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## LearnSmart Labs: Lab Safety

### General Lab Outline

**Total Time: 1 hr., 5 min.**

- 1. Core Concepts: Lab Safety (10 min.)**
- 2. Hand Washing Procedure (15 min.)**
- 3. Personal Safety (15 min.)**
- 4. Proper Disposal of Materials (15 min.)**
- 5. Final Summary Questions (10 min.)**

### Assessed Learning Outcomes

#### **1. Core Concepts: Lab Safety**

- Explain why laboratory safety is important.
- List common laboratory hazards that must be considered when developing lab safety practices.
- Summarize the standard rules and practices for the scientific lab setting.
- Recognize safety equipment that is usually available in the lab.
- Explain the correct handling of laboratory emergencies.

#### **2. Hand Washing**

- Preparation for the hand washing simulator.
  - Understand the important role of hand washing in relation to lab work.
  - Recall the correct sequence of steps during hand washing.
- Execution of hand washing.
  - Remove watch before applying soap.
  - Wet hands with water before applying soap.
  - Apply soap.
  - Clean under your nails with brush.
  - Rub and scrub wet soapy hands at least 20 seconds.
  - Rinse hands.
  - Dry hands with clean towel.
  - Turn off the water faucet with a towel.
  - Discard towels correctly.
  - Successfully clean hands.
  - Help question: Watch
  - Help question: Soap
  - Help question: Scrub hands
  - Help question: Clean nails
  - Help question: Towel

#### **3. Personal Protective Equipment Exercise**

- Preparation for the personal protective equipment exercise.
  - Recognize that it is prohibited to bring food or beverages into the lab.
  - Recognize that lab coat should always be worn in the lab.
  - Recall when laboratory gloves should be used in the lab.
  - Recall when long hair should be tied back during laboratory work.
  - Recall when eyewear should be worn during laboratory work.
  - Recognize that shoes worn during laboratory work should always cover the toes.
- Mastery of the utilization of personal protective equipment.
  - Recognize that you should never have food or beverages in the lab.

## LearnSmart Labs: Lab Safety

- Recognize that you should always wear a lab coat in the lab.
- Recognize that gloves should be worn when working with dangerous chemicals.
- Recognize that long hair should be tied up when working with open flames.
- Recognize that eyewear should be worn when working with corrosive, irritating, or infectious materials.
- Recognize that closed toed shoes should always be worn in the lab.
- Identify possible risks from experimental setup.
- Help question: Food and beverages
- Help question: Lab coat
- Help question: Gloves
- Help question: Hair
- Help question: Glasses
- Help question: Shoes
- Identify possible risks in dissection setup.
- Identify possible risks in pH setup.
- Identify possible risks in staining setup.

### 4. Disposal of Materials in the Laboratory

- Preparation for the disposal of materials exercise.
  - Recall the items that should be placed into a sharps container.
  - Recall the items that should be placed into a biohazard container.
  - Recall the items that can be placed into the regular waste bin.
  - Recall the items that should be autoclaved after use.
  - Recall the items that should be washed in the sink after use.
  - Recall that unknown chemicals should not be disposed of without consulting the instructor or an MSDS sheet.
- Mastery of disposal of materials.
  - Recognize that sharp objects should be placed in the sharps container.
  - Recognize that biological substances should be discarded in the biohazard container.
  - Recognize that some objects need to be washed at the end of a lab exercise.
  - Recognize that uncontaminated waste can be discarded in the regular waste bin.
  - Recognize that reusable objects requiring sterilization should be placed in the autoclave basket.
  - Help question: Sharp objects
  - Help question: Biohazardous materials
  - Help question: Objects that need cleaning
  - Help question: Materials that need to go into the normal trash
  - Help question: Objects that should be autoclaved

### 5. Final Summary Questions

- Recognize correct and unsafe laboratory safety practices in still image.
- Recognize correct and unsafe laboratory safety practices in video.
- Identify incorrect use of lab coats in case study.

