Name____Period_____Assignment #_____

__________Teacher initials for procedures__________Teacher initials for practice data collection

__________Teacher initials for experimental data collection

How do physiological changes affect minute volume?

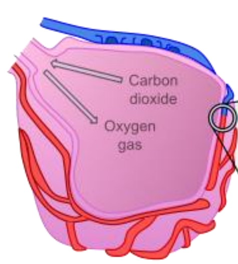
Review Lecture Question #'s 1 part 2, 6, 9, and 32

Annotate Text and answer questions 1-9

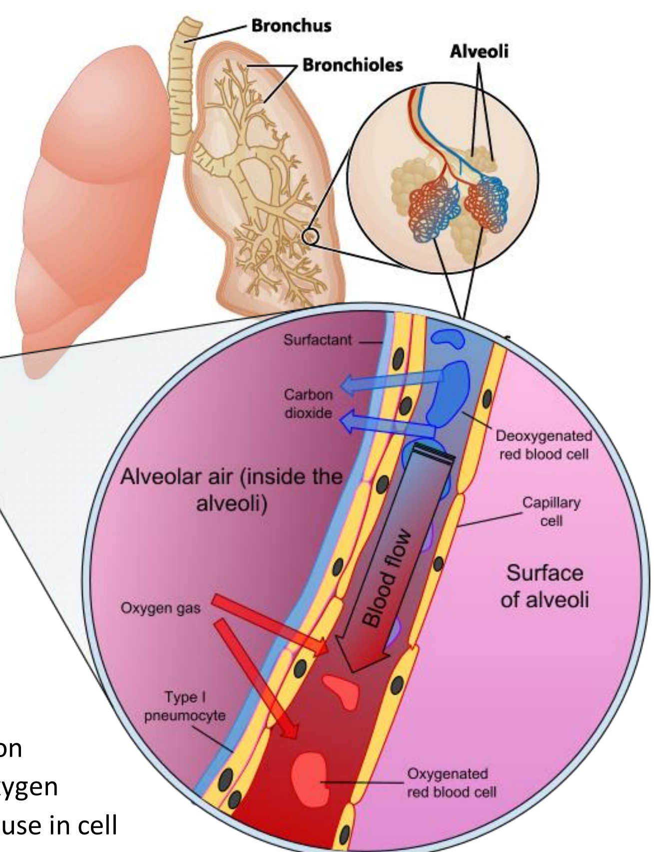
Annotating Text
☐ **UNDERLINE** concepts you think might be useful for understanding or solving the problem
☐ **Box** information you think might be helpful for designing your investigation
☐ ← Write **notes** in the left margin
☐ → Write **questions and answers** in the right margin
Each paragraph (including each step of the procedures) must have something underlined or boxed, **AND** have something written in the margins (a question and/or note).

Introduction:

Cellular respiration, or simply respiration, is the conversion of food into usable energy in the form of ATP. There are both aerobic and anaerobic pathways cells utilize for this. However, cells cannot meet their energy needs for long with anaerobic respiration alone. This is why most organisms require a constant supply of oxygen.



Cross section of an alveoli with capillaries



Ventilation maintains concentration gradients of oxygen and carbon dioxide between air in alveoli and blood flowing in adjacent capillaries. All organisms absorb one gas from the environment and release a different one. This process is called gas exchange. Leaves absorb carbon dioxide to use in photosynthesis and release the oxygen produced by this process. Lungs absorb oxygen for use in cell respiration and release the carbon dioxide produced by this process.

Terrestrial organisms exchange gases with the air. Aquatic organisms absorb dissolved oxygen gas from water. In humans, gas exchange occurs in small air sacs called alveoli inside the lungs

Gas exchange happens by diffusion between air in the alveoli and blood flowing in the adjacent capillaries. The gases only diffuse because there is a concentration gradient: the air in the alveolus has a higher concentration of oxygen and a lower concentration of carbon dioxide than the blood in the capillary. To maintain these concentration gradients "fresh" air must be pumped into the alveoli and "stale" air must be removed. This process is called ventilation. Fresh air has a high concentration of O_2 and a low concentration of CO_2 relative to the blood. Stale air has a smaller concentration gradient of O_2 and CO_2 resulting in a decrease in gas exchange.

