Respiration with Thermal Analysis

How often do you breathe in and out? Most of the time, we do not think about breathing, and don’t notice we are doing it. In this experiment, you will determine your respiration rate by examining the temperature of the air at your nostrils. When you inhale, the air entering your nostrils is room temperature. When you exhale, the air leaving your nostrils has been warmed by the inside of your lungs.

OBJECTIVES

* Use Thermal Analysis to measure temperature.
* Analyze graph of temperature *vs*. time to determine respiration rate.
* Average the respiration rate for the students in the class.

MATERIALS

|  |  |
| --- | --- |
| iPad®, iPhone®, or iPod® with lightning port |  |
| Vernier Thermal Analysis for FLIR ONE™ app |  |
| FLIR ONE™ thermal camera for iOS |  |

PROCEDURE

1. Open the Vernier Thermal Analysis app on your device.

2. Tap the + sign to start a new experiment.

3. Attach the FLIR ONE thermal camera to the lightning port with the lenses facing you.

If you also have the FLIR ONE app on your device, there will be a box that pops up with the message that FLIR ONE would like to communicate with the FLIR Systems FLIR ONE Camera. Tap Ignore.

If the camera battery does not have enough charge, the app will close.

4. Set up the app to record minimum temperature at your nostrils using the following steps.

1. Set the device and camera on the table facing up.
2. Position your face over the camera.
3. In the settings, tap Mirror.
4. In the settings, tap Calibration, and adjust the image until the visible outline matches the thermal area of your face.
5. Add a spot thermometer on the screen a little above and to the left of your nose. Drag the corner of the spot thermometer to make a rectangle covering your nose. Scroll the setting on this region from AVG to MIN to read the minimum temperature of the region.

5. Adjust the color palette so you can see the cooler air enter your nostrils and the warmer air leave your nostrils.

1. In the Settings, tap Range.
2. Decrease the range a little from the top and bottom as you watch the thermal image of your nostrils. The difference between inhaling and exhaling should be clearly visible as a color change.

6. Record data for one minute.

1. Tap the red, circular Record button.
2. Watch the image to make sure your face stays still with your nose inside the rectangle while you breathe normally.
3. Watch the graph and stop recording data when the graph reaches 60 seconds.

7. When the app prompts, save the data.

1. Tap Save. The Experiments list will appear.
2. Find the most recent experiment, and rename it with your name by tapping the circled i.
3. Open your experiment by tapping the name.

8. Determine the number of breaths during one minute.

1. Count the number of low points on the graph. This is the number of inhales. Record this number in the data table.
2. Count the number of high points on the graph. This is the number of exhales. Record this number in the data table.
3. Average the two values to determine the average breaths per minute

9. The other members of your lab group should perform the experiment.

DATA

|  |  |  |  |
| --- | --- | --- | --- |
| Run | Number of inhales | Number of exhales | Average breaths per minute |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |

ANALYSIS Questions

1. What is the average respiration rate of your class?

2. Is your respiration rate lower or higher than the class average?

3. Do you think using the thermal camera is an accurate way to measure respiration rate? Please explain.

4. Describe another respiration experiment you could do with the thermal camera.

Extensions

1. Repeat the experiment after jumping in place 15 times. Before starting, make a prediction about your respiration rate. Describe what you learned from doing the experiment.

2. Measure the respiration rate of a pet, such as a dog, cat, or rabbit.

3. Could you use this technique to measure the respiration rate of a lizard or snake? Investigate and explain why you think this would or would not work.

4. Can you measure the respiration rate of a person on the other side of a pane of glass? Investigate and explain why this does or does not work.