Science Objectives

- Students will determine the effect of exercise on heart rate, respiratory rate, and air flow in and out of the lungs.
- Students will correlate the fitness level of an individual with amount of daily exercise.

Vocabulary

- amplitude
- frequency
- heart rate
- respiratory rate

About the Lesson

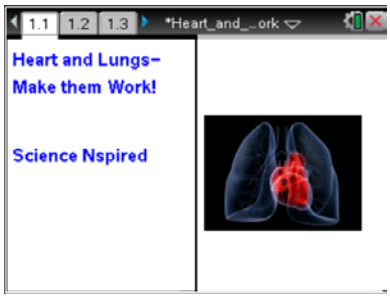
- In this lesson students will study the effect of exercise on heart rate, respiratory rate and air flow in and out of the lungs.
- As a result, students will:
  - Analyze graphs that represent how exercise changes vital signs of the cardiovascular and respiratory systems.
  - Relate the shape of the graph to changing levels of CO_2 that occur as a result of exercise.
  - Make predictions on how daily exercise affects physical fitness.

TI-Nspire™ Navigator™

- Send out the *Heart_and_Lungs_Make_Them_Work.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *Heart_and_Lungs_Make_Them_Work.tns* document
- TI-Nspire™ Technology



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Use a minimized slider

Tech Tips:

Make sure that students understand how to select a variable to add to a scatter plot.

Lesson Materials:

Student Activity

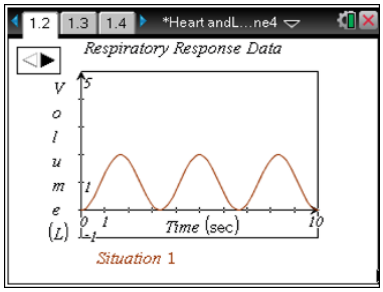
- Heart_and_Lungs_Make_Them_Work_Student.doc
- Heart_and_Lungs_Make_Them_Work_Student.pdf

TI-Nspire document

- Heart_and_Lungs_Make_Them_Work.tns

Discussion Points and Possible Answers

Move to page 1.2.



1. Page 1.2 contains graphs of breathing rates, using volume over time during three different "Situations." Students answer various questions about each situation from the individual graphs.

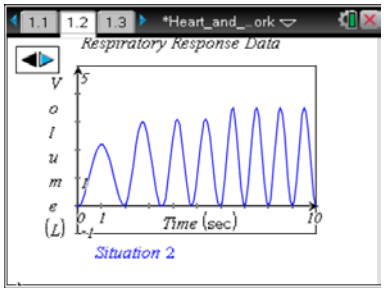
Situation 1

This scenario shows the graph of volume over time of a student just breathing normally.

Tech Tip: Students just click the ▶ or ◀ to move between situations.

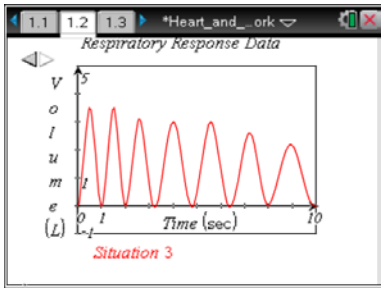
Situation 2

This graph shows increased lung volume and increased respiratory rate, which occur as a student begins to exercise.



Situation 3

Finally, this graph shows a decrease in respiratory rate and lung volume, which happens when a student has stopped exercising.



Move to pages 1.3–1.5.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q1. What is the height of the wave (amplitude) measuring?

Answer: A. amount of air moving in and out of the lungs

Q2. What is the distance between wave peaks (frequency) measuring?

Answer: B. respiratory rate

Q3. What is the best explanation for what the student was doing during Situation 1 of the data collection?

Answer: D. breathing normally

Return to page 1.2.

Have students answer the remaining questions on the activity sheet only. Students will click the ▶ icon in the top left of the screen to advance to Situation 2.

Q4. What is the best explanation for what the student was doing during Situation 2 of the data collection?

