know what each part is and what each part of the microscope does.

1. **ocular or eyepiece** – contains a lens that magnifies
2. **arm** – provides support for the body tube
3. **stage** – the platform where a slide is placed to be viewed
4. **stage opening** – allows light to pass through the slide
5. **fine adjustment knob** – used to bring the specimen into sharp focus
6. **coarse adjustment knob** – used to focus the microscope
7. **base** – supports the entire microscope
8. **light or mirror** – produces or reflects light up through the specimen on the slide to the eye
9. **diaphragm** – regulates the amount of light
10. **diaphragm lever** – opens or closes diaphragm
11. **stage clips** – holds slide in place
12. **high-power objective** – provides the smallest field of view and the highest magnification
13. **low-power objective** – provides the largest field of view and the lowest magnification
14. **nosepiece** – holds the objectives and rotates to change magnification
15. **body tube** – allows light to pass up to the eye and provides the proper distance between the eyepiece lens and the objective lens.



Light Microscope Diagram

Magnification

A light microscope has several lenses that magnify what you are viewing, which is why it is sometimes called a ***compound microscope***. To find out how much magnification is being used, you first look at the eyepiece (ocular). It should be marked with a number such as 10×. This number means that the lens in the eyepiece magnifies 10 times. Now look at the low-power objective. It is also marked with a number that tells its magnification. To find the total magnification being used, you multiply the two numbers.

Note: ***The higher the magnification, the smaller the field of view.***

Example: The eyepiece of a light microscope is marked 10×, and the low-power objective is marked 4×. What is the total magnification?

$$10 \times 4 = 40$$

Multiply the ocular magnification by the objective magnification. For this example, the total magnification is 40 times.

Steps to Using A Light Microscope

To use the microscope you should follow these steps:

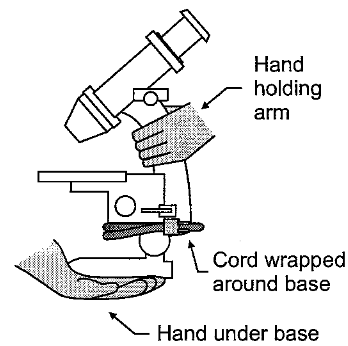


Fig. 1-19
Holding a Light Microscope

1. Figure 1-19 shows the correct way to carry a microscope. Carry the microscope with one hand under the **base** and your other hand holding the **arm.** If the microscope has a cord, make sure the cord is wrapped securely around the base and is not dangling. Place the microscope on the table with the arm towards you and the back of the base about an inch from the table's edge.

2. Wipe the **eyepiece lens (ocular)** and the lens of each **objective** with a piece of lens paper. Turn the low-power objective in line with the **body tube**. It should click into position. If the microscope is electric, plug the power cord into an electrical outlet.

3. Turn on the **light** or adjust the **mirror**, and turn the **diaphragm** so that the greatest amount of light is admitted. Place your eye to the eyepiece. You should see a uniform circle of light called the ***field of view***.

4. Place a prepared slide on the **stage** of the microscope and clip it into place. Adjust the slide with your fingers until the object is in the center of the stage opening and hold it in place with the **stage clips.**

5. While watching from the side of the microscope, turn the low power objective down as far as it will go. Do not touch the slide with the objective lens or force it when it reaches the automatic stop.

6. Place your eye to the eyepiece and, as you watch the field, turn the **coarse adjustment knob** slowly toward you. Watch for the material on the slide to appear in the field. Always use the coarse adjustment to bring the slide into focus.

7. Bring the specimen into sharp focus with the **fine adjustment knob**. As you look through the eyepiece, turn the fine adjustment knob slowly back and forth. Different fine adjustments will shift the focus to bring out details at different levels of an object.

8. Make sure that the specimen is in the exact center of the field, check for sharp focus, and turn the high-power objective into position.