## Student Instructions for Lab Experiments

### Core Concepts: Lab Safety

It is critical that you understand how to work safely in the lab. Following the appropriate lab etiquette and regulations are important to maintain your own safety and the safety of others around you.

## LearnSmart Labs: Lab Safety

This set of simulators will help you learn how to work safely in the lab. Before you use the simulators, explore some foundational ideas about lab safety by clicking on the yellow Core Concepts bar.

While some laboratory safety practices are consistent in any lab environment, there are others that depend on the specific lab setting, the lab instructor, or the exact exercise that is currently being conducted.

The goal in this module is to introduce you to the major safety practices utilized in most lab settings. During all lab exercises, you will constantly be in an environment where lab safety is critical. It's important that you remain vigilant and check with your instructor if you are ever unsure about something.

To start this module, we are going to explore some core concepts of lab safety. I am going to start by asking you some questions.

Don't worry if you do not know the answers at first. Based on your answers, I will be guiding you through a specialized learning session that includes resources to help you learn these important concepts.

After you view these short learning resources, it is important that you click on one of the "get it" or "don't get it" arrows at the bottom of that resource screen to indicate if it has helped you understand the concept.

### General Lab Safety Practices

- Always ask your instructor if you have any questions about safety.

### Hand Washing Procedure

Hand washing is one of the most important safety practices in the laboratory. You should always wash your hands thoroughly before you start and after you have finished in the lab. Click on Hand Washing Procedure to get started with this exercise.

Before you practice your hand washing technique, I would like you to explore some basic information. First, you should understand why hand washing is an important practice. Secondly, you should know the steps of correct hand washing technique.

Let's visit these concepts now.

### Important to Know About Hand Washing

- Why hand washing is important.
- The steps of correct hand washing.

Complete this exercise by demonstrating the correct method for washing your hands.

Remember, the order and timing of the steps are important for good hand washing practices.

### Simulation:

Use your cursor and click on the items you want to interact with. Click on the watch to remove it or one of the faucets to turn on the water. The hand-washing procedure can be found in the instructions.

### Instructions

1. Your task is to correctly wash your hands according to the sequence you just learned.
2. To proceed, click on what you need for the next step. Start by turning on the water.
3. Press "Continue" when you are done.

## LearnSmart Labs: Lab Safety

### Personal Safety

It's important to know the appropriate attire for working in the lab. To learn about the appropriate protective clothing click on Personal Safety.

Before we move to the exercise, I would like to make sure that you have the necessary knowledge of personal protective equipment that should be used in the laboratory.

It is important that you understand how each personal protective practice addresses specific hazards in the laboratory.

#### Important to Know About Personal Safety

- The different types of personal protective equipment commonly used in a laboratory.
- How each personal protective practice addresses specific laboratory hazards.

In the following simulation, this student is entering the laboratory. On the lab bench, you will see the materials for a lab exercise in either: mouse dissection, cell staining or pH measurements.

You will be able to zoom in on the lab bench to see the materials more closely and assess the potential hazards in this lab scenario.

#### Simulation:

Your task is to determine which precautions the student should take to protect herself. While some practices are usually used in the lab regardless of the exercise, this activity is designed to assess if you can recognize the actual hazards involved in a particular activity.

Therefore, for this exercise, choose only the personal protective equipment that is applicable to the actual hazards in this specific lab exercise. To add or remove items from the student, click directly on the item you wish to change (see arrows). Press "Continue" to get started with the exercise.



Please look at the setup in order to identify potential dangers. Thereafter, wear the minimal set of safety equipment and perform actions that are necessary for working with those items.

#### Instructions

Your task in this exercise is to address the potential danger and dress accordingly. Follow the steps below:

1. Zoom in on the experimental setup on the lab bench and identify potential dangers.
2. Wear the safety equipment that is required. You should only take precautions that are necessary.
3. Press "Continue" to proceed.

## LearnSmart Labs: Lab Safety

### Proper Disposal of Materials

Before you move on to the disposal exercise, let's look at the correct practices for the disposal of lab materials.

