VERNIER RESPIRATORY LABS

Lung Volumes and Capacities

DATA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 1 | | | | |
| Volume measurement  (L) | | Individual (L) | Class average (Male)  (L) | Class average (Female)  (L) |
| Tidal Volume (TV) | |  |  |  |
| Inspiratory Reserve (IRV) | |  |  |  |
| Expiratory Reserve (ERV) | |  |  |  |
| Vital Capacity (VC) | |  |  |  |
| Residual Volume (RV) | | ≈1.5 | ≈1.5 | ≈1.5 |
| Total Lung Capacity (TLC) | |  |  |  |

Data Analysis

1. What was your Tidal Volume (TV)? What would you expect your TV to be if you inhaled a foreign object which completely obstructed your right mainstem bronchus?

2. Describe the difference between lung volumes for males and females. What might account for this?

3. Calculate your Minute Volume at rest.

(TV × breaths/minute) = Minute Volume at rest

If you are taking shallow breaths (TV = 0.20 L) to avoid severe pain from rib fractures, what respiratory rate will be required to achieve the same minute volume?

4. Exposure to occupational hazards such as coal dust, silica dust, and asbestos may lead to *fibrosis*, or scarring of lung tissue. With this condition, the lungs become stiff and have more “recoil.” What would happen to TLC and VC under these conditions?

5. In severe emphysema there is destruction of lung tissue and reduced recoil. What would you expect to happen to TLC and VC?

6. What would you expect to happen to your Expiratory Reserve Volume when you are treading water in a lake?

Warming Function of Nasal Passageways

**DATA**

|  |  |  |  |
| --- | --- | --- | --- |
| Table 1 | | | |
|  | Run 1  (nose inhalation) | Run 2  (mouth inhalation) | ∆*t*Run 1 – ∆*t*Run 2 |
| Maximum temperature (°C) |  |  |  |
| Minimum temperature (°C) |  |  |  |
| ∆*t* (°C) |  |  |  |

**Data Analysis**

1. Reviewing your data, what conclusions can you reach regarding where inhaled air receives most of its heat?

2. What proportion of the difference in temperature between inhaled and exhaled air can be attributed to the nasal passageways when nose breathing? Assume that the warming contribution of the mouth is negligible. (For the denominator, use the ∆*t* value for Run 1 in Table 1).

3. The average surface area of the nasal passageways is 160 cm2 and the average surface area of the alveoli in the lungs is approximately 100 m2 (1 × 106 cm2). Use the data you collected to calculate the amount of heat contribution per unit area of

(a) nasal epithelium surface area to which the air is exposed.

(b) alveolar surface area to which the air is exposed.

In both cases, ignore confounding variables such as the volume of air that stays in the bronchi (also called *dead space*) and the volume of air that does not leave the lungs, also called *functional residual capacity.*

4. Describe a situation in which it would be beneficial to breathe through the mouth.

O2 Extraction by the Lungs

**DATA**

|  |  |  |  |
| --- | --- | --- | --- |
| Table 1 | | | |
| Breath | Mean O2 concentration (%) | ∆O2 concentration (%) | Percent of existing O2 removed with each breath (%) |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |

**Data Analysis**

1. Extrapolating from the graph, how many more breaths would it take to use up all of the oxygen in the bag?

2. Use the data from column 4 in Table 1 to decide whether there was any significant change in the efficiency of oxygen extraction by the lungs with successive breaths. Use your knowledge of oxygen binding to hemoglobin to explain your findings. Does this support the idea that lack of oxygen is what leads to the discomfort you may have experienced at the end of the experiment?

3. While the O2 concentration in the bag declines with each breath, the volume of air breathed in remains the same. What is replacing the volume of oxygen that is being lost with each breath?

4. Air is humidified by the lungs such that the partial pressure of water (in the form of gas molecules) in the alveoli is 6.266 kPa (47 mm Hg). Use this information to explain why the windows in your car may fog up after you have been driving for 30 minutes.

5. Assume that the volume of air breathed in and out with normal breathing is 500 mL, or ¼ the volume breathed in and out during this experiment (1 gallon ≈ 4 L). Also assume that the efficiency of oxygen extraction is the same for these smaller breaths. How long would it take without supplemental oxygen tanks to use up all of the oxygen in a Gemini space capsule   
(2-man space capsule used between 1964−1966 with 2.26 m3 of habitable space)?

6. Barometric or atmospheric pressure refers to the sum total of the pressure of all gases present. At sea level it is approximately 101.3 kPa (760 mm Hg). What is the oxygen pressure in the bag at the start of the experiment? What is it at the end of the experiment? (Perform these calculations using the current barometric pressure at your location, if available.)

7. Assume the barometric pressure at the top of Mt. Everest (8,850 m) is 32.7 kPa (245 mm Hg). What is the oxygen pressure there? What percent of oxygen would need to be breathed at the top of Mt. Everest, or in a commercial airliner flying at that altitude, to equal the pressure of oxygen breathed at sea level?