



# Cardiac Trail

## Seventh Grade Life Science Outdoor Investigation

**Rational:** Slope is an important factor to consider when designing a trail on a hillside. Steep trails require more physical effort to hike on than do trails with a gentle slope. A very steep slope may be too difficult for young people, old people or people in poor physical condition.

Pulse rate is a good indicator of physical exertion. Working muscles need more blood circulating through them than do resting muscles to remove waste products and to supply oxygen and nutrients. The harder muscles work, the faster the heart pumps to provide the required blood. The increased heart rate produces a faster pulse rate in the arteries.

In this activity, students use their pulse rates as a measure of the effort expended in walking up various slopes, with the group basing their decision on the appropriate maximum slope for trails.

**S7CS1 Students will explore the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.**

- Understand the importance of—and keep—honest, clear, and accurate records in science.
- Understand that hypotheses can be valuable, even if they turn out not to be completely accurate.

**S7CS3 Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.**

- Analyze scientific data by using, interpreting, and comparing numbers in several equivalent forms, such as integers, fractions, decimals, and percents.
- Use the mean, median, and mode to analyze a set of scientific data.
- Apply the metric system to a scientific investigation that includes metric to metric conversion. (i.e. centimeters to meters).
- Draw conclusions based on analyzed data.
- Decide what degree of precision is adequate, and round off appropriately.
- Address the relationship between accuracy and precision and the importance of each.

**S7CS4 Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities.**

- Use appropriate technology to store and retrieve scientific information in topical, alphabetical, numerical, and keyword files, and create simple files.
- Use appropriate tools for measuring objects and/or substances.
- Learn and use on a regular basis standard safety practices for scientific investigations.

**S7L2 Students will describe the structure and function of cells, tissues, organs, and organ systems.**

- Explain that cells take in nutrients in order to grow and divide and to make needed materials.
- Relate cell structures (cell membrane, nucleus, cytoplasm, chloroplasts, mitochondria) to basic cell functions.
- Explain that cells are organized into tissues, tissues into organs, organs into systems, and systems into organisms.
- Explain that tissues, organs, and organ systems serve the needs cells have for oxygen, food, and waste removal.
- Explain the purpose of the major organ systems in the human body (i.e., digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection from disease).