You should be able to clean up your lab materials in a way that ensures your safety and the safety of others that use the lab space.

Let's review this information now.

#### Important to Know About Disposal Practices

- How to dispose of lab materials properly into the correct receptacle.

#### Simulation:

This morning, you came into the lab eager to work on culturing E. coli for some lab experiments. However, as soon as you enter the lab, you see that another student has not cleaned the bench after they finished working.

Before you begin your work for the day, you will need to clean their mess up.

On the next screen, clean up the lab area by dragging and dropping the used items into the correct place of disposal.

#### Cleaning Up the Lab Bench



Please dispose of all of the items on the lab bench in the right containers.

#### Instructions

Your task is to clear the table so that you can start your work.

Put each of the items in the correct containers and press "Continue."

### Final Summary Questions

In the next section, you will be viewing a video and an image of a student in the lab. You will be looking for correct and incorrect lab safety practices.

Also, you will apply what you know about personal protection to a true case story.

Let's see what you have learned.

#### Final Summary Questions

- Identify correct and incorrect lab safety practices.
- Apply your knowledge about personal protection to a true case story.

Looking at this picture, you will see some incorrect and correct safety practices.

## LearnSmart Labs: Lab Safety

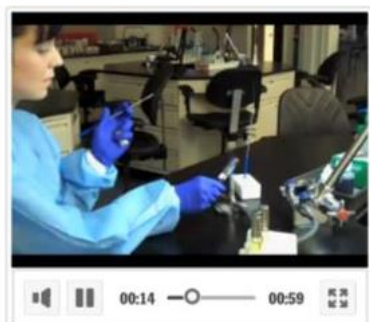
Click "Continue" when you have finished carefully observing this image. You will then be asked questions about the unsafe practices depicted in this picture.

**What is wrong in this picture?**



Watch this short video of a student conducting a lab exercise. Pay close attention to her safety practices as you watch.

After you finish viewing the video, you will be asked to identify areas of correct and incorrect safety practices.



### **Case Study: Fatal Accident at an Undergraduate Laboratory**

Just after Christmas in 2008, a young laboratory assistant was transferring a chemical compound in a plastic syringe.

The chemical, t-butyl lithium, ignites instantly when exposed to air, and unfortunately, the syringe accidentally came apart during the transfer.

The sweater made of synthetic material worn by the lab student caught fire, and she suffered second- and third-degree burns on nearly half of her body.

Sadly, she died eighteen days later.

## LearnSmart Labs: Lab Safety

### Case Study: Fatal Accident at an Undergraduate Laboratory



Answer these questions to show your understanding of relevant hazards and lab safety consideration in this case study.

#### Finishing the Case

When working with dangerous chemicals, it is always important to follow your institution's chemical hygiene plan and refer to the Material Safety and Data Sheets.

Correct personal protective equipment is also imperative. In this case, the lab assistant's uncovered sweater may have been a critical safety hazard.

A flame-resistant lab coat may have lessened the severity of her burns and may have even saved her life.

Remember, many lab safety protocols have been designed to protect you from injury.

Make sure you follow them carefully.

#### Type of Student Report

Students are provided the following types of reports at the conclusion of these lab experiments.

- **Hand Washing** – *Debriefing*
- **Personal Safety** – *Debriefing*
- **Proper Disposal of Materials** – *Debriefing*



## LearnSmart Labs: Scientific Method

### General Lab Outline

**Total Time: 1 hr., 10 min.**

- 1. Core Concepts: Scientific Method (10 min.)**
- 2. Science in Theory: LearnSmart Labs 4 Phases (30 min.)**

*Four Phases*

*Hypothesis Phase*

*Experiment Phase*

*Analysis Phase*

*Report Phase*

*Final Summary Questions*

- 3. Science in Action: Pillbugs (30 min.)**

*Pillbug's External Anatomy*

*Pillbug's Motion*

*Core Concepts: Pillbug's Preferences*

### Assessed Learning Outcomes

#### 1. Scientific Method

- Recall what distinguishes scientific results from other claims.
- Recall that scientific tests are systematic and reproducible.