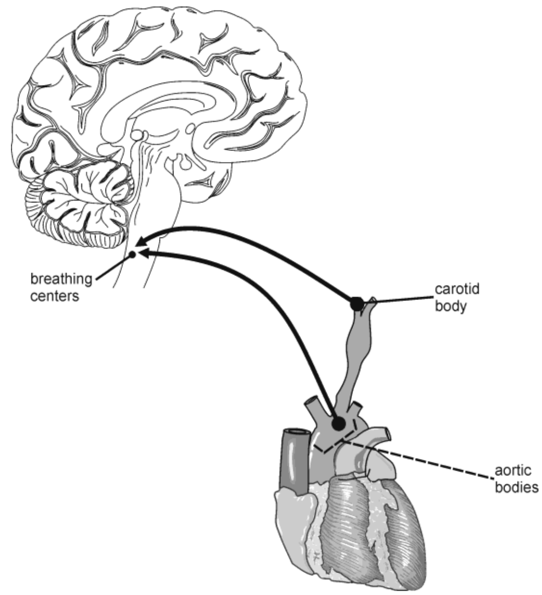


Figure 1

The respiratory cycle of inspiration and expiration is controlled by complex somatic and autonomic mechanisms. Autonomic (unconscious regulation) of respiration mainly involves the brain stem (pons and medulla), and cerebellum. Somatic (conscious regulation) mainly involves inputs from the somatosensory cortex and the cerebellum on the brain stem. Chemoreceptors involved with respiratory regulation detect changes in blood O_2, CO_2, and pH levels. Sensory input from peripheral stretch receptors in the lungs and chemoreceptors located in the carotid and aortic bodies is sent to the respiratory centers in the medulla and pons. This information is relayed to the cerebellum, and on to higher cortical areas.

At rest, the average adult male produces approximately 200 mL of CO_2 each minute, but this may increase to over 2000 mL with exercise or heavy work. Breathing rapidly (hyperventilation) lowers CO_2 levels due to an increased opportunity for gas exchange in the lungs. Holding one's breath (hypoventilation) or re-breathing air (such as breathing into a paper bag) raises CO_2 levels because there is less opportunity for gas exchange. Importantly, hyperventilation and hypoventilation refers to ventilation that is out of sync with cellular respiration (see equation below). Notice that for every 1 oxygen molecule consumed, exactly 1 carbon dioxide molecule is produced. As cellular respiration increases, the amount of oxygen consumed keeps pace with the amount of carbon dioxide produced. In other words, an increase or decrease in ventilation does not reflect hyperventilation or hypoventilation if the change in ventilation rate is in response to a change in cellular respiration.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 32ATP \text{ (formed from 32 ADP and 32 } P_i\text{)}$$

Enzymes and other proteins are very sensitive to pH changes. Maintaining blood pH homeostasis is essential because small changes in pH inhibit the function of proteins involved in vital physiological processes. The blood pH buffering system is described by the equation below. The four chemical species below exist in equilibrium. This means that increasing the concentration of one increases the others and vice versa proportionately. Carbon dioxide (CO_2) dissolves in blood forming carbonic acid and therefore lowers blood pH. The blood buffering system is enhanced by changing ventilation rate, which changes blood CO_2 concentration if the change in ventilation rate is independent of changes in cellular respiration.

$$HCO_3^- \leftrightarrow H^+ \leftrightarrow H_2CO_3 \leftrightarrow H_2O + CO_2$$

