

MODULE

lung capacity



INTRODUCTION

The purpose of this module is for students to measure the normal capacity of their lungs by measuring the volume of air in their lungs. This is a good activity for integrating mathematics with science as students calibrate their own lung capacity bags.

Two activities make up Module 4:
Activity 9: Calibrating Lung Capacity Bags
Activity 10: Measuring Lung Capacity

Each of the activities in this package has at least one Extension related to historical events, inventions, or people that relate to the circulatory and respiratory systems. These Extensions are indicated with a ♥. Encourage students to use a variety of media to complete their research projects.

TEACHER BACKGROUND

During normal quiet breathing about 500 ml of air moves in and out of the lungs with each breath. The amount of air that can be forcefully exhaled after a normal quiet inhalation is an additional 3100 ml. The lungs normally retain 2400 ml of air after normal quiet exhalation, and 1200 ml of this reserve can be forcefully exhaled. There is always at least 1200 ml of air retained in the lungs to prevent collapse of the alveoli. The total lung capacity for a healthy young adult male after maximum inhalation is 6000 ml (6 liters), or about one and a half gallons. Lung capacity can be compared to

height so that your students can determine what the average total lung capacity is for your class (see Table 1 below). You may choose to use this table with the students or have students create their own to accompany Activity 10.

Table 1: Average Lung Volume (L) Versus Body Height (cm)

TLC = total lung capacity

VC = Vital capacity

	Sex	130 cm	150cm	170 cm
TLC	M	2.55 L	3.62 L	5.49 L
	F	2.41 L	3.41 L	4.66 L
VC	M	1.96 L	2.85 L	4.21 L
	F	1.78 L	2.60 L	3.56 L
RV	M	0.60 L	0.85 L	1.11 L
	F	0.61 L	0.85 L	1.05 L

RV = Reserve volume

There are five definitions included here that describe lung volume and capacity that are necessary in order to interpret data that is found on websites and in textbooks. Refer to both the CD-ROM and Website to enhance this series of activities.

Tidal Volume is the amount of air moved into or out of the lungs when breathing normally under resting conditions.

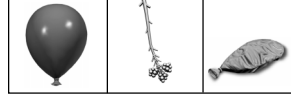
Residual Volume is the volume of air that remains in the lungs after forced exhalation.

Vital Capacity is the maximum volume of air that can be exhaled from the lungs after maximum inhalation.

Total Lung Capacity is the total volume of air contained in the lungs after maximum inhalation.

Functional Residual Capacity is the amount of air remaining in the lungs after normal exhalation at rest.

ACTIVITY 9



calibrating lung capacity bags

ACTIVITY INSTRUCTIONS

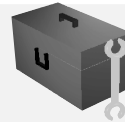


AT THE END OF THIS ACTIVITY, DISINFECT THE MOUTHPIECES ACCORDING TO THE DIRECTIONS IN THE INTRODUCTORY MATERIALS.

REMEMBER, BLEACH IS NOT ALLOWED IN THE CLASSROOM.

The lung capacity bags must be marked so that each student will be able to determine the volume of air expelled in a normal breath in Activity 10. This would be a good time to revisit general issues about measurement. Using a standard system of measurement is vital to the sharing of scientific information. In science, the metric system is used universally. If you have not already done so, a discussion of different systems of measurement would be appropriate here. Emphasize to students that if they are comparing results, or generating a class-wide graph or chart, that all bags need to be marked consistently. The reliability of instruments (and how they are calibrated) in science is a concern at all levels in all disciplines of science.

Materials



- Lung capacity bags
- Mouthpieces
- Rubber bands
- Masking tape
- Marker or pencil
- Tape measure
- Science Notebooks

Overview

Students work in groups of 4 (even though each student will calibrate his or her own lung capacity bag). Students measure every 2.5 cm and make a mark [2.5 cm = 0.1 liter (0.10 L); 25.5 cm = 1 liter (1.0 L)] so that they can accurately measure the amount of air that they exhale (Activity 10). Students will build directly on this activity as they collect and measure the amount of air that they exhale in Activity 10.

Homework, Assessment, and Standards

Homework

Have students choose a tool that they use at home or at school (ruler, measuring cup, protractor, scale, etc.) and imagine what they would do if it did not have markings on it. How could they determine where to make the marks? Each student should come to class with at least three ideas of how to figure out where to put the marks.

Assessment

Students write a story about a place where everyone has his or her own system of measurement. Include in the story what kinds of problems people would have in buying food and clothing, preparing food and sharing recipes, replicating science experiments, etc. Students should also create a final solution to the problem.

