ScienceCube

Respiratory Rate and Lung Function Test

1. **Explain how respiratory rates change under different conditions.**
2. **Measure lung capacity and explain the information obtained from lung function test reports.**

Fundamental Concept