bicarbonate — Excess is removed by kidneys

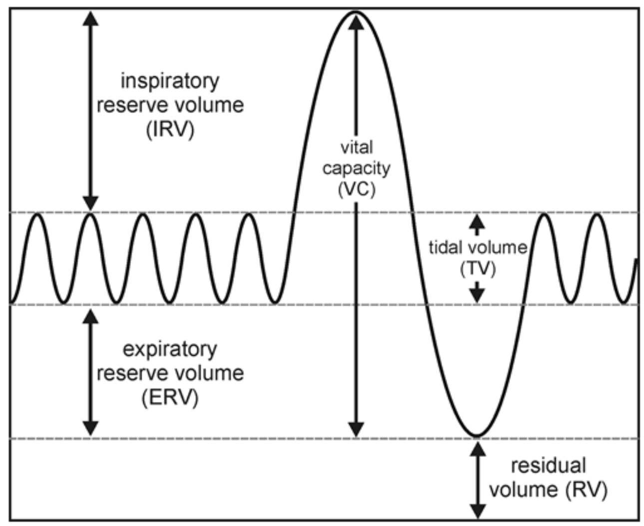
Hydrogen ion pH = [H⁺]

Carbonic acid

Water

Carbon dioxide — Excess is removed by lungs

Minute ventilation is the amount of air expired per minute. The chart to the right represents lung volumes. The tidal volume is the depth of inspiration and force of expiration due to autonomic stimulation. Inspiratory reserve volume and expiratory reserve volume are the additional volumes of air your lungs can move in or out respectively with either autonomic or somatic (voluntary) stimulation.



Important: Do not attempt this experiment if you are currently suffering from a respiratory ailment such as the cold or flu.

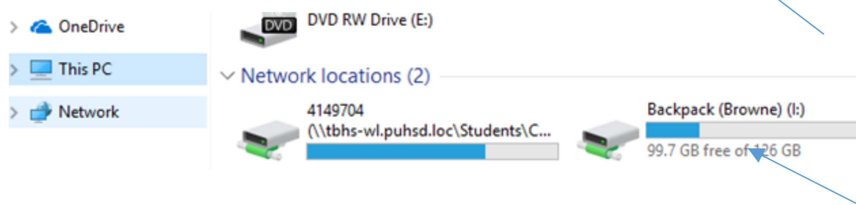
Procedures:

Below are procedures for collecting data to calculate minute ventilation to determine lung capacity

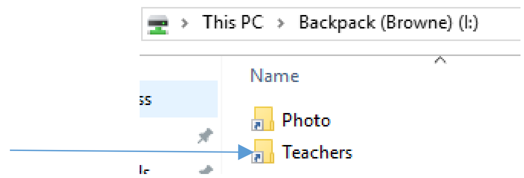
Data is easier to collect and analyze if LabQuest is connected to a computer and Logger Pro software is used