#### 2. LearnSmart Labs 4 Phases

- The Basics of the 4 Phases
  - 4 phases basic.
  - Learn the 4 phases.
- The Hypothesis Phase
  - Describe the hypothesis phase.
  - Identify components of the hypothesis phase in an example.
  - Explain why the testing strategy is more important than the true hypothesis.
  - Distinguish between dependent and independent variables.
- The Experiment Phase
  - Describe the experiment phase.
  - Identify different parts of the experiment phase in an example.
- The Analysis Phase
  - Describe the analysis phase.
  - Graphing in an example.
  - Evaluating the hypothesis in an example.
- Report Phase
  - Scientific paper.

#### 3. Pillbug Experiment

- Describe the Pillbug's External Anatomy
  - Count the number of legs of the pillbug.
  - Recall how the pillbug respires.
  - Recall the pillbug's diet.
- Describe the Pillbug's Motion
  - Describe the way the pillbug moves.

## LearnSmart Labs: Scientific Method

- Identify behaviors that protect the pillbug from predators.
- Identify behaviors that help the pillbug acquire food.
- Experiment: Explore the Pillbug's Preferences
  - Core pre-lab concepts.
    - Explain how to use choice chambers to explore animal behavior.
    - Choose what to have as test and control substances.
    - Explain the purpose of a controlled experiment.
  - In-lab learning objectives.
    - Hypothesis.
    - Strategy.
    - Carry out experiment.
      - Use appropriate control substance.
      - Use appropriate test substance.
      - Use appropriate number of pillbugs.
      - Wait long enough for trends to show.
      - Make a sufficient number of measurements.
      - Use both chambers for experiment.
      - Make correct measurements.
  - Analyze data.
    - Calculate averages correctly.
    - Graph the data in a way that allows you to evaluate your hypothesis.
  - Post-lab learning objectives.
    - Recall why it is important to have a control substance.
    - Recall why it's important to perform a controlled experiment.
    - Use a controlled experiment to evaluate a test.
    - Evaluate the degree of support for a hypothesis given data.

### Student Instructions for Lab Experiments

#### Core Concepts: Scientific Method

The body of scientific information we have today is the result of many experiments using the scientific method.

The scientific method is behind the tremendous advances we've made in understanding the world we live in. Let's look at what's special about the scientific approach.

Important to Know about the Scientific Method

- Differences between scientific method and other claims.
- Scientific tests are systematic and reproducible.

#### Science in Theory: LearnSmart Labs 4 Phases

This shows the overview of the various phases of a lab that follows the process of science.

#### Four Phases

In LearnSmart Labs, we mean it when we say that you're the scientist. You will go through the full circle of scientific work.

Your current phase always shows in the bar at the top of the screen.

## LearnSmart Labs: Scientific Method

In real life, it is very common to start the process by making informal observations of the phenomenon before formulating the hypothesis.

The Four Phases When You're the Scientist

- Hypothesis phase
- Experiment phase
- Analysis phase
- Report phase

### **Final Summary Questions**

Next, you will see an overview of your performance in the section you just finished. Click "Retry" to go back and redo any parts you did not finish in the first try.

Next, you will see an overview of your performance.

- See how you performed on the section you just finished.
- Use the opportunity to go back and redo any parts you are not satisfied with.

### **Science in Action: Pillbugs**

We will start by using the scientific method in practice. Go directly to the experiment or learn more about the pillbugs first.

#### **Pillbug External Anatomy**

Scientific experiments are based on previous observations. Before we take the pillbugs into the lab, we will take a closer look at their anatomy and motion.

Important to Know About Pillbug's Anatomy and Motion

- Legs
- Respiration
- Diet
- How pillbugs move

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.



