Respiration Lab Instructions

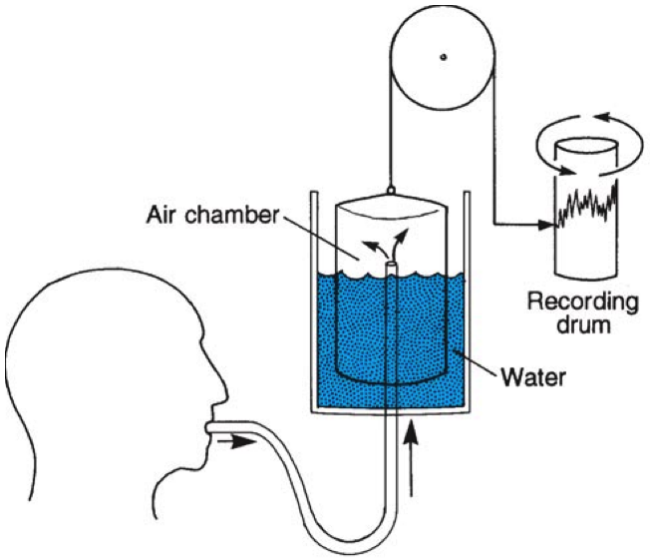
This laboratory investigation can be performed in any order. Be sure to read all instructions for each section before performing the experiment.

PART 1 – STUDENT WET SPIROMETER

The spirometer has long been the workhorse of the pulmonary scientist. It is a simple and currently very useful instrument which was devised over 100 years ago by John Hutchinson. He wanted an accurate method for measuring what he termed ''vital capacity" of human lungs, which is the largest amount of air that can be exhaled following maximal inspiration.

THE WET SPIROMETER

The conventional wet spirometer is a water filled reservoir penetrated by an airpipe positioned with its opening above the water level. A smaller canister, called a bell, is placed inside the reservoir, trapping a small volume of air above the pipe. The subject breathes into the spirometer through a flexible tube attached to the airpipe. When the subject exhales into the spirometer, the volume of exhausted gas enters the bell and raises it in the reservoir. Conversely, when the subject inhales air from a partly filled bell, the bell moves downward (WE WILL NOT BE DOING THIS!). The amount of bell movement corresponds to the volume of gas exchanged, which can be recorded on chart paper or measure on a calibrated scale attached to the spirometer.



WET SPIROMETER

The respiratory cycle can be divided into four distinct volumes or stages that are:

1. Residual volume (RV) or functional residual capacity is the volume of air that is always left in the lungs after exhaling to the fullest extent.

2. Tidal volume (TV) is the volume of air inhaled or exhaled during a normal breath.

3. Inspiratory reserve volume (IRV) is the maximum volume of air that can be inhaled during normal breathing (tidal volume).

4. Expiratory reserve volume (ERV) is the maximum volume of air that can be expelled in excess of the air exhaled in normal breathing (tidal volume)

Materials Needed

- Student Cardboard Mouthpiece
- Student wet spirometer apparatus
- Nose plug
- Alcohol wipe

Experiment 1 – Measuring Tidal Volume (TV)

Tidal Volume (TV): Amount of air either inhaled or exhaled during a single breath. This volume is usually around 400 or 500 mL in males at rest, but can be considerably greater in large or athletic individuals and is increased markedly during exercise.

1. Student should **SIT** by the spirometer, breathing quietly in and out of the mouth with the nose plug in place.
2. Student places mouthpiece of the spirometer between the lips (making a tight seal) and exhales in a normal, **unforced way**, into the spirometer.
3. The volume should be read and recorded from the scale by the partner.
   (NOTE: The spirometer measures in Liters, but your data needs to be measured in mL)
4. Remove the mouthpiece holder from the tube until the spirometer is reset to "0."
   DO NOT PRESS ON THE DRUM WITH THE MOUTHPIECE HOLDER STILL IN PLACE - YOU WILL BE CLEANING UP A LOT OF WATER!!!!
5. Repeat the experiment twice (for a total of three recordings), making sure that the pointer is reset to zero before each reading.