1. Open File Explorer

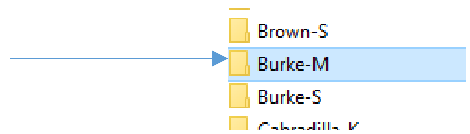
2. Open Backpack



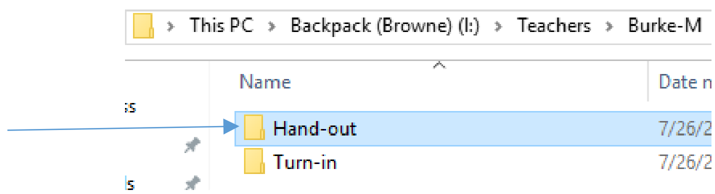
3. Open Teachers folder



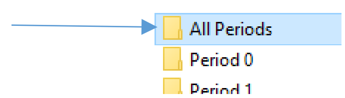
4. Open Burke-M folder



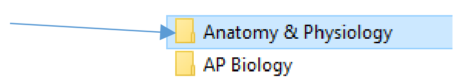
5. Open Hand-out folder



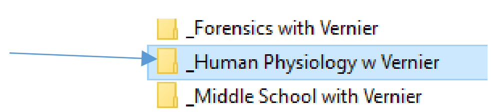
6. Open All Periods folder



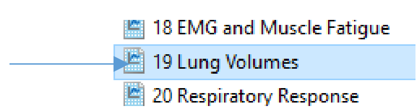
7. Open Anatomy & Physiology folder



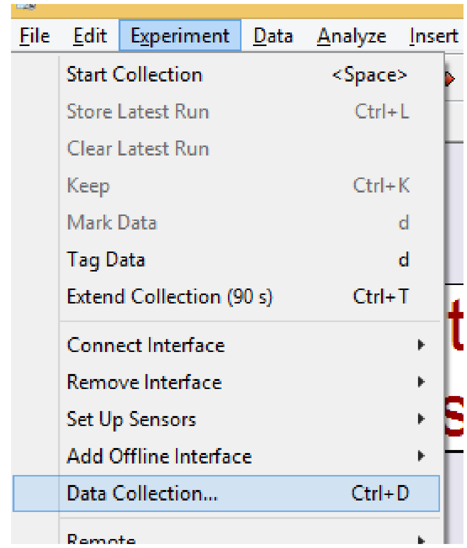
8. Open _Human Physiology w Vernier folder



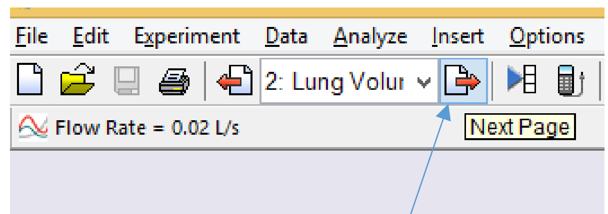
9. Open 19 Lung Volumes file



10. Use USB cable to connect LabQuest to computer
11. Connect the Spirometer to LabQuest
12. Click *Experiment* and then *Data Collection*. Change *Duration* to 120 seconds and confirm *Collection Rate* is set to 100 samples/second

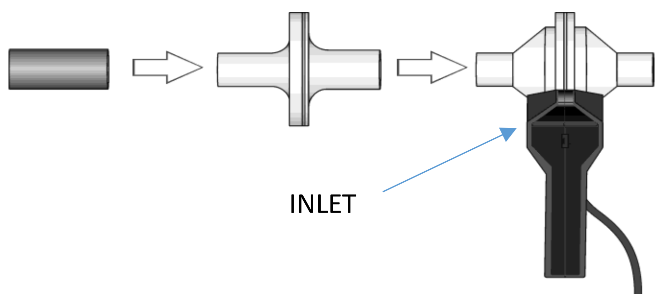


13. Click the *Next Page* symbol. You should be on the page shown to the right (2: Lung Volume)

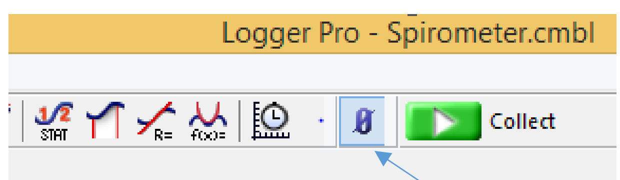


14. Label a bacterial filter and mouthpiece with your name. You will reuse these throughout the experiment. Store in the plastic bag provided.

15. Attach the larger diameter side of the disposable bacterial filter to the "Inlet" side of the Spirometer head. Attach a disposable Spirometer mouthpiece to the other end of the bacterial filter



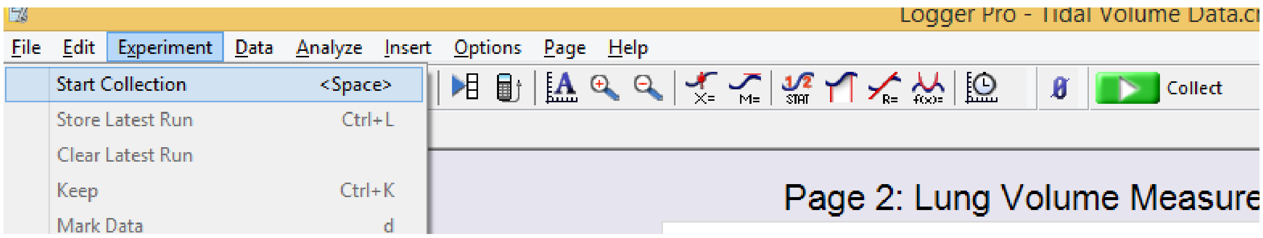
16. Hold the Spirometer in one or both hands. Brace your arm(s) against a solid surface, such as a table, and choose Zero from the Sensors menu.