#### **Pillbug's Motion**

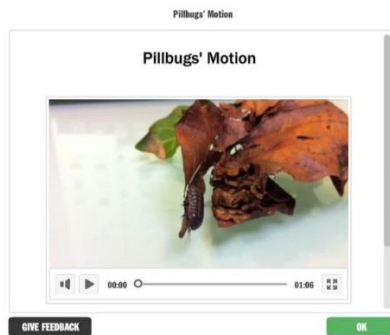
Observe the pillbug's motion carefully. After the video we will discuss how the pillbug moves and how it reacts to stimuli.

## LearnSmart Labs: Scientific Method

Start the video by clicking on the play button in the lower left corner of the video.

Pillbugs prefer moist, dark environments and spend most of the daylight hours under some sort of shelter such as rocks, mulch, and leaf litter. They will avoid dry, hot places, and direct sunlight. At night, pillbugs move out into their environment to feed on decaying organic matter and also on plant foliage.

When a pillbug is attracted to a substance, it will move toward it. This is considered a positive response. When repelled, a pillbug will move away. This is recorded as a negative response. When agitated or frightened, pillbugs will exhibit a characteristic response in which they roll up into a tight ball.



### **Core concepts: Pillbug's Preferences**

Before we move on to the lab, I want to make sure that you have the necessary knowledge to plan and execute the experiments.

A choice chamber allows a pillbug to choose between two different environments or stimuli. The pillbugs are placed in the center, and different substances are placed in the side chambers.

When a pillbug moves toward a substance in one of the side chambers, this is recorded as a positive response. Movement away is a negative response.

In a controlled experiment, all variables are held constant except the one being tested. This allows scientists to examine and learn the effects of one variable without bias or interaction from others.

Important to Know About Pillbug's Preferences

- How to use choice chambers to explore animal behavior.
- The purpose of a controlled experiment.

### **Pillbug's Preferences**

Now you are going to make a hypothesis about what environment the pillbug prefers and test it in the lab.

There are two containers of solid materials. One contains cornstarch and the other contains sand. Cornstarch is derived from corn and contains organic nutrients. The sand is cleaned, and therefore lacks any contaminants.

Both cornstarch and sand have a similar texture and dry "feel." Once you have formulated your hypothesis, design a controlled experiment that will test your idea.

# LearnSmart Labs: Scientific Method

## Instructional Video

View before starting the experiment.



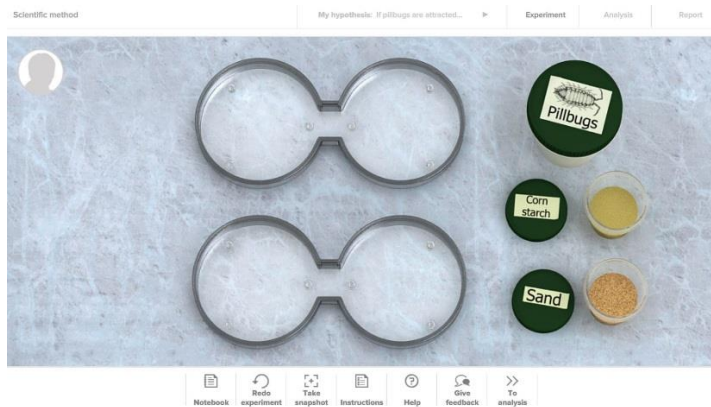
## Simulator

Now it is time to test your hypothesis. Have a number of pillbugs choose between a test substance and control substance. You can write your measurements in the notebook.

## Instructions

1. In each plate of the 2 chambers you can put 1 spoon of cornstarch, 1 spoon of sand or you can leave the plate empty. Remember that one chamber should be used as a control group.
2. Place 10 pillbugs in both the upper and lower chambers.
3. Monitor the location of the pillbugs and record results in your notebook at regular intervals.

Tip: You can take snapshots at set intervals to make it easier to record your data in the notebook at a later time.



## Analyze Your Data

Now calculate the average number of pillbugs over time for each dish and fill in the last row of the table.

## Instructions

1. Calculate the average number of pillbugs for each dish and record it in the table.
2. Create a graph to test your hypothesis.
3. Remember to save the graph to make it show in your final lab report.