Experiment 2 – Measuring Expiratory Reserve Volume (ERV)

Expiratory Reserve Volume (ERV): Amount of air that can be forcefully expelled in excess of normal exhalation at rest. The Expiratory Reserve Volume is approximately 1,100 mL in young adult males.

1. Student should **STAND**, breathing normally in and out of the mouth for a minute or so with the **nose plug in place**.
2. After a normal exhalation, student puts the mouthpiece between the lips, and **forcibly exhales** all the additional air possible.
3. The volume should be read and recorded from the scale by the partner.
   (NOTE: The spirometer measures in Liters, but your data needs to be measured in mL)
4. Remove the mouthpiece holder from the tube until the spirometer is reset to "0."
5. Repeat the experiment twice (for a total of three recordings), making sure that the pointer is reset to zero before each reading.

Experiment 3 – Measuring Inspiratory Reserve Volume (IRV)

Inspiratory Reserve Volume (IRV): Amount of air inhaled in excess of normal restful inspiration. Among young adult males this volume is approximately 3,000 mL.

1. **STANDING**, the student breathes normally for a minute in and out of the mouth with the nose plug in place, then **breathes in as deeply as possible**. With the mouthpiece inserted, the student then **exhales normally**, without forcing the air out.
2. The volume should be read and recorded from the scale by the partner. **(NOTE: The spirometer measures in Liters, but your data needs to be measured in mL)**
3. The IRV reading is obtained by subtracting the student's TV from the reading recorded on the spirometer.
4. Remove the mouthpiece holder from the tube until the spirometer is reset to "0."
5. Repeat the experiment twice (for a total of three recordings), making sure that the pointer is reset to zero before each reading.

Experiment 4 – Measuring Vital Capacity (VC)

Vital Capacity (VC) which is the maximum amount of air that can be inhaled or exhaled and can be calculated using the following equation: VC = TV+ IRV + ERV
Normal VC is roughly 4,500 mL.

1. The student, **STANDING** with the nose plug in place, slowly and deeply breathes in and out for three complete breaths, then breathes in as deeply as possible, places the spirometer mouthpiece in position, and breathes out as **forcibly as possible**.
2. The volume should be read and recorded from the scale by the partner. **(NOTE: The spirometer measures in Liters, but your data needs to be measured in mL)**
3. Remove the mouthpiece holder from the tube until the spirometer is reset to "0."
4. Repeat the experiment twice (for a total of three recordings), making sure that the pointer is reset to zero before each reading.

CLEAN UP: Make sure the mouthpiece holder is removed from the tube, and the spirometer is reset to "0." Throw away the cardboard mouthpiece and wipe the nose plug with an alcohol wipe and discard trash.