Note: The spirometer must be held straight up and down (as shown above) during data collection. Do not move or tilt the spirometer while collecting data.

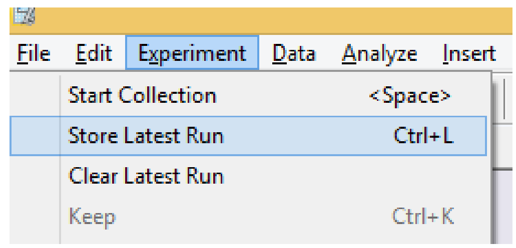
17. Sanitize nose clamp with isopropyl alcohol and cotton swab. Use nose clamp to ensure all volume change occurs through your mouth.

18. Taking normal breaths, begin data collection with an inhalation and continue to breathe in and out. Click *Experiment* and *then Start Collection* or the green *Collect* button

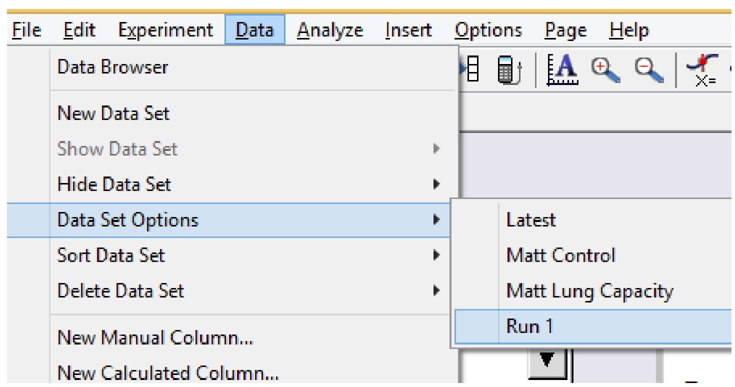


19. Collect data for 120 seconds

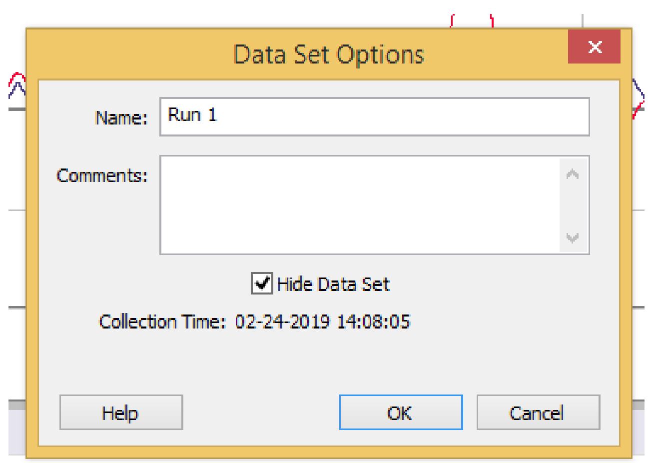
20. Click *Experiment* and then *Store Run Latest Run*



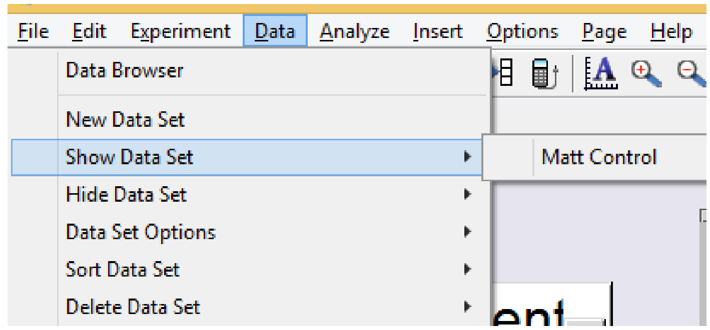
21. Click *Data*, then *Data Options*, then *Run 1*.