## LearnSmart Labs: Scientific Method

ANALYZE YOUR DATA

Time (min)	Empty Upper Left	Empty Upper Right	Empty Lower Left	Empty Lower Right
min				
min				
min				
min				
min				
min				
Average				

Create Graph

### Lab Report

#### 1. Hypothesis

*You should complete the following.*

- Hypothesis
- Strategy.

#### 2. Introduction

*You should complete the following.*

- Explain how to use choice chambers to explore animal behavior.
- Choose what to have as test and control substances.
- Explain the purpose of a controlled experiment.

#### 3. Materials

*You should complete the following.*

- Use appropriate test substance.
- Use appropriate control substance.
- Use appropriate number of pillbugs.
- Explain how to use choice chambers to explore animal behavior.

#### 4. Methods

*You should complete the following.*

- Use appropriate control substance.
- Wait long enough for trends to show.
- Choose what to have as test and control substances.
- Use both chambers for experiment.

#### 5. Results

*You should complete the following.*

- Make a sufficient number of measurements.
- Make correct measurements.
- Calculate averages correctly.
- Graph the data in a way that allows you to evaluate your hypothesis.
- Use a control experiment to evaluate a test.

#### 6. Discussion

*You should complete the following.*

- Evaluate the degree of support for a hypothesis given data.
- Use a control experiment to evaluate a test.
- Recall why it's important to make a control experiment.
- Recall why it is important to have a control substance.

#### 7. Conclusion

*You should complete the following.*

## LearnSmart Labs: Scientific Method

- Use a control experiment to evaluate a test.

### Type of Student Report

Students are provided the following types of reports at the conclusion of these lab experiments.

- **LearnSmart Labs 4 Phases** – *Debriefing*
- **Experiment: Explore the Pillbug's Preferences** – *Lab Report*

# LearnSmart Labs: Metric Measurements

## General Lab Outline

Total Time: 1 hr, 40 min.

1. Core Concepts: Metric Measurements (10 min.)
2. Length (20 min.)
3. Weight (15 min.)
4. Volume (25 min.)
5. Temperature (20 min.)

## Assessed Learning Outcomes

### 1. Core Concepts

- Understand the international system of units.
- Know the base unit of SI for length.
- Know the base unit of SI for weight.
- Know the base unit of SI for volume.
- Understand prefixes of SI.
- Conversion of derived units.

### 2. Length

- **Core concepts: Length**
- Know the base unit of metric measurement for length.
- Know the meaning of the prefix centi-.
- Know the meaning of the prefix milli-.
- Be able to interconvert meters and centimeters.
- Be able to interconvert centimeters and millimeters.
- Be able to interconvert meters and millimeters.
- Diameter of Circles
  - Experimental Learning Objectives
    - Measure the diameters of circles in centimeters.
- Length of humerus bone.
  - Experimental Learning Objectives
    - Perform correct measurement of humerus bone.
  - Post-Lab Review
    - Recall the best practice for measuring the length of irregular objects.
- Further perspectives.
  - Recall the relative distances of kilometers and miles.
  - Recall the average height of a person.
  - Recall differences between the metric system and the standard system.
  - Recall that 1 meter is roughly equivalent to 3 feet.
  - Recall that 1 meter is roughly equivalent to 1 yard.

### 3. Weight

- Core concepts: weight.
  - Know the base unit of metric measurement of weight.
  - Know the most commonly used prefixes with the base unit of weight.
  - Convert between grams and milligrams.
- Using a scale.
  - Experimental learning objectives.



## LearnSmart Labs: Metric Measurements

- Measure the weight of an object.
- Measure the weight of salt in a beaker.
- Correct use of the TARE button.
- Further perspectives.
  - Recall that 1 g = 0.0022 lbs.
  - Critical thinking about weight.