**Enduring Understanding:** Exercise increases the cell's need for oxygen, food and waste removal.

**Essential Question(s):** How are cells, tissues, organs and organ systems affected by exercise?

**Pre-Assessment:** Students will write a brief paragraph on how they think cells are affected during exercise.

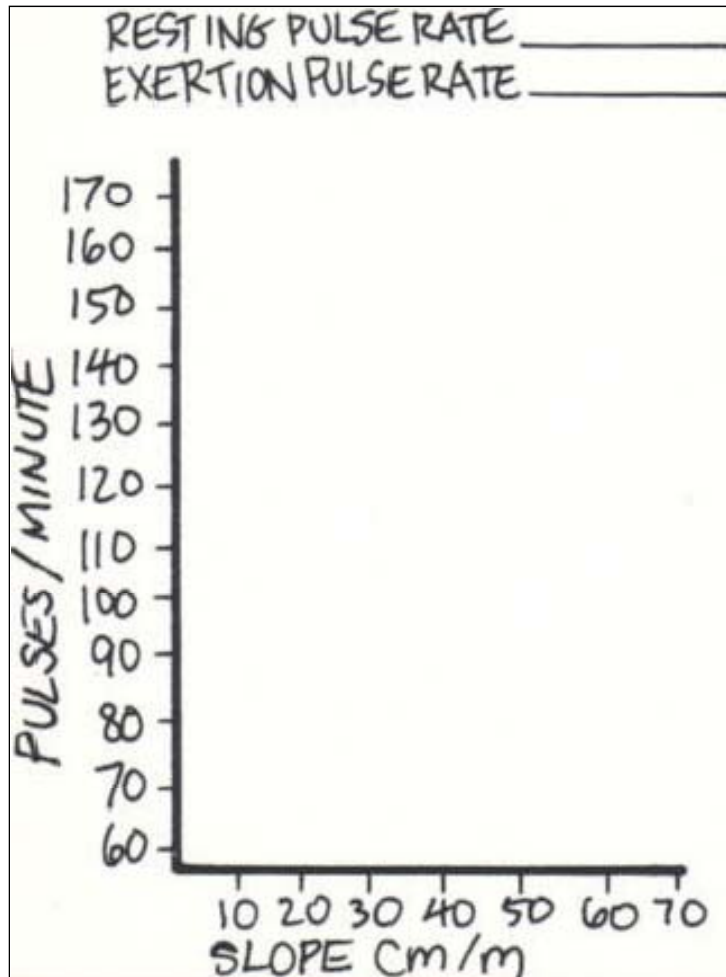
<p><b>Outcome/ Performance Expectations</b></p>	<p><i>Identify the learning goals for this inquiry-based task.</i></p> <ul style="list-style-type: none"> <li>• Students will observe changes in body systems during exercise.</li> <li>• Students will design an investigation to lead them to conclude that as they exercise, the cell’s need for oxygen, food and waste removal increases.</li> <li>• Students will explain how cells obtain oxygen and nutrients and remove waste.</li> <li>• Students will recognize how cells, tissues, organs and organ systems are related.</li> <li>• Students will create a lab report in which they will draw conclusions about the relationship between cellular needs and exercise. The report will also present evidence to explain/support their conclusions.</li> </ul>
<p><b>Write a concept statement...How would you formulate an expert idea?</b></p>	<p><i>List examples of how students may incorporate their ideas into investigations. Class discussion to guide student. Begin with teacher led questions:</i></p> <p><b><u>Engaging Students:</u></b></p> <ul style="list-style-type: none"> <li>• Think about the processes your body is carrying out while you are at rest. (Make sure to guide students to think about each level of organization.)</li> <li>• How do cells get nutrients and oxygen that they need?</li> <li>• How do cells remove wastes that they do not need?</li> <li>• How does the hierarchy of organization help cells to gain needed materials and remove unneeded materials?</li> </ul> <p><b><u>Questions:</u></b></p> <ul style="list-style-type: none"> <li>• Is your pulse rate an indicator of the relationship between cellular needs and exercise?</li> </ul> <p><b><u>Hypotheses:</u></b></p> <ol style="list-style-type: none"> <li>1. The pulse rate is a good indicator of the relationship between cellular needs and exercise.</li> <li>2. The pulse rate is not a good indicator of the relationship between cellular needs and exercise.</li> </ol> <p><b><u>Predictions:</u></b></p> <ul style="list-style-type: none"> <li>• If the pulse rate is a good indicator of the relationship between cellular needs and exercise, then the pulse rate will increase as the body increases its stress level.</li> </ul>
<p><b>Identify necessary data and observations...What data would demonstrate the mastery of the concept by ALL students in the classroom?</b></p>	<p><i>Identify relevant observations and data collected to aide in conceptualizing knowledge-making exploration.</i></p> <ul style="list-style-type: none"> <li>• Record data relating to body processes such as pulse rate, breathing rate, blood pressure, and perspiration rate while at rest.</li> <li>• Record data relating to the same body processes after a period of exercise (ie. Fast walking around football field; Walking up a “nature trail”).</li> <li>• Construct some type of chart to compare their data.</li> <li>• Use a lab report to discuss conclusions drawn from inquiry task. Students should make sure to provide the evidence that they used to support their conclusions.</li> </ul> <p><b><u>Possible Misconceptions:</u></b></p> <ul style="list-style-type: none"> <li>• Body systems/processes are not related to one another. Each system acts independently of each other. ---The inquiry task should result in the students drawing the conclusion that all systems work together to ensure the needs of the cells.</li> <li>• Only the digestive system rids the body of wastes. ---From observations made in the inquiry lab, students should note that perspiration and respiration both increase. Lead students to the understanding that not only are they taking in more oxygen as they inhale more frequently, but they are ridding the body of more carbon dioxide as they are exhaling more frequently. Also, they should note that their sweat contains waste products.</li> </ul>

Write procedures that will cause students to organize data...Test a procedure using known concepts.

List sample procedural statements that students may use to organize their data.

**Methodology:**

1. Students will record pulse rate while at rest. Demonstrate the procedure for taking a pulse. Show the group the correct hand and finger positions.
2. When all the students are relaxed and ready, have everyone silently count his own pulse for thirty seconds while standing still. Record each student's pulse rate in *pulses per minute*. (Multiply the thirty-second counts by 2) on a blank sheet of the data board. Average the rates to find the *resting pulse rate* for each group and record that rate at the top of the graph page. Draw a horizontal line across the graph at that resting-pulse value.
3. Next determine the pulse rate resulting from extreme exertion. Take groups of students out for either a long and fast run or a series of jumping jacks. When everyone is puffing, stop and immediately take a pulse reading. Again, average the pulse readings. This group average will be the *excessive-exertion pulse rate*, that is, too much work for walking over a trail. Record this value as the resting-pulse rate and draw the horizontal line on the graph. There are now two values that represent extremes of physical exertion: no exertion (resting) and excessive exertion (running or jumping jacks).