22. Name the Run as you see fit. If you click the *Hide Data Set* box as shown to the right, the next Run will be on a blank graph. If you don't, the next run will be super imposed on Run 1

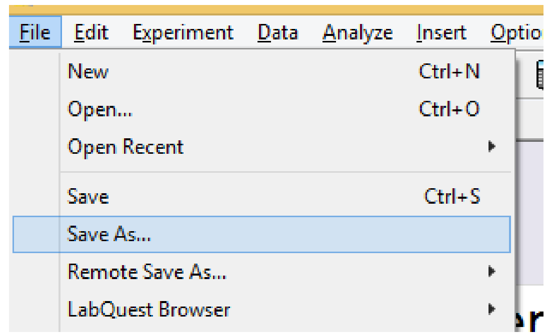


23. At any time, you can Show, Hide, or Delete any combination of Runs you have saved

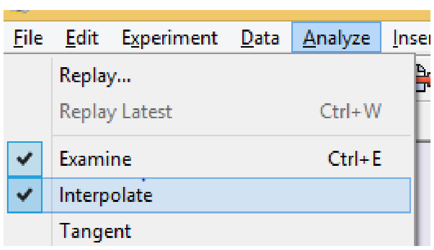


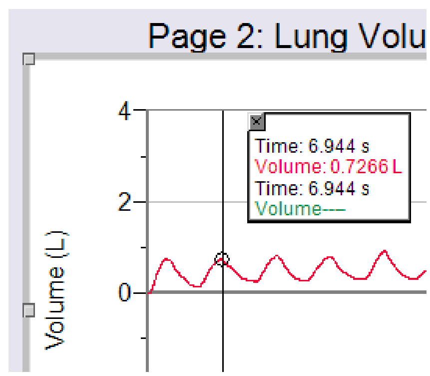
24. Click *File* and then *Save As…*
25. Save file in a place you can easily retrieve

    IMPORTANT*: This file cannot be opened and read unless you are using a computer with Logger Pro Software installed*



26. Click *Analyze* and then *Interpolate*. This will improve data analysis accuracy and efficiency.





27. Select a representative peak and valley in a portion of your graph.
28. Tap the peak and note the volume value.
29. Tap the bottom of the valley that follows it and note the volume value.
30. Calculate the Δy value and record it, to the nearest 0.1 L, as Tidal Volume below. **Use appropriate units and show work!**

31. Repeat the last 4 steps several times and calculate the average Tidal Volume. **Use appropriate units and show work!**

32. Select two adjacent peaks in your graph.
33. Tap the first peak and note the time value.
34. Tap the second peak and note the time value.
35. Use the two values to calculate Δx. Use the value to calculate the ventilation rate in breaths/minute. Record this value to the nearest 0.1 breaths/min below. **Use appropriate units and show work!**

36. Repeat the last 4 steps several times and calculate the average ventilation rate. **Use appropriate units and show work!**

37. Calculate and record the Minute Volume values. **Use appropriate units and show work!**

    (Average Tidal Volume)(Average Respiration Rate) = Average Minute Volume

38. Hide previous Run

    Remember to use the nose piece and keep the spirometer straight up and do not move it or tilt it during data collection

39. Taking normal breaths, begin data collection with an inhalation and continue to breathe normally for several breaths

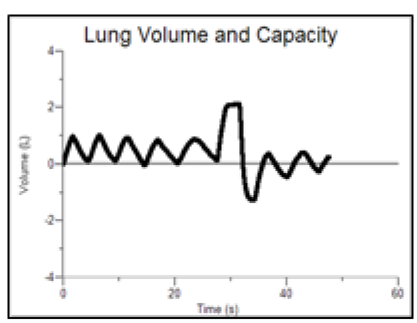
40. Fill your lungs as much a possible and exhale as fully as possible

    It is essential that you inhale and exhale with as much force as you are capable of. ***Use your inspiratory and expiratory skeletal muscles!***