### 4. Volume

- Core concepts: Volume
  - Know the base unit of metric measurement of volume.
  - Know the most common prefixes used with the base unit for volume.
  - Interconvert between liters and milliliters.
  - Recall that 1 milliliter (ml) corresponds to 1 cubic centimeter (cm<sup>3</sup>).
  - Recall that 1 liter (L) corresponds to 1000 cubic centimeters (cm<sup>3</sup>).
  - Calculate the volume of a block in cubic centimeters (cm<sup>3</sup>).
- Measure the liquid level.
  - Experimental Learning Objectives
    - Perform correct measurement of the volume of water in a graduated cylinder.
  - Post-Lab Review
    - Recall how to perform measurements in a graduated cylinder.
- Measure the volume of a drop.
  - Experimental Learning Objectives
    - Estimate the volume of water drops from a dropper pipette.
  - Post-Lab Review
    - Evaluate the size of droplets.
- Measure the volume of objects.
  - Experimental Learning Objectives
    - Use a graduated cylinder to calculate the volume of objects.
- Further perspectives.
  - Comparing the accuracy of measurement systems.
  - Recall that 30 ml = 1 ounce.
  - Recall that 240 ml = 1 cup.
  - Recall that 1 quart (946 ml) is roughly equivalent to 1 liter (1000 ml).

### 5. Temperature

- Core Concepts: Temperature
  - Differentiate between the Fahrenheit, Celsius, and Kelvin temperature scales.
  - Be able to convert between degrees Fahrenheit and degrees Celsius.
  - Recall the normal body temperature at the Celsius temperature scale.
  - Recall the normal room temperature at the Celsius temperature scale.
- Temperature measurements.
  - Experimental learning objectives.
    - Measure temperatures on a thermometer with a Celsius scale.
- Further perspectives.
  - Know how to interconvert between Fahrenheit and Celsius temperature scales.
  - Recall that water freezes at 32 degrees F and 0 degrees C.
  - Recall that water boils at 212 degrees F and 100 degrees C.
  - Relating freezing and boiling temperatures of water to the Celsius temperature scale.
  - Relating body temperature to the Celsius temperature scale.

## LearnSmart Labs: Metric Measurements

### 6. Final Summary Questions

- Explain the relationships between volume and weight.
- Apply general conversions between  $m^3$  and liter.

### Student Instructions for Lab Experiments

#### Core Concepts: Metric Measurements

In this lab, you will learn about the metric system, the units used within the system and how to interconvert them.

Important to Know About the Metric System

*Why*

- It is the standard system of measurement in the biological and physical sciences.
- Advantageous to use because conversions between units are in factors of ten.

*How*

- Know the metric base units for length, weight, volume, and temperature.
- Know the common prefixes of derived units of length, weight, volume, and temperature.
- Be able to interconvert between units.

#### Core Concepts: Length

In this section, you will learn about the lengths units in the metric system. In the exercise, you will learn how to perform length measurements with a metric ruler.

Before we move on to the labs, I would like to make sure that you have the necessary knowledge of the units of length used in the metric system.

Important to Know About Metric Units of Length: Meters, Centimeters, and Millimeters

- The definitions of meters (m), centimeters (cm) and millimeters (mm).
- How to convert between these units.

#### Diameter of Circles

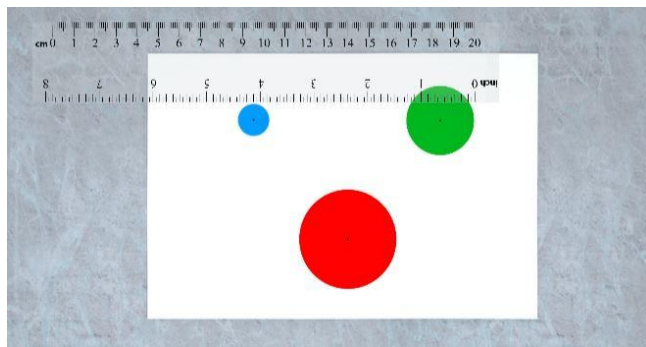
In this short activity, you will need to accurately measure the diameter of several circles.