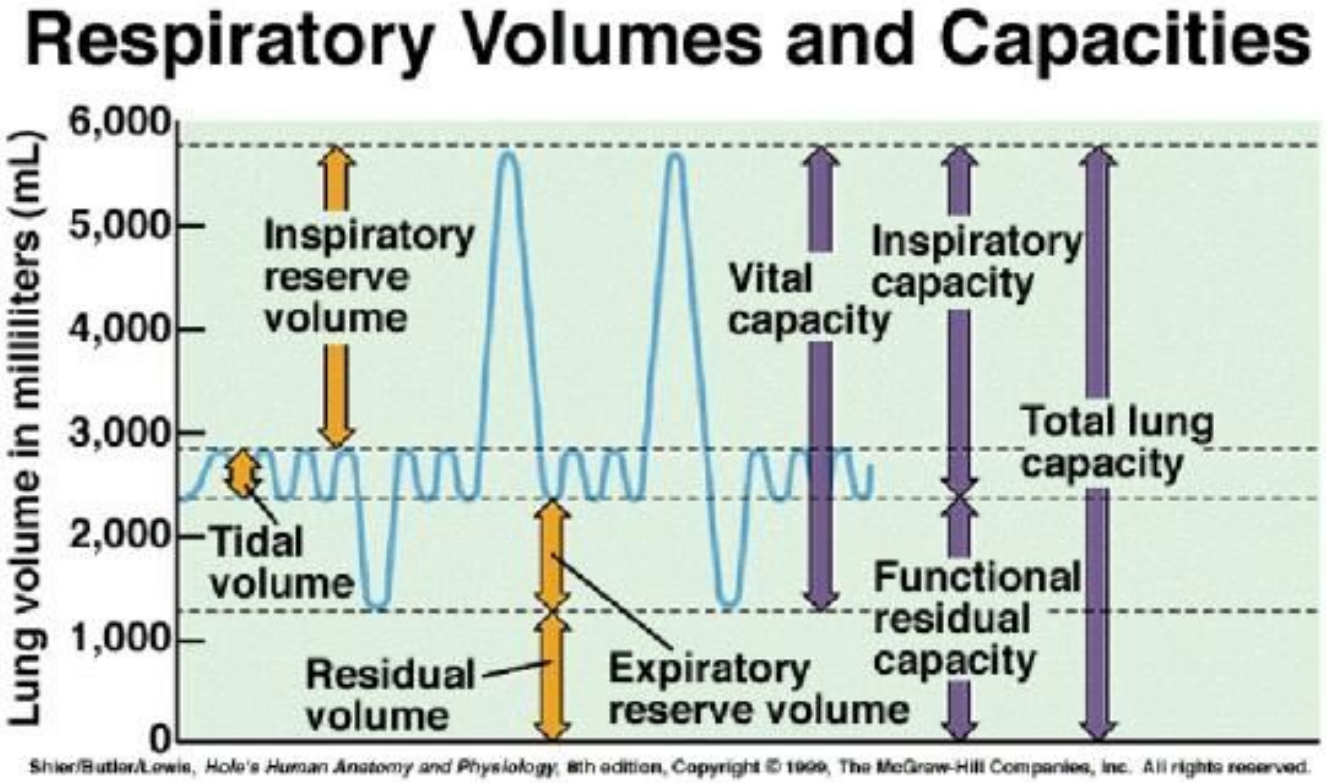
Use the following to complete Table 2 on your Student Sheet

Inspiratory Capacity (IC): The amount of air which can be inhaled after normal expiration (IC = IRV + TV). Normal IC is roughly 3000 mL.

Functional Residual Capacity (FRC) is the volume of air present in the lungs at the end of passive expiration. (ERV + RV). Normal is roughly 1800-2300 mL.

Residual Volume (RV): Amount of air remaining in the lungs after maximum forced expiration. This volume is normally about 1,200 mL in young adult males at rest. The residual volume exists because the normal healthy lung is never fully collapsed.

Total Lung Capacity (TLC): volume of air contained in the lungs at the end of a maximal inspiration (TV+ IRV + ERV + RV). For a normal male it is roughly 6000 mL.



PART 2 – LUNG MODEL

Materials Needed

- Lung Model

Procedure

1. Draw and label the model on your student sheet when it is at rest.
2. With your index finger and thumb, gently pull down the tab. Draw the model on your student sheet.
3. Gently push the tab into the cavity (towards the top of the bottle). Draw the model on your student sheet.
4. **Go to this website http://www.cliffsnotes.com/study-guides/anatomy-and-physiology/the-respiratory-system/mechanics-of-breathing to answer questions 1 - 3 on your student sheet.**