Have students create a concept map (or other visual organizer – see introductory materials) for the word “measurement.” Since visual organizers are ways for students to arrange ideas in ways that make sense to them, grading this would be difficult except as an exercise that is either completed or not. You can look for measurement terms, a hierarchy of units (for example, milligrams, grams, kilograms), or similarity of units (miles, feet, yards).

Have students make a chart comparing different units of measurement. For example, the Kelvin, Celsius, and Fahrenheit temperature scales or Metrics (International System of Units or SI and

the English System of measurement). Each student (group or pair of students) will justify the choice of method of information presentation. Why did they choose to set up the table or chart the way they did?

This may be a good time for students to create a new K-W-L chart or to create some version of one to continue to keep track of questions and answers they have about tobacco and its affect on their bodies, or have students enter what they learned and what they would like to learn on the K-W-L chart created in Activity 3. Students can refer to their CD-ROM Lab Notebook for information to include on the K-W-L chart.

Standards

Florida Sunshine State Standards

Science: SC.E.1.2.1, SC.E.1.2.4, SC.E.1.2.5, SC.F.1.2.1, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.2.2.1, SC.H.3.2.2, SC.H.3.2.4

Health: HE.A.1.2.1

Mathematics: MA.A.1.2.1, MA.A.1.2.2, MA.1.2.3, MA.A.2.2.1, MA.B.1.2.1, MA.B.1.2.2, MA.B.2.2.1, MA.B.2.2.2, MA.B.3.2.1, MA.B.4.2.1, MA.B.4.2.2, MA.E.1.2.1

Language Arts: LA.A.2.2.1, LA.A.2.2.5, LA.A.2.2.8, LA.B.2.2.1, LA.B.2.2.2, LA.B.2.2.4, LA.B.2.2.3, LA.B.2.2.5, LA.C.1.2.1, LA.C.3.2.3, LA.C.3.2.5, LA.D.2.2.4,

Social Studies: SS.A.2.2.1, SS.A. 3.2.1

Extensions

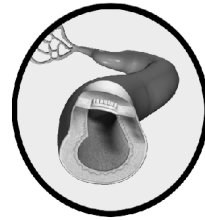
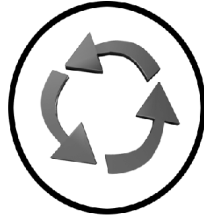
♥ Research Anders Celsius who invented the centigrade scale of temperature measurement in 1742. Originally, Celsius had 0 degrees as boiling and 100 degrees as freezing. These were switched in 1743 by Jean Pierre Christin to give us the system we now use.

Read aloud The Librarian Who Measured the Earth, by Kathryn Lasky, to begin a discussion of indirect measurement. The story tells how Eratosthenes figured out a way to measure the circumference of the Earth without ever leaving his home – a measurement that is only 200 miles different from our actual present-day calculations. (ISBN 0-316-51526-4)

Another way to measure volume of air is by water displacement. Using a pan, a tube to breathe into, a beaker to measure water, and a 2-liter soda bottle that has been thoroughly washed, students can measure their lung capacity. Mark the 2 L bottle at regular increments (you can use a measuring cup, graduated cylinder, or beaker to get an accurate measurement). Fill the pan half full of water. Turn the soda bottle upside down with a piece of tubing sticking out of the water. Blow into the tube. Water will be forced out of the soda bottle. Students can read and record the volume of air by checking the mark on the side of the bottle.

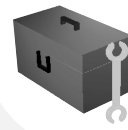
ACTIVITY 9

CALIBRATING LUNG BAGS



In order to measure the amount of air that you exhale, you first must mark the lung capacity bags (using masking tape).

1. Place a piece of masking tape the length of the bag from the bottom of the bag to the top of the bag.
2. Start at the bottom of the bag and measure up 2.5 cm. Mark that spot and label it 0.10 L. Continue measuring and marking every 2.5 cm until you reach 1 L. Then continue to mark each 2.5 cm (1.1 L, 1.2 L, etc.) until you reach 3 L.

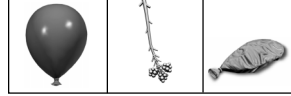


Collect Your Materials

- Tape measure
- Lung capacity bags with mouthpieces
- Rubber bands
- Masking tape
- Pencil or marker
- Science Notebooks

3. Insert mouthpiece into the open end of the bag and secure it with a rubber band. Be sure that it is airtight.
4. In your Science Notebook, answer the following:
 - a) Why is it important to mark every tenth of a liter?
 - b) If you did not, would it make a difference to your data collection?
 - c) Can you think of any other things that are marked in this way? List them in your Science Notebook.

