Investigation: Determining Lung volume

Healthy lungs can take in more oxygen and expel wastes from the body with much greater efficiency than unhealthy lungs can. In this activity, you will examine indicators of general health by measuring lung capacity at rest.

Materials:
Respirometer with disposable mouthpieces.

Procedures:

1. Set gauge to zero before you place a new, unused mouthpiece in the Respirometer.
2. Be careful no to inhale at any time through the mouthpiece. Develop a regular relaxed breathing pattern so you will obtain accurate results. After inhaling normally, place the mouthpiece attached to the Respirometer in your mouth and exhale normally. Read the gauge on the Respirometer. Record the volume exhaled as tidal volume.
3. Reset the Respirometer to zero. Inhale normally, then place the mouthpiece attached to the Respirometer in your mouth and exhale normally. Read the gauge on the Respirometer and then exhale forcibly. Record the difference as expiratory reserve volume.
4. Reset the Respirometer to zero. Inhale as much air as possible and then exhale for as long as you can into the Respirometer. Read the gauge on the Respirometer. Record the value as vital capacity.
5. Repeat steps 1 to 4 for two more trials, without changing the mouthpiece.

Definitions:

Tidal Volume: the amount of air inhaled and exhaled in normal breath.

Expiratory Reserve Volume: the amount of air that can be forcibly exhaled after a normal exhalation.

Vital Capacity: the maximum amount of air that can be exhaled.
Analysis:

a) Determine your respiratory reserve volume by using the following formula:

\[
\text{vital capacity} = \text{inspiratory reserve volume} + \text{expiratory reserve volume} + \text{tidal volume}
\]

Synthesis:

b) Predict how the tidal volume and vital capacity of a marathon runner might differ from that of the average Canadian.

c) How might bronchitis affect your expiratory reserve volume? Provide your reasons.

d) Predict how the respiratory volumes collected from a person with emphysema would differ from those you collected.

Application:

1. The following readings were taken for patients A and B on a Respirometer (Table 1). Use the equation for vital capacity to determine the unknown value in each case.

<table>
<thead>
<tr>
<th></th>
<th>Patient A</th>
<th>Patient B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vital Capacity (L)</strong></td>
<td>?</td>
<td>5.1</td>
</tr>
<tr>
<td><strong>Inspiratory Reserve Volume (L)</strong></td>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>Expiratory Reserve Volume (L)</strong></td>
<td>1.2</td>
<td>?</td>
</tr>
<tr>
<td><strong>Tidal Volume (L)</strong></td>
<td>0.6</td>
<td>0.8</td>
</tr>
</tbody>
</table>

2. The amount of air that remains in the lungs after a forced exhalation is called the residual volume. Why is it difficult to measure the residual volume experimentally?

3. Under conditions of heavy exercise, tidal volume is different than at rest. Would it be closer to one’s expiratory reserve volume, inspiratory reserve volume, or vital capacity?

4. Why might respiratory volumes be measured during exercise? Provide a list of what could be investigated or diagnosed.