9. ***Correct the high-power focus by using the fine adjustment only.*** You will notice that you can see more of the slide using the low-power objective but you don't see as much detail. When using the high-power objective, you see more detail, but the field of view is smaller.

10. After you have observed your specimen, remove the slide and turn the low-power objective back into place. Clean the lenses and stage with lens paper. Don't forget to turn off the light and unplug the microscope if needed.

11. The microscope should be covered to protect it from dust and then stored in an upright position according to your teacher's instructions.

Preparing Slides

After you know how to set up and focus a microscope using a prepared slide, you will want to make your own slides to view. A common method of making a temporary slide is called a *wet mount slide.* To make a wet mount slide, follow the steps below:

1. Get a slide and coverslip; make sure that they are clean.
2. Place your specimen in the center of the slide. Remember that it should be thin enough to allow light to pass through it.
3. Place a drop of water on the specimen.
4. Hold the coverslip at a 45° angle to the slide as shown in figure 1-20. Carefully lower the edge of the coverslip until it touches the drop of water. Then, slowly lower the coverslip so that the water drop spreads out evenly.
5. Using the method in step 4 should minimize air bubbles trapped under the coverslip. If an air bubble does get trapped, gently tap the coverslip with a pencil eraser to remove the bubble.
6. If your drop of water was large and there is excess water under the coverslip, you can remove the extra water by holding a paper towel to the edge of the coverslip. The coverslip will hold the specimen in place. Your specimen is now ready to view!

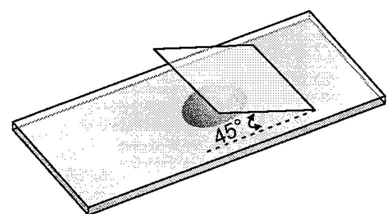
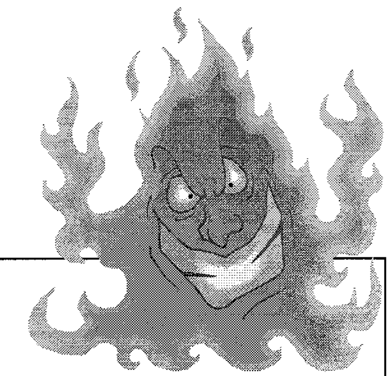


Fig. 1-20
Preparing a Wet Mount Slide

Equipment, Procedures, and Safety



Section 1.6
Equipment Used for Heating

Pre-View 1.6

- **Bunsen burner** – equipment that uses a gas flame to heat
- **Test tube clamp** – equipment specifically designed to hold test tubes, especially when hot
- **Hot plate** – equipment that uses electricity to heat
- **Tongs** – equipment used to move hot glassware like beakers and flasks
- **Heat resistant gloves** – gloves usually made of asbestos and used to handle hot labware

Many biology experiments use a heat source as part of the lab equipment. While the heat source may be as simple as a light bulb, it is more often a hot plate burner or a Bunsen burner.

Bunsen Burner

A **Bunsen burner** uses gas to produce a flame. To use a Bunsen burner, follow these steps:

1. Make sure that the gas outlet handle is fully closed — at a 90° angle to the outlet.
2. Connect the hose leading from the burner to the gas outlet.
3. Turn the handle on the gas outlet to open — the handle will be parallel to the outlet.
4. Turn the gas adjustment knob at the base of the burner to allow good gas flow through the burner.
5. Hold a lighted match a little to the side of the gas flow so that the gas flow doesn't blow out the flame.
6. Turn the air control vent to get a blue flame. The hottest part of the flame will be at the top of the bright blue inner flame.

