

Lesson Name : How Do Your Heart & Lungs Measure Up?

Expedition Link: Physiology – The team will study how the human organism reacts to changes in physical environment. Particularly, they will acquire measurements and comment on how working and sleeping at high altitudes in extreme conditions affects mission operations. Health metrics, such as blood saturation and pulse rate, will be monitored for each of the team members throughout the course of the expedition.

National Science Standards:

K-4.3 students should develop understanding of organisms and environments

5-8.3 students should develop understanding about diversity and adaptations of organisms

9-12.6 students should develop understanding of science and technology in local, national, and global challenges

9-12.7 students should develop understanding of science as a human endeavor

California State Science Standards:

California State Science Standards 4th

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California Science Standards 5th

Earth Science

Scientific Investigation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California State Science Standards 6th

Earth Science

Scientific Investigation

7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California State Science Standards 7th

Earth and Life History (Earth Science)

Scientific Investigation

7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California State Science Standards 8th Grade

Scientific Investigation

9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

9th-12th California State Science Standards

Investigation and Experimentation

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations.

How's Your Heart?

Procedure:

The students will measure their heart rate and explore conditions that can affect it. They'll explore the affects of various physical activities on their heart rate.

A. Have the students locate their pulse points on their neck by placing their index finger beneath the ear and jawbone. To locate their pulse on their wrist have the students place their right index and middle finger on the palm side of their left wrist.

B. Have the students count the number of beats in 15 seconds. Multiply this by four ($15 \times 4 = 60$). This is how many times the heart beats in one minute. Have students enter this as their "at rest" heart rate on their record sheet. (Student pulse rate at rest will vary between 60 - 110 beats per minute.)

C. Have the students exercise such as running in place, pushups, or some other exercise for one minute. Have them stop and calculate their pulse rate again for 15 seconds. The students need to calculate their heart rate for each physical activity and indicate this on their record sheet.

D. Have the students compare the heart rates of students in their class. Have them find the average heart rate of all the students.

1. For homework have the students collect pulse rates from adults and record this on another record sheet. Have the class find the average heart rate for their parents. Compare their heartbeats with the student's average heart rate.

2. The amount of time the heart takes to return to a normal at-rest rate after exercise is called **recovery time**. This is a measure of the body's general fitness. The shorter the recovery time, the higher the level of fitness. Have the students determine their recovery rate by first measuring and recording their pulse rate at rest. Then, have them run in place for 5 minutes and record their pulse rate every minute until the at-rest rate is reached. They need to record the time it took for their heart to return to the normal rate.

Student Name _____

“How’s Your Heart” Student - Student Record Sheet

At Rest Heart Beat for two minutes

(Number of Beats in 15 seconds x 4) _____ beats per minute

Class Average Beats per minute _____

(Name of Physical Activity) _____ for two minutes

(Number of Beats in 15 seconds x 4) _____ beats per minute

Class Average Beats per minute _____

(Name of Physical Activity) _____ for two minutes

(Number of Beats in 15 seconds x 4) _____ beats per minute

Class Average Beats per minute _____

(Name of Physical Activity) _____ for two minutes

(Number of Beats in 15 seconds x 4) _____ beats per minute

Class Average Beats per minute _____

SYNTHESIS of DATA

Compare the results of the student data with the results of the class data.

At Rest Heart Beat: My Data _____ Class Average _____

_____ for two minutes My Data _____ Class Average _____

_____ for two minutes My Data _____ Class Average _____

_____ for two minutes My Data _____ Class Average _____

Conclusions: Compare the data from each test. What do you conclude? Use the back of this page if you need more space.

Capacity of Air in the Lungs

The students will measure their lung capacity and explore conditions that can affect the capacity of air their lungs can hold. The students will also find their respiration rate. They'll explore the affects of various activities on their respiratory rate.

Materials: Each student will need;

- 60 cm length of vinyl tubing
- small to medium size balloon
- Student record sheet
- one clean plastic drinking straw
- metric tape measure

Each group of 4 students

- one 2 liter or 1 gallon clear plastic jug
- metric measuring cup
- masking tape
- permanent marking pen
- container for water (plastic wash tub)
- funnel
- food coloring
- eye dropper
- sponge
- stopwatch

Air in the Lung Examination

The students will find their lung capacity using displacement. They will find their **tidal air** (air inhaled or exhaled during normal breathing), **tidal air + reserve air** (reserve air is air forced out after normal exhalation), and **vital capacity** (maximum air exhaled during forced breathing).

Procedure

Teacher Preparation

- Place a strip of tape along the side of the jug from top to bottom.
- Use the metric measuring cup and funnel to fill the jug with water. Mark and label on the tape every 50 ml level as you fill the jug (start at 100 ml, 150 ml, 200ml, 250 ml, 500 ml, 750 ml). Add a few drops of food coloring to the water to see the level.
- Add water to the wash tub to a depth of 10 cm.

D. Hold your hand over the opening of the full jug and tip it upside down in the tub. Do not let any water escape from the jug. Remove your hand from the mouth of the jug after it is underwater. Support the bottle upright so it doesn't tip over.

E. Place one end of the vinyl tubing in the mouth of the jug with the mouth of the jug underwater so it protrudes about 8 - 10 cm into the jug. Insert a clean plastic straw into the other end of the tubing.