Answer: C. increasing physical activity

Q5. Using the terms *frequency* and *amplitude*, justify your answer choice for Question 4.

Answer: Both frequency and amplitude increased only gradually from Situation 1, which would have happened as the student increased physical activity.

3. Students will click the ▶ icon in the top left of the screen to advance to Situation 3.

Q6. What is the best explanation for what the student was doing during Situation 3 of the data collection?

Answer: C. decreasing physical activity

Q7. Using the terms *frequency* and *amplitude*, justify your answer choice for Question 6.

Answer: The frequency and amplitude of the peaks were lower than in Situation 2. They were not as low and constant as in Situation 1.

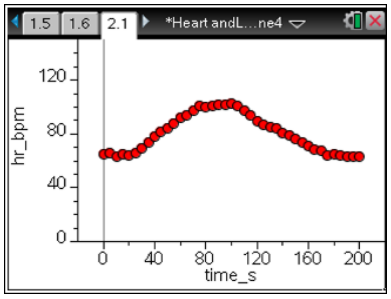
Q8. Describe the overall pattern of the total graph on page 1.2 in terms of CO_2 levels and their effect on changes that occurred in the respiratory response.

Answer: The CO_2 levels increased as a result of exercising the muscles. Increased cellular respiration in the muscle cells released excess CO_2. Both respiratory rate and amounts of air flowing in and out of the lungs increased to eliminate the excess CO_2.

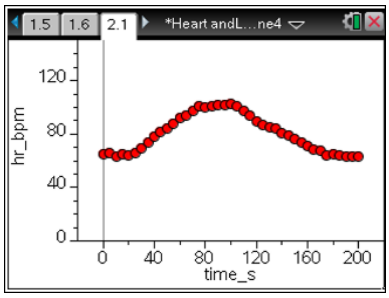
Move to pages 2.1 and 2.2.

The graph on page 2.2 represents the heart rate data for a well-conditioned athlete performing a 200-second stress test of the following:

a. Standing still for 40 sec.
b. Running in place for the next 60 sec.
c. Standing still for the remaining 100 sec.



Q9. On the graph below, sketch a graph for a non-athlete, performing the same activity.



Answer: The graph should: 1) begin higher on the Y-axis; 2) have a steeper increased slope; 3) be completely higher than the other graph; and 4) end a little higher than where it began.

Q10. Explain your rationale for how you sketched the non-athlete's graph in Question 9.

Answer: Non-athletes typically have a higher resting heart rate than athletes. Their heart rate increases faster and is higher than athletes because their heart muscle isn't as strong. It also takes a longer time for a non-athlete's heart to relax to its original resting heart rate.

4. Now check your answers to Questions 9 and 10 by doing the following steps on your handheld.
   a. Press **Menu > Plot Properties > Add Y Variable.**
   b. Select **hr2_bpm** and the graph for the non-athlete will appear.

> **Tech Tip:** Ignore the auto-window, which deleted the lower end of the *y*-axis. Explain to students that this auto-window adjustment is part of the technical design of this simulation and is not mathematically correct.

Q11. Describe how your prediction graph compared to the correct graph. Note: Ignore the auto-window which adjusts the *y*-axis.

Answer: Answers will vary accordingly.

TI-Nspire Navigator Opportunities

Perform a quick poll that surveys the difference between athletes/non-athletes resting heart rate.
Select different ranges beginning with 60–70, 71–80, etc.
Students can create histograms, and you can do a screen capture to examine their work.
Use TI-Nspire Navigator to capture screen shots of student progress and to retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolio.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show. Ask students what other variables besides daily exercise affect respiratory rates and heart rates.

Talk about what the 3 Situation graphs would have looked like if the student had been hyperventilating or holding a breath. (A graph for hyperventilation would have shown a more rapid increase in amplitude and frequency. A graph for holding breath would have displayed a constant volume, but not a zero volume.)

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator. The TI-Nspire Navigator Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.