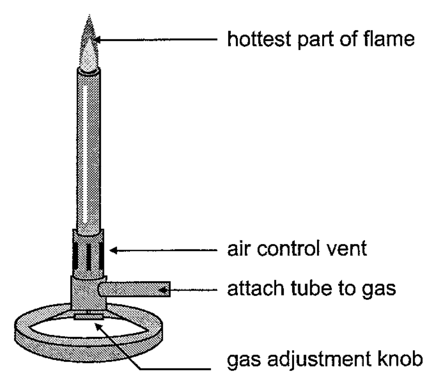


Fig. 1-21 Bunsen Burner

The flame of a Bunsen burner can reach temperatures up to 1500°C. That's hot! Bunsen burners are commonly used to heat liquids in test tubes or to heat solid objects that can be held by tongs.

Heating a Test Tube Over a Bunsen Burner Flame

When you heat materials in a test tube, you should remember these special rules:

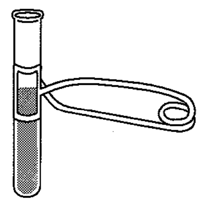


Fig. 1-22 Test Tube and Holder

1. Always use a test tube clamp to hold the test tube by the body, not the rim. Tongs and holders not designed to hold test tubes can easily break the glass, so use only test tube clamps specifically made to hold test tubes.
2. Do not cap or plug the tube while you are heating it.
3. The open end of the test tube should always be pointed away from yourself and others.
4. Don't fill the test tube all the way to the top.
5. Don't put the test tube in the hottest part of the flame. Keep the test tube moving in and out of the flame so one part doesn't overheat.

Hot Plates

Hot plates may be used for some experiments. Even though they do not produce an open flame, they must be used with caution. They should never be left unattended. Hot plates are commonly used to heat liquids in beakers and flasks, especially when the liquid needs to be stirred. (Many hot plates have built-in stirrers that will spin magnetic stir bars when these bars are placed in the liquid on top of the hot plate.)

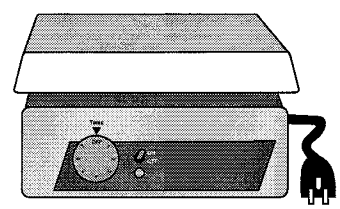
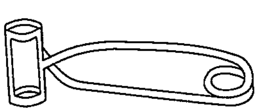


Fig. 1-23 Hot Plate

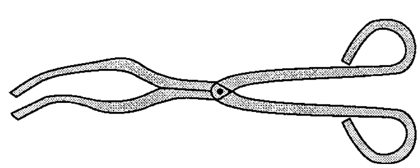
Heat Safety

- Open flames and hot plates should never be left unattended.
- Keep all flammable and combustible materials away from open flames.
- Long hair should always be tied back when working with an open flame. Hair is flammable!
- Use appropriate equipment to handle hot glassware. Use test tube holders for test tubes; use tongs for beakers, flasks, or crucibles; or use heat-resistant gloves (often made of asbestos) when handling hot glassware.
- *Hot glassware looks the same as cold glassware!* You cannot tell if glassware is hot or not by looking at it. If in doubt, handle the glassware as if it is too hot to touch by using the appropriate clamps, tongs, or gloves.