Student Activity

A. Direct the students to breathe normally and exhale once through the straw. They need to record how much water is displaced from the jug. This measurement is called **tidal air** (air inhaled or exhaled during normal breathing).

B. Refill the jug with water. Repeat steps 4 and 5. This time have the students exhale one normal breath through the straw, then continue and try to force as much air as they can out of their lungs. Have them record this amount as **tidal air + reserve air**. (Reserve air is air forced out after normal exhalation.)

C. Refill the jug. Have each student take a deep breath and exhale as much air as possible through the straw. Measure this volume and have them record it as **vital capacity** (maximum air exhaled during forced breathing).

D. Repeat the procedure for each member of the group. Be sure each person uses his or her own piece of vinyl tubing and a new straw.

Alternative Method

Another method for measuring lung capacity is to have the students use a meter tape to find the volume of small or medium size balloons. The students will need to measure the circumference of the balloon at its widest spot and use the formula for finding the volume of a sphere. Be sure to have the students stretch the balloon several times to loosen them before finding their lung capacity. This method isn't as accurate as the displacement method, however, it is easier to prepare. Be sure each student has the same size balloon.

A. Have the students breathe normally, and exhale once into the balloon. Have them use the metric tape and measure the circumference of the balloon at its widest spot. Have them use the formula for finding the volume of a sphere (on the student record sheet) to determine the volume of the balloon. This measurement is **tidal air** (air inhaled or exhaled during normal breathing). It is approximately half the capacity of your lung capacity.

B. Each student will exhale one normal breath into the balloon, then continue and try to force as much air out of their lungs as they can. They'll use the formula for finding the volume of a sphere found on the student record sheet to determine the volume of the balloon. Have them record this amount as **tidal air + reserve air**. (Reserve air is air forced out after normal exhalation.)

C. Have the students take a deep breath and exhale as much air as possible into the balloon. Have them measure this volume and record it as **vital capacity** (maximum air exhaled during forced breathing).

Respiratory Rate for Physical Activities

The students will measure their respiratory rate for one minute and explore conditions that can affect it. They'll explore the affects of various physical activities on their respiratory rate.

Materials: Each student will need;

- Student Record Sheet

Materials: Each team will need;

- one stopwatch

Procedure

- A. Divide the students into teams of 2-3.
- B. Place females on one team and males on another team.
- C. Tell the students that one student will sit and breathe normally, while another student can count the number of breaths, and the other student can act as the timekeeper. Have each student record his or her resting respiratory rate.
- D. Have the teams repeat the process after doing several different physical activities. Each student needs to record his or her respiratory rates after each physical activity.
- E. Have the students find the class average for their resting respiratory rate. Have them compare their resting respiratory rates with the class average. How did they compare?
- F. Homework Connection: Have the students find the resting respiratory rates for members of their family.

Finding Lung Capacity

Directions: Inhale a normal breath. Exhale this breath into your balloon. Measure the circumference of the balloon at its widest spot. Measure the circumference of the balloon in centimeters. Follow the directions for each type of measurement. Record your measurements. Convert your answer to milliliters.

Tidal Air Capacity (air inhaled or exhaled during normal breathing)

Circumference of the balloon _____ cm divided (\div) by π (3.14) = radius _____ cm

Use this formula to find the Volume of the balloon = $(\frac{4}{3}) \times 3.14 \times r^3$

Do the math:

(1 cm³ = 1 ml) Tidal Air capacity equals _____ cm³ = _____ ml
(Volume of Lungs)

Tidal air + Reserve Air (Reserve air is air forced out after normal exhalation.)

Circumference of the balloon _____ cm divided (\div) by π (3.14) = radius _____ cm

Use this formula to find the Volume of the balloon = $(\frac{4}{3}) \times 3.14 \times r^3$

Do the math:

(1 cm³ = 1 ml) Tidal air + Reserve Air capacity equals _____ cm³ = _____ ml
(Volume of Lungs)

Vital Capacity (maximum air exhaled during forced breathing)

Circumference of the balloon _____ cm divided (\div) by π (3.14) = radius _____ cm

Use this formula to find the Volume of the balloon = $(\frac{4}{3}) \times 3.14 \times r^3$

Do the math:

(1 cm³ = 1 ml) Vital Air capacity equals _____ cm³ = _____ ml
(Volume of Lungs)

Student Name _____

Finding Your Resting Respiratory Rate - Student Record Sheet

Name of Physical Activity _____

(Number of Breaths in 60 seconds) _____ breaths per minute

Class Average Breaths per minute _____

Name of Physical Activity _____

(Number of Breaths in 60 seconds) _____ breaths per minute

Class Average Breaths per minute _____

Name of Physical Activity _____

(Number of Breaths in 60 seconds) _____ breaths per minute

Class Average Breaths per minute _____

Name of Physical Activity _____

(Number of Breaths in 60 seconds) _____ breaths per minute

Class Average Breaths per minute _____

SYNTHESIS of DATA

Compare the results of the student data with the results of the class data.

Physical Activity _____ My Data _____ Class Average _____

Physical Activity _____ My Data _____ Class Average _____

Physical Activity _____ My Data _____ Class Average _____

Physical Activity _____ My Data _____ Class Average _____

Conclusions: Compare the data from each test. What do you conclude? Use the back of this page if you need more space.