Use a ruler to measure the diameter of each circle to the nearest millimeter.

Record your measurements in the notebook and when you are done, click “End Experiment” to proceed.

#### Simulator

Use the ruler to measure the diameter of each circle. Note your readings in the notebook.



## LearnSmart Labs: Metric Measurements

### Instructions

1. Pick up the ruler and use it to measure the diameter of each of the three circles.
2. Record your observations in the notebook.

Lab Notebook	
Diameter of circles (in cm)	
Blue circle	cm
Green circle	cm
Red circle	cm

### Length of Humerus Bone

In this activity, you will measure the length of a bone.

Use a meter stick and the triangles to measure the bone as accurately as possible.

Record your measurement in the notebook.

Measure the Length of an Irregular Object.

- In this activity, you should measure the length of a humerus bone.
- Position your eye at a right angle to the bone ends when you perform your measurements.
- Use the triangles as guides to perform accurate measurements.

### Simulator

In this activity, you should measure the length of the bone using the ruler and the two triangles.

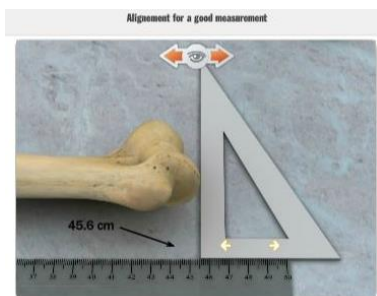
### Instructions

Use the ruler and the two triangles to measure the length of the humerus bone.

1. Perform a measurement of the left and right ends of the bone.
2. To perform correct measurements, zoom in on the bone and use the arrows with the eye icon to adjust the point of view until it's perpendicular to the edge of the bone.
3. Then move the triangle and align it with the bone end, and read the measurement on the ruler.
4. Record your measurements in the notebook and use these to calculate the length of the bone.  
 $\text{Bone length} + \text{right measurement} - \text{left measurement}$ .

Here is an example of correct alignment for the measurement of the right end of the bone.

Notice that both the eye and the square need to be properly placed in order to get a good length estimate. In this example, the correct reading for the right end of the bone is 45.6 centimeters.



## LearnSmart Labs: Metric Measurements

### Core Concepts: Weight

In this section, you will learn about the weight units used in the metric system. In the exercise, you will learn how to use a scale to weigh objects.

Before we move on to the labs, I would like to make sure that you have the necessary knowledge of the weight units used in the metric system.

Important to Know About Weight Units

- The definitions of grams (g) and milligrams (mg).
- How to convert between these units.
- How to perform correct measurements with a digital scale.

### Measurement of Weight

In this activity, you will weigh a measured amount of salt.

You will need a beaker and a digital scale for this experiment. Weigh the beaker first and record your findings.

Then proceed to measure the weight of a spoonful of salt.

Remember to use the TARE button to reset the weight before weighing the beaker and the salt.

Write your readings in the notebook.

#### Simulator

Measure the weight of the beaker and of a spoonful of salt and write the readings in the notebook. Use the TARE button to reset the weight.

#### Instructions

The goal is to measure the weight of a spoonful of salt.

1. Measure the weight of the beaker.
2. Measure the weight of the beaker with a spoonful of salt.
3. Calculate the weight of the salt and write your readings in the notebook.

Remember to use the TARE button to reset the scale.

### Core Concepts: Volume

In this section, you will learn about the volume units used in the metric system. You will also practice some exercises of how to perform accurate volume measurements in graduated cylinders.

Before we move to the labs, I would like to make sure that you have the necessary knowledge of the volume units used in the metric system.

Important to Know About Volume Units

- The definitions of liters (L) and milliliters (ml).
- How to convert between liters and milliliters.
- How to convert between cubic centimeters (cm<sup>3</sup>) and milliliters (ml).

### Measure Liquid Level

In this activity, you will measure a volume of liquid using a graduated cylinder.

It is important to remember to measure from the meniscus, which is the lowest margin of the water level.

To measure accurately, you should move your eye to be in the plane of the meniscus.