**A Breath of Air!**

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Lab: Measuring Lung Capacity**

Breathing is one of those critical bodily functions that, for most of us, we carry on daily with hardly a conscious thought! You know that your lungs deliver vital oxygen to the blood, and expire waste carbon dioxide out of the body. This exchange occurs in the alveoli and capillaries in the lungs.

You also know from experience that your lungs can respond to the body's changing needs for oxygen. The amount of air that you move in and out of your lungs depends on how quickly you are breathing.  When you are at rest, your breathing slows down and you do not have to breathe as deeply.

Human lung capacity can be measured in several ways. One can use a piece of laboratory equipment called a **spirometer,** pictured to the right. However, lung capacity also can be measured by using a balloon! The data you gather with the balloon may not be as accurate compared to the data gathered using a spirometer.

Several different **lung volume** measurements can be made:

1. The **largest possible amount of air** that can be **exhaled after drawing in a deep breath** is the **vital capacity**.
2. The amount of air that **remains** in the lungs after **exhaling normally**, but which can be expelled, is the **expiratory reserve**.
3. The amount of air breathed in or expelled during **normal breathing** is about 500 cm³. This volume of air is called the **tidal volume.** (A certain amount of air in the lungs cannot be expelled. This amount is the residual volume.)

***In this lab investigation, you will***

1. exhale into a balloon to measure your tidal volume, expiratory reserve, and vital capacity.
2. **convert** balloon measurements to **volume units** (cubic centimeter units (cm³) by reading and using a graph.
3. compare your **experimental data** with **lung capacity data** obtained from a **spirometer.**
4. explain why differences may exist between your experimental data and average lung capacity data.

**Materials:**

Round balloon

Metric ruler

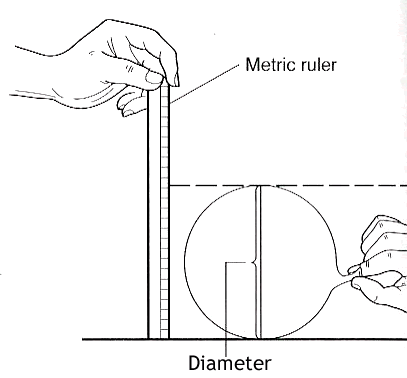
**Procedure:**

**Part A. Vital Capacity**

* Take as deep a breath as possible. Then exhale all the air you can into the balloon, and pinch the balloon closed to prevent air from escaping.
* Measure and record the diameter of the balloon in **column A of Table 1.** **Use Figure 1 as a guide for measuring balloon diameter.**
* Deflate the balloon and run **4 more trials**. Record the diameter of the balloon for each trial.

Adapted from *Investigating Living Systems,* Glencoe/McGraw Hill

**Figure 1**

****

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **TABLE 1. BALLOON DIAMETERS AND LUNG VOLUMES** | | | | | | |
|  | BALLOON DIAMETER IN CENTIMETERS | | LUNG VOLUME IN CUBIC CENTIMETERS | | |  |
|
|  | A | B | C | D | E | F |
|  | VITAL | EXPIRATORY | TIDAL | VITAL | EXPIRATORY | TIDAL |
| TRIAL | CAPACITY | RESERVE | VOLUME | CAPACITY | RESERVE | VOLUME |
| 1 |  |  |  |  |  |  |
|
| 2 |  |  |  |  |  |  |
|
| 3 |  |  |  |  |  |  |
|
| 4 |  |  |  |  |  |  |
|
| 5 |  |  |  |  |  |  |
|
|  |  |  | Total |  |  |  |
|  |  |  |
|  |  |  | Average |  |  |  |
|  |  |  |

**Part B. Expiratory Reserve**

***Read all of Part B before starting.***

* **Exhale normally.**
* **Without inhaling** as you normally would, put the balloon in your mouth, and exhale all the air still left in your lungs. **NOTE: this is different from what you did in Part A.**
* Measure and record the diameter of the balloon in **Column B of Table 1.**
* **Run 4 more trials**. Record the diameter of the balloon for each trial.

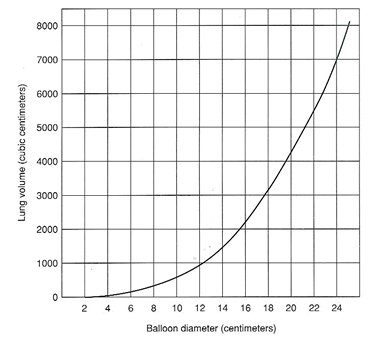
**Part C. Tidal Volume**

* Take in a **normal breath.** Exhale into the balloon **only as much air as you would normally exhale**. **DO NOT** **force your breathing**.
* Record the diameter of the balloon in centimeters in **Column C of Table 1.**
* **Run 4 more trials**. Measure and record each balloon diameter in **Table 1.**

**Part D. Conversion of Diameters to Volume**

Lung volume is expressed in cubic centimeter units (cm³). (1000 cm³) = 1 liter

* To convert from balloon diameter to volume, locate the balloon diameter on the **horizontal axis of Figure 2**. Follow this number up to the **heavy line**, then move across to locate the corresponding volume. For example, if your balloon diameter is 14.5 cm, then the corresponding lung volume is 1500cm
* Convert **each diameter** for **vital capacity, tidal volume, and expiratory reserve to volume.**
* **Record the volumes in Columns D, E, and F of Table 1.**
* Calculate and record your **average lung volume** for each of the 3 measurements.



**Analysis**

1. Define the following terms:
2. Vital capacity\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Expiratory reserve\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Tidal volume\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Using your **average volume** measurements in **Table 1**, record your measured
6. Vital capacity\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. Expiratory reserve\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Tidal volume\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. The following values were obtained through the use of a spirometer. Note that these are **average values.**

**TABLE 2. “AVERAGE” ADULT LUNG VOLUMES MEASURED WITH A SPIROMETER**

|  |  |  |
| --- | --- | --- |
|  | MALE | FEMALE |
| Vital capacity | 5000 cm³ | 4000 cm³ |
| Expiratory reserve | 1200 cm³ | 1000 cm³ |
| Tidal volume | 525 cm³ | 475 cm³ |

1. How does **your average vital capacity** compare to the value obtained by a spirometer?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Why might these numbers not agree?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What are some things that you can do to **improve the accuracy** of the data in this experiment without using a spirometer?

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**A close relationship between height and vital capacity exists.**

You will need to measure your height in cm first .

*(NOTE: Your height in inches x 2.54 will give you your height in centimeters.)*

* Record your height below under “A”. Complete the rest of the chart by using your height for Column A and one of the following factors for Column B:
* Record the **number 20** for females, 22 for female athletes, **25 for males**, 29 for male athletes in Column B. (NOTE: Your height in inches x 2.54 will give you your height in centimeters.)
* Now multiply the number in Column A with the number in Column B to get your **Calculated Vital Capacity**. Record this number in Column C and answer the questions that follow:

|  |  |  |
| --- | --- | --- |
| A  YOUR HEIGHT IN  CENTIMETERS | B  FACTOR | C  CALCULATED VITAL  CAPACITY ( A x B) |
|  |  |  |

4. Calculated vs. Experimental Values

1. Are your calculated and experimental values the same?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Explain.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. Now you will calculate your Breathing Rate and determine how much air you inhale in 1 minute!

a) What is your breathing rate for 1 minute? (Measure the number of times you breathe in and out in 1 minute) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_breaths per minute

b) How much air (in cm³) do you inhale in 1 minute? (HINT: Use your **average tidal**

**volume** from Table1.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_