ACTIVITY 10



measuring lung capacity

TEACHER BACKGROUND

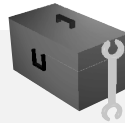
TEACHER BACKGROUND for Activities 9 and 10 are found at the beginning of Module 4. Before beginning Activity 10, see the section on Health and Safety Issues in the introductory materials.



NOTE: At the end of this activity, you will sanitize the lung capacity bags using a 10% bleach solution (see Health and Safety Issues). Turn the bags inside out before sanitizing. **DO NOT STORE OR USE BLEACH IN THE CLASSROOM.**

ACTIVITY INSTRUCTIONS

Materials



Lung capacity bag
Science Notebook
Stopwatch
Graph Paper

Overview

Students will collect air that they exhale to determine their individual lung capacity, repeating the trials to find averages. Use Table 1 (Teacher Background section) as a model for a class chart. Discuss the value of accumulating, recording, and presenting whole class information. Before beginning, you may wish to have students calculate their height in centimeters and record the measurement on a common table. Later on they can enter their average lung capacity, making the connection between height and lung capacity.

Working in pairs (although each student will have his or her own lung capacity bag), each student will keep his or her own data table in the Science Notebook. It will be easier for students to work with a partner to read the bag and/or record lung capacity on their data tables. Since students are creating their own data tables based on what they want to find out, this is a good time to discuss the concept of

variables in a scientific investigation. A variable is something that changes in an experiment. For example, if you were doing an experiment on plant growth (light/no light or water/no water), the light or water would be the variables.

Students with asthma may be familiar with medical tests that measure lung function. Ask if any of the students are comfortable with describing those tests, what they are used for and what it feels like. Those with firsthand knowledge can provide a context for understanding the real-world connection for figuring out these volumes. Depending upon the level of interest and knowledge, you may want to include for the students a discussion of the five lung capacity terms included in the Teacher Background section of this Module.

Homework, Assessment, and Standards

Homework

Have students measure the height of five other people or pets (for example, family members, cats, dogs, horses, etc.). Then have them predict what the lung capacity would be for each living thing they have measured. Predictions will be made using either the table provided in the Teacher Background section of this Module or using the class table if you created one.

Assessment

Use the section on “The Breath of Life” in How Your Body Works to facilitate a discussion of why understanding how our lungs work is so important. When making lifestyle choices, the more information we

have the better able we are to make informed choices.

Check Science Notebooks for answers to questions from the Student Page. Do the answers reflect the data gathered from the various tests performed? If so, then the student has successfully completed the task. If not, students should be encouraged to collaborate with others in the group to identify the difference between the unacceptable answer and one that you consider to be a “good answer.” Note that the questions dealing with averages and graphing are similar to those found in the mathematics portion of the FCAT and Terra Nova.

Have students share their data tables. Tables should contain all three trials and the average. There should be at least three variables.

Discuss with students how numbers might differ if a person has asthma or other lung disease. If you have chosen to keep a class chart, there may be one or two children whose numbers do not fit the pattern of height versus lung capacity. Discuss reasons why: a mistake in calculating average, a mistake in reading the capacity bag, an illness that affected a student’s breathing, or breathing through the nose and mouth instead of just the mouth.

This may be a good time for students to create a new K-W-L chart or to create some version of one to continue to keep track of questions and answers they have about tobacco and its affect on their bodies. Or, have students enter what they learned and what they would like to learn on the K-W-L chart created in Activity 3.

Students can refer to their CD-ROM Lab Notebook for information to include on the K-W-L chart.

Standards

Florida Sunshine State Standards

Science: SC.A.1.2.1, SC.C.2.2.3, SC.F.1.2.1, SC.F.1.2.3, SC.H.1.2.1, SC. 1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC. H. 2.2.1, SC. H.3.2.2, SC.H.3.2.4

Health: HE.A.1.2.1, HE.B.1.2.1, HE.B.1.2.2, HE.C.1.2.1, HE.C.1.2.2, HE.C.1.2.3

Mathematics: MA.B.1.2.1, MA.B.1.2.2, MA.B.3.2.1, MA.B.4.2.1, MA.B.4.2.2, MA.E.1.2.1, MA.E.1.2.2, MA.E.1.2.3, MA.D.1.2.2, MA.E.1.2.3, MA.E.2.2.1, MA.E.2.2.2, MA.E.3.2.1, MA.E.3.2.2