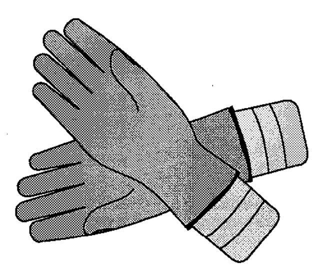
Equipment for Handling Hot Glassware



Test Tube Clamp



Crucible/Beaker Tongs



Asbestos/Heat Resistant Gloves

Equipment, Procedures, and Safety

Section 1.7
Laboratory Safety and Protective Equipment

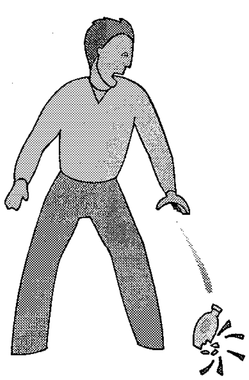
Pre-View 1.7

- **Eyewash station** – used to rinse the eyes when they have contacted a chemical
- **Safety shower** – used to rinse the skin or clothing of a hazardous chemical
- **Biohazards container** – container used to collect biohazards such as blood, cell cultures, or living tissues
- **Broken glass container** – container used to collect broken glass
- **Fire extinguisher** – used to put out a fire
- **Safety glasses** or **safety goggles** – personal safety equipment used to protect the eyes whenever glassware, chemicals, or biohazards are used in a laboratory experiment
- **Lab apron** – personal safety equipment used to protect clothing from chemicals or biohazards
- **Gloves** – personal safety equipment used to protect the hands; latex or nitrile material is used to protect against chemicals and biohazards; asbestos material is often used to protect against heat
- **Biohazard** – anything that can transport a disease or illness; examples: blood, cell cultures, animal tissue
- **Volatile liquid** – a liquid that evaporates (vaporizes) quickly and easily; often creates flammable gases

Laboratory Safety Equipment

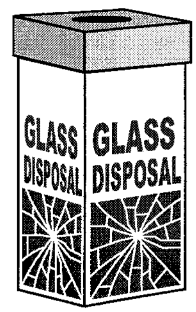
Before you start your first lab activity, you should know the location of the safety equipment in the room and when and how to use it. Most laboratories include the following safety equipment:

- An **emergency eyewash station** should be used only when needed to rinse away chemicals that have gotten into your eyes. Instructions for use will be written on the eyewash station. They will include holding your eyes open in the stream of water for 5 to 15 minutes.
- A **safety shower** is used only when necessary to rinse off chemicals that are splashed or spilled onto your skin or clothing.
- Absorbent material is used to contain small spills.
- A **biohazards container** is used for disposal of living tissues, cells, or any other biohazard.



- A **broken glass container** should be used instead of a trash can to dispose of broken glassware.
- A **fire extinguisher** is used to put out small fires. You should read the directions before an emergency occurs. Most fire extinguishers work by using "PASS" —

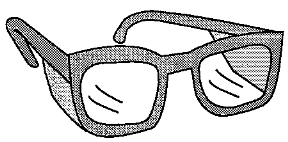
  P – pull the pin
  A – aim the nozzle
  S – squeeze the handle to release the foam/chemical
  S – sweep the nozzle from side to side, always pointing at the base of the flames

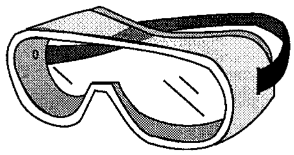


Personal Safety Equipment

Personal safety equipment is used in a lab for your protection.

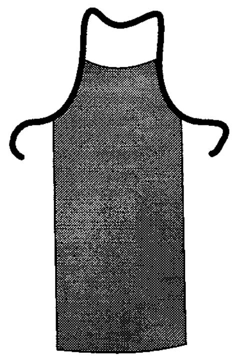
Safety Glasses/ Safety Goggles





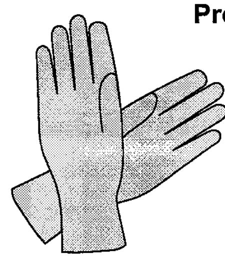
Safety glasses or **goggles** must be worn if any chemicals, biohazards, or glassware is used.

Lab Apron



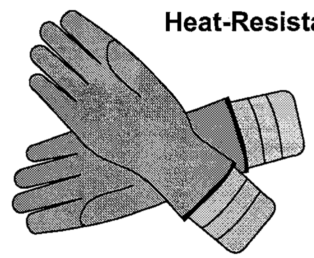
Lab aprons help protect your skin and clothing from chemicals or biohazards.

Protective Gloves



Latex or **nitrile gloves** may be needed to protect your hands against biohazards or chemicals.

Heat-Resistant Gloves



Heat-resistant gloves, often made of asbestos, may be needed to protect your hands from heat.