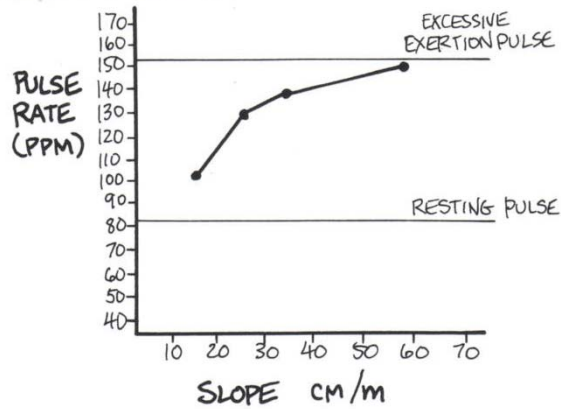
Data will be recorded on a data table. Students may use computer based spreadsheet programs to organize data.

### THEIR PRELIMINARY DATA:

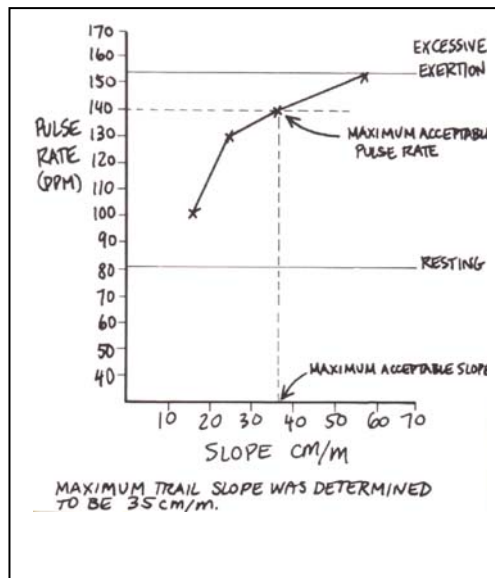
GROUP RESTING PULSE RATE: 82 PPM  
GROUP EXERTION PULSE RATE (RUNNING): 154 PPM

THEIR SLOPE DATA:	SLOPE (m/m)	PULSE RATE
	16	101
	35	138
	60	150
	26	130

### PLOTTING THEIR DATA:



1. Tell the students that you have selected three test slopes (trails) that vary in steepness from gentle to very steep. Point out the flag markers. Explain that the group will start at the upper end of each test slope and rest long enough to allow their pulse rates to return to near the resting rate. The group will then walk at a trail-hiking pace down to the end of the test slope and back up to the starting point (round trip) where they will immediately take pulse readings which are averaged and recorded on the graph. Start with the gentle slope and repeat this procedure for the other test slopes.
2. Once the pulse rates have been recorded, students are to decide which on the *maximum acceptable pulse rate* for trail hikers. The value should fall between the resting and the excessive-exertion pulse rates. Once a pulse rate is chosen, students use their graph to determine the slope most likely to produce that pulse rate.
3. As illustrated below, the students used the graph to chose a heart rate of 140 beats per minute as the maximum pulse rate, and used their graph to determine that a slope of about 35 centimeters/meter (35% slope) would produce that rate.



<b>Instructional Extensions</b>	<ol style="list-style-type: none"> <li>1. <i>What happens to a person's pulse rate on increasingly steep slopes? Would the pulse rate continue to rise with increase of slope or would it eventually level off?</i></li> <li>2. <i>How are cells, tissues, organs and organ systems affected by exercise?</i></li> <li>3. <i>What was the range of pulse rates in each group for any one slope?</i></li> <li>4. <i>If you were to build a trail through your activity area, what other factors might affect the decision of the maximum acceptable slope? (Trail surface, plants and animals living in the environment, erosion, length of trail.)</i></li> </ol>
<b>Materials List for Each Group and Estimated Cost</b>	<p>1 stopwatch - \$10.00  1 slope-measuring device (See the Measuring Slope Sheet) - \$5.00  1 data board for graphing - \$2.00  1 marking pen/pencil - \$.50  1 5- or 10-meter length of cord or twine (for measuring distance)  6 to 8 irrigation marking type flags - \$5.00</p>
<b>Instructional Tasks Accommodations for ELL Students</b>	<p><i>ELL students will be provided with a list of step-by-step directions for lab. ELL student will work with student proficient in English. ELL student will be provided with a teacher-generated lab report containing notations to ensure their understanding of lab terminology.</i></p>
<b>Instructional Tasks Accommodations for Students with Disabilities</b>	<p><i>Students will be provided with a checklist for lab. Students will be provided a step-by-step checklist for making the pamphlet. Student will work with a responsible student when constructing the graph on computer. Provide students with a teacher-generated lab report.</i></p>
<b>Instructional Tasks Accommodations for Gifted Students</b>	<p><i>Students will gather all students' data and construct a graph to display students' pulse rate and blood pressure. Students will analyze the data and hypothesize why there were differences among the students' data.</i></p>

