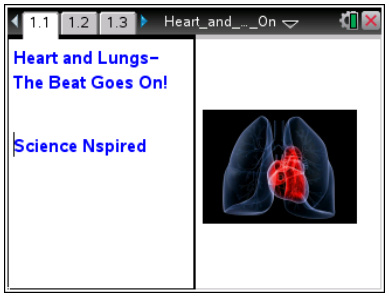
Science Objectives

- Students will determine the effect of exercise on heart rate, respiratory rate, and airflow 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 airflow 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_The_Beat_Goes_On!.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Heart_and_Lungs_The_Beat_Goes_On!_Student.doc
- Heart_and_Lungs_The_Beat_Goes_On!_Student.pdf

TI-Nspire document

- Heart_and_Lungs_The_Beat_Goes_On!.tns

Discussion Points and Possible Answers

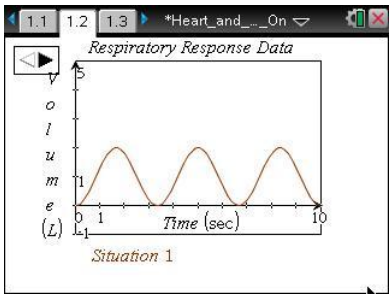
Allow students to read the background information on their student activity sheet.

Move to page 1.2.

1. Page 1.2 contains graphs of breathing rates that use volume versus time during three different "Situations." Students answer various questions about each situation from the individual graphs. Before looking at the graphs, you may want to discuss what it means to hyperventilate.

Situation 1

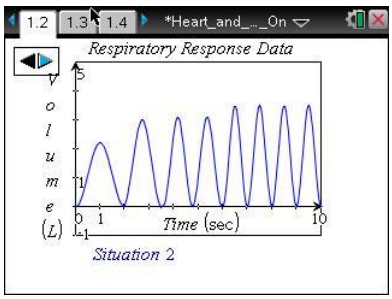
This scenario shows the graph of volume of air versus time of a student, who is just breathing normally.



Tech Tip: Students select the right or left arrows (▶ or ◀) to move between situations.

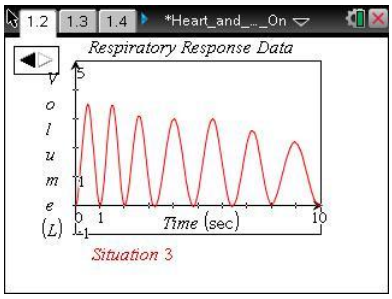
Situation 2

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.

Using the Situation 1 Graph, have students answer questions 1-3 in the TNS file, on the activity sheet, or both.

Q1. What is the height of a wave crest, or the **amplitude**, measuring?

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

Q2. What is the number of wave peaks in 10 seconds, or the **frequency**, measuring?

Answer: B. respiratory rate

Q3. What was the student most likely doing during Situation 1 of the data collection?

Answer: D. breathing normally

Return to page 1.2.

Have students answer questions 4-9 on their activity sheet only.

2. Students will select the right arrow ▶ in the top left of the screen to view the graph for Situation 2.

Q4. What was the student most likely doing during Situation 2 of the data collection?

Answer: C. increasing physical activity

Q5. Using the terms *frequency* and *amplitude*, explain 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 select the right arrow ▶ in the top left of the screen to view the graph for Situation 3.

Q6. What was the student most likely doing during Situation 3 of the data collection?

Answer: C. decreasing physical activity

Q7. Using the terms *frequency* and *amplitude*, explain 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. So the graph shows the lungs slowly down and returning to normal as the physical activity level decreases.

Q8. Breathing in brings oxygen to the blood, and breathing out carries carbon dioxide out of the blood. When a person exercises, it creates more carbon dioxide, or CO_2, in their blood. For each Situation, describe how the level of CO_2 in the student's blood changes over the 10 sec period.

Answer: During Situation 1, the CO_2 levels stayed constant. During Situation 2, the CO_2 levels increased over the time as a result of exercising the muscles. During Situation 3, the CO_2 levels decreased over the time. Both respiratory rate and amounts of air flowing in and out of the lungs increased to eliminate the excess CO_2.

Q9. Look at the overall pattern of each graph on page 1.2. For each Situation, describe the effect that changes in CO_2 levels had on the volume of air and on the respiration rate.

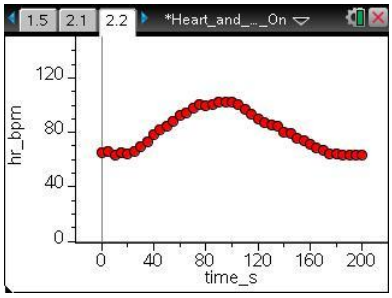
Answer: As the CO_2 levels increased, both respiratory rate and the amount of air flowing in and out of the lungs increased to eliminate the excess CO_2. As the CO_2 levels decreased, both respiratory rate and the amount of air flowing in and out of the lungs decreased.

Move to pages 2.1 and 2.2.

Have students answer questions 10-13 on their activity sheet.

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:

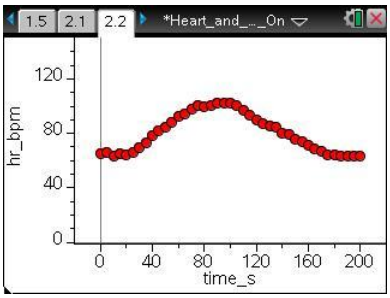
a. Standing still for 40 sec.
b. Running in place for the next 60 sec.
c. Standing still for the remaining 100 sec.



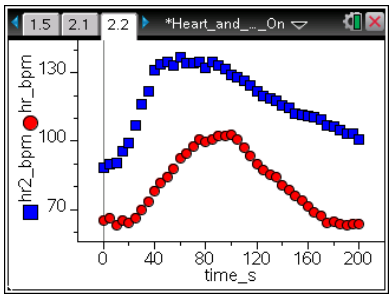
Q10. An athlete participates in exercise often, which means that their muscles, including their heart, get stronger. When a muscle gets stronger, it can use less effort, or energy to accomplish the same task. What effect on a person's heart beat would you expect to see as their heart gets stronger?

Answer: The heart rate would decrease.

Q11. On the graph below from page 2.2, sketch a graph for a non-athlete who is performing the same activity.



Sample Answer:



Answer: The graph should: 1) begin higher on the *y*-axis; 2) have a faster increase (steeper slope); 3) be above the other graph at all points; and 4) end a little higher than where it began.

Q12. Explain your reasoning for how you sketched the non-athlete's graph in Question 11.

Answer: Non-athletes typically have a higher resting heart rate than athletes have. The heart rate of a non-athlete also increases faster and is higher than an athlete's during exercise because the 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 answer to Question 11 by selecting **Menu > Plot Properties > Add Y Variable > hr2_bpm** to add the data for the non-athlete.

Tech Tip: To add data for the non-athlete, students should select **> Plot Properties > Add Y Variable > hr2_bpm**. They may need to back-out to the main Tools Menu to see the desired menu option.

Q13. Describe how your prediction graph compares with the graph on your device. 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 the resting heart rates of athletes and non-athletes. 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 three 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 a 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.