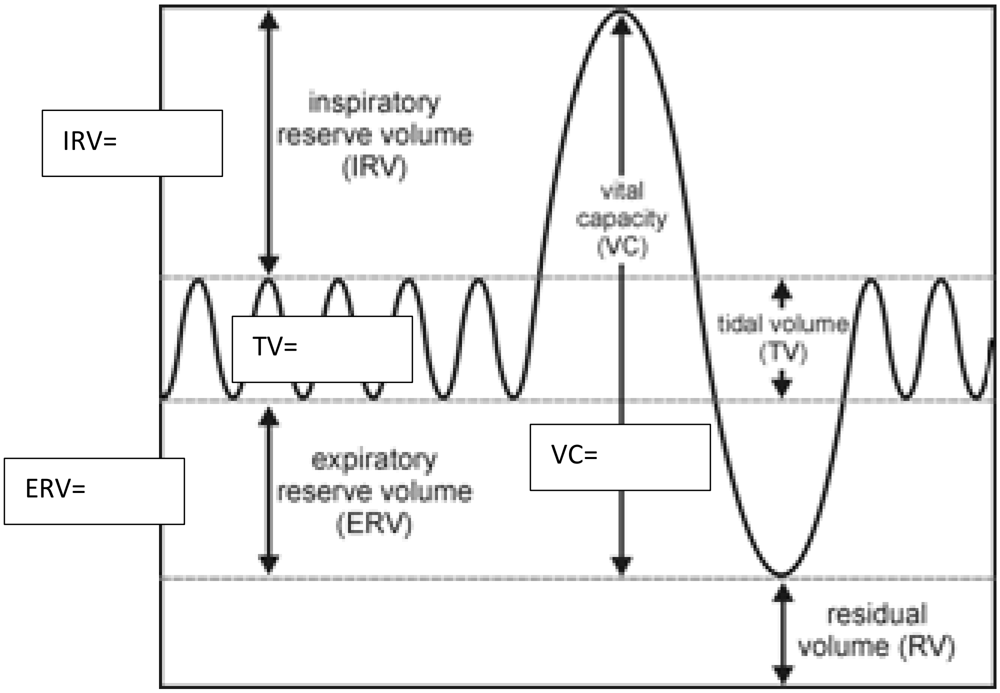
41. Return to normal breathing for several inhalations and exhalations

42. Click the Stop button

43. Save and name the Run appropriately



44. Calculate and record your lung volumes on the lung volumes chart below. **Use appropriate units and show work!**



45. Show the calculations above to your teacher

Your task:
Determine how physiological changes affect minute ventilation

To determine what type of data you will need to collect, answer the following questions:

1) What type of measurements will you need to record during your investigation?

To determine how you will collect your data, answer the following questions?

2) What will serve as your control condition?
3) What types of treatment conditions will you need to set up and how will you do it?
4) How many trails will you need to do?
5) How often will you collect data and when will you do it?

6) How will you keep track of the data you collect and how will you organize the data?

To determine how you will analyze your data, answer the following questions:

7) How will you determine if there is a difference between the treatment condition and the control condition?

8) What types of calculations will you need to make?

9) What type of chart will you make to help make sense of your data?

Connections to Crosscutting Concepts

As you work through your investigation, be sure to think about:

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system
- Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials
- Feedback (negative or positive) can stabilize or destabilize a system.

ADI Investigation Proposal TGB Version

Guiding Question:	
Claim:	
Alternative claims:	

Method:	What data will you collect? How will this data help you answer the guiding question?

Data and chart(s)

Guiding Question:

Our Claim:

Our Evidence:

Analysis: break it down (Illustrate and describe your data)

Interpretation: What does the analysis mean?

Our Justification of the Evidence:

Use your scientific knowledge and analysis to support your interpretation

Check out questions:

1) Are observations and inferences the same?

2) Explain your answer to the last question above using examples from your investigation

3) Explain how your investigation was a controlled experiment.

4) An important goal in science is to explain the underlying cause for observations. Explain why this is important using an example from your investigation.

5) Scientists often need to track how matter moves in, out, and through a system. Explain why this is important using an example from your investigation.

6) Structure is related to function in living things. Explain how the structures of the respiratory system and blood fit their function using specifics from the lab.

7) How might breathing into a paper bag help someone who is extremely anxious and hyperventilating?

8) Some patients with severe emphysema have constant high levels of CO_2 because of inadequate ventilation. The central nervous system breathing center in these patients becomes insensitive to CO_2 and more dependent on the level of O_2, which is low. These patients are said to have "oxygen-dependent respiratory drive." What might happen if you give such a person high levels of supplemental O_2?