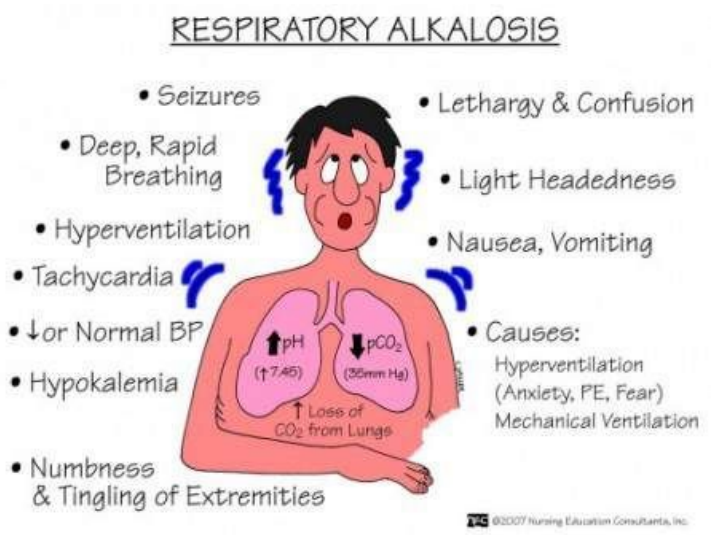
PART 3 –Changing the Amount of Gas Exchange During Breathing

Materials Needed

- Pulse Oximeter

Hyperventilation vs Hypoventilation

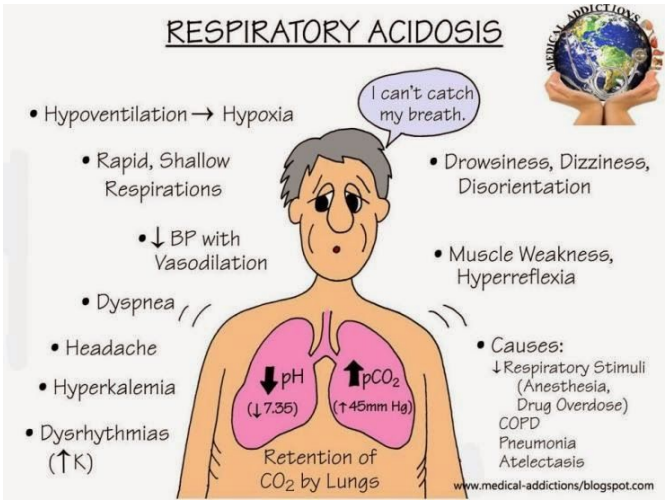
1. To complete the introduction table on your student sheet, you will click on the links below.
    a. Hyperventilation link:
    http://www.healthline.com/symptom/hyperventilation



    b. Hypoventilation link:

    http://emedicine.medscape.com/article/304381-overview

    http://emedicine.medscape.com/article/304381-treatment



Part A. Resting Breathing Rate – Table 1

1. Place the pulse oximeter on your index finger.
2. Have your partner watch the clock for 30 seconds while your count the number of times you inhale.
3. Immediately record your Oxygen Saturation levels from the pulse oximeter.
4. Repeat two more times.
5. Calculate the average number of breaths and oxygen saturation levels.
6. Multiply the average number of breaths by two to get the average resting breathing rate per minute.
7. Record your observations of how you feel.

Part B. Breathing Rate and Hyperventilation – Table 2

1. Place the pulse oximeter on your index finger.
2. Have your partner watch the clock for 15 seconds, while you count the number of times you breathe if you hyperventilate (breath fast and deep) for 15s while seated at your desk.
3. Immediately record your Oxygen Saturation levels from the pulse oximeter.
4. Repeat two more times.
5. Calculate the average number of breaths and oxygen saturation levels.
6. Multiply the average number of breaths by four to get the average breathing rate per minute while hyperventilation.

Part C. Breathing Rate and Hypoventilation – Table 3

1. Place the pulse oximeter on your index finger.
2. Have your partner watch the clock for 15 seconds, while you count the number of times you breathe if you hypoventilate (breath slow and shallow) for 15s while seated at your desk.
3. Immediately record your Oxygen Saturation levels from the pulse oximeter.
4. Repeat two more times.
5. Calculate the average number of breaths and oxygen saturation levels.
6. Multiply the average number of breaths by four to get the average breathing rate per minute while hypoventilating.