Modified from : M.R. Abraham, "Inquiry and the Learning Cycle Approach," Chapter 4, *Chemists Guide to Effective Teaching*, Prentice Hall, 2005

Outdoor Biology Instructional Strategies, Lawrence Hall of Science, University of California, Berkeley, CA

# Cardiac Trail Slope Measuring Direction Sheet And Equipment List

Outdoor Biology Instructional Strategies

## MATERIALS FOR ONE SLOPE-MEASURING DEVICE

- 1 meter stick\*
- 1 125-cm length of strong cord\*
- 1 25-cm sharpened stick
- 1 line level\* or level tube consisting of a test tube\*, popsicle stick\*, and a cork\*
- household ammonia\*
- water
- tape\*

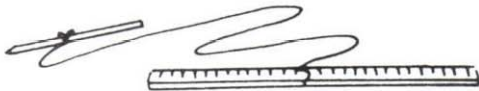
\* Available from Delta Education.

## ASSEMBLING THE SLOPE-MEASURING DEVICE

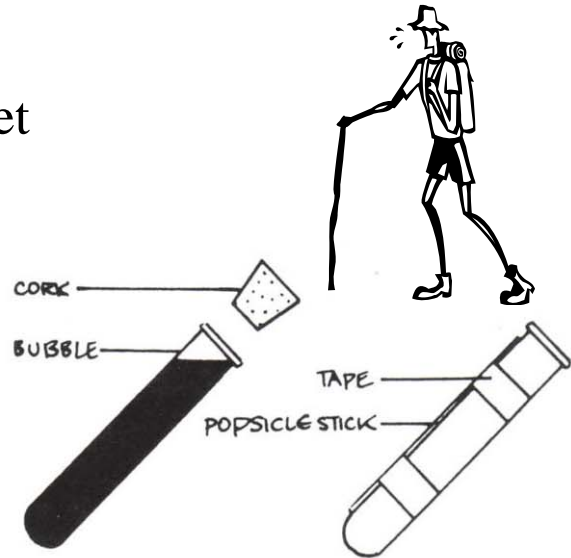
1. Sharpen the 25-cm stick and fasten the cord to it with a knot that enables the cord to slide up and down the stick. This is the "anchor stick."



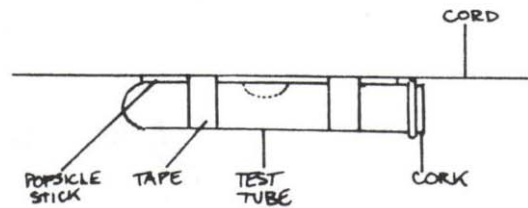
2. Attach the free end of the cord to the meter stick so that the distance between the two sticks is one meter. Make a knot that can slide on the meter stick. (You can use any stick marked off in centimeters if you do not have a meter stick.)



3. Attach a line level to the center of the line between the sticks. Here are instructions for making a level, if you choose to make your own. Fill the test tube almost full of water and add a drop of ammonia to stop algae growth. Cork the tube so that a small bubble remains. Trim off the top of the cork. If your test tube has a flared lip



at the top, tape a popsicle stick to the side of the tube before taping the tube to the center of the cord. Your level should look like this:



## TO USE THE SLOPE-MEASURING DEVICE

1. Place the anchor stick in the ground at the upper part of the slope. Push the string down to ground level.
2. Go down the slope until the string is taut, and rest the meter stick vertically on the ground (zero-end down).
3. Slide the knot on the meter stick up or down until the line level indicates the cord is level.
4. Read the value under the knot on the meter stick. This is the slope in centimeters per meter.