General Laboratory Procedures and Safety Rules

Your teacher may provide you with a specific list of safety rules. Here are some safety rules that everyone should know:

- Do not attempt any unauthorized experiments. Do only what your teacher has approved and told you to do.
- Read all directions before you begin every lab activity and follow the instructions carefully.
- If you are not sure what you should do during the activity, stop and get help from the teacher.
- If you get confused during an activity and are not sure of what you have done, dispose of the materials you were using and start over.
- Your teacher will tell you how to dispose of chemicals correctly. Do not pour them down the drain unless told to do so. NEVER put any unused chemical back into the original container.
- In case of a spill or broken glass, follow your teacher's instructions. Broken glass is usually put into a broken glass container and NOT in the trash can.
- Tell your teacher about any accidents — even little ones that you think don't matter.
- Clean up your area after finishing the activity. Clean the laboratory table and equipment thoroughly.
- Return all materials to their proper places.
- Wash your hands before you leave the classroom.
- ALWAYS remember — SAFETY FIRST!

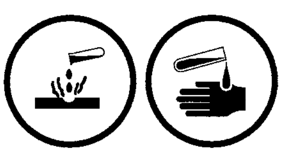
Common Safety Symbols

Safety is the first priority in any laboratory. Most biology textbooks have an appendix at the back of the book that gives detailed science safety rules and safety symbols.

The safety symbols alert you to possible hazards and remind you that special precautions and protective equipment may be needed for a certain activity. The following is a list of common symbols and their meanings.

Biohazard

This symbol means that biohazardous materials are present. **Biohazards** are materials that can transport disease or illness. Examples of biohazards are human and animal blood, animal tissues, viruses, bacteria, fungi, and cultured cells. Wear gloves to prevent touching the materials and dispose of them properly. These materials are usually disposed into a biohazards container. Wash your hands after completing the activity.



Corrosive

These symbols indicate that corrosive chemicals, such as acids, are used. Do not inhale the fumes or get the chemical on your skin or clothing. Make sure you wear safety glasses and an apron.

Flammable/Combustible
(Keep away from flames)

These symbols indicate that a chemical or material is flammable or combustible. These types of materials should be kept away from sparks or open flames. The vapors formed from volatile liquids are often flammable. (A **volatile liquid** is one that evaporates, or vaporizes, quickly and easily.)

No Food or Drink

No food or drinks allowed in the lab.

Poisonous/
Toxic

This symbol indicates that poisonous or toxic materials are used. Avoid contact with your skin and wear gloves and safety glasses. Keep noxious (dangerous) chemicals under a fume hood. Make sure that you dispose of these materials properly and wash your hands after handling these materials.

Radiation

The radiation symbol indicates that radioactive energy is emitted from a piece of equipment. For example, x-rays are a form of radiation. Exposure to radiation should be minimized and monitored.

Additional Chemical and Biohazard Safety

- As already mentioned, never bring food or drinks into the laboratory when performing an experiment. One of the main reasons for this rule is the presence of dangerous chemicals and biohazards often used during an experiment.
- Always wear safety goggles or glasses to protect the eyes and a laboratory apron to protect skin and clothing when working with chemicals or biohazards.
- Never inhale fumes from chemicals unless directed to do so. If an experiment calls for a chemical to be smelled, it should be wafted to the nose by holding the chemical away from the nose and gently moving the fumes towards the nose with the hand. See figure 1-24.
- Do not allow chemicals to come into contact with skin or clothing. In case of skin or eye contact, rinse with water immediately. In some cases, immediate medical attention may also be needed.

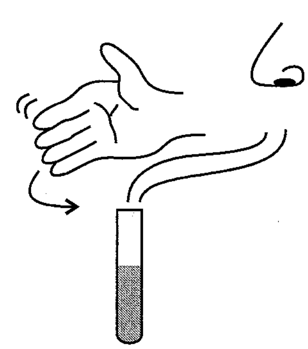


Fig. 1-24 Wafting a Chemical