Language Arts: LA.A.2.2.1, LA.2.2.5, LA.A.2.2.8, LA.B.2.2.1, LA.B.2.2.3, LA.B.2.2.5, LA.C.3.2.3, LA.C.3.2.5, LA.E.1.2.1

Social Studies: SS.A.3.2.1

National Science Content Standards: A, B, C, E, F, & G



Students write science fiction stories about creatures from other worlds that have either limited or expanded lung capacity and how it would affect their activities. Keeping in mind the elements of science fiction (tells a good story, includes science facts, includes facets of human nature, presents something strange and unusual), stories should incorporate facts about lung capacity gleaned from this activity. This could be the basis for a narrative demand writing prompt similar to those in Florida Writes!

Extensions

Read “The Truth About Pyecraft” by H.G.Wells (In Knight, D. F. [Ed.] [1973], The Golden Road: Great Tales of Fantasy and the Supernatural. New York: Simon & Schuster). Not only is this story about making decisions that affect your life, but it also concerns units of measurement and the confusion between weight and mass.

♥ Have students research John Gibbon, who in 1951 developed the first heart-lung machine.

ACTIVITY 10

MEASURING LUNG CAPACITY



In this activity, you will be measuring the tidal and vital capacity of your lungs. Air moves in and out of your lungs because of changes in pressure from one part of the lungs to another. Tidal capacity is the amount of air breathed into and out of the lungs under normal resting conditions. The largest volume of air that you can move in and out of your lungs is called vital capacity. These amounts are different for different people and depend upon several things – the size of your chest cavity, your posture, and other factors, such as the diameter of your bronchioles. A larger person usually has a larger lung capacity; if a person is standing up straight or stooped over it will also affect how much air is moved in and out of the lungs.

Diseases such as asthma, emphysema and heart disease can affect the amount of air a person can move in and out of their lungs.

1. Decide what your variables will be. A variable is something that you change in an experiment or activity. An example of a variable that you might use in this activity is standing straight up, taking a normal breath or a deep breath.

2. Make your data table so that you can record all information quickly and easily. On the left side going down the page, list Trial 1, Trial 2, and Trial 3. The last label on the left side of the table should



Collect your materials

- Pre-marked lung capacity bags for each student (from Activity 9)
- Science Notebook
- Data table
- Stopwatch to share with group members

ACTIVITY **10** measuring lung capacity

be Average. Going across, label the top of each column with your variables such as "normal breathing standing up," "deep breathing standing up" " normal breathing bending over," or "deep breathing bending over." You can come up with other variables on your own. Draw your data table in your Science Notebook.

3. Now it is time to begin your investigation! It's probably a good idea to determine your tidal and vital volumes while sitting or standing normally before investigating other variables. Inhale normally and then exhale normally into the lung capacity bag to determine your tidal volume.

Without letting any air out of the bag, roll the bag from the top until you have pushed all the air to the bottom of the bag. Record the volume of air. Take turns with your partner and do this three times, recording each trial on your data table under the correct heading.

4. Now, determine your vital capacity by taking the deepest breath you can and exhaling as hard as you can into the lung capacity bags. Record the volume of air. Take turns with your partner and do this three times, recording each trial on your data table under the correct heading.

5. In your Science Notebook, write down your observations and answers to these questions in sentence form. What happened with each trial? Was there a difference in the results from each trial?

6. What other variables can you use to test lung capacity? (For example, you could perform tests of lung capacity while sitting, while stooped over, and while standing straight and record them on the data table.) Be sure to label your table with your variable and indicate whether you took normal breaths or deep breaths.

7. In your Science Notebook, write down any other questions that you have now that you have done all of your tests on lung capacity. What are you wondering about? What else would you like to know about lung capacity?

8. Use the information on your data table to find the average lung capacity while breathing normally and for the other variables that you

ACTIVITY **10** measuring lung capacity

chose. Enter the average on the data table. Write a paragraph in your Science Notebook that tells what you found. For example, you may wish to start with the following: "My average lung capacity when I breathe normally is _____ liters. This number changes when" Now, you finish the paragraph.

9. With your group or your partner, brainstorm ways to graph the data that you collected in this investigation. List the ways in your Science Notebook.

10. Using graph paper, make a graph to show your results to your teacher, your parents, and others in your class. This could be a line graph or a bar graph. When you decide which one you will use, write down in your Science Notebook why you chose that type of graph.

11. Share your data table and graph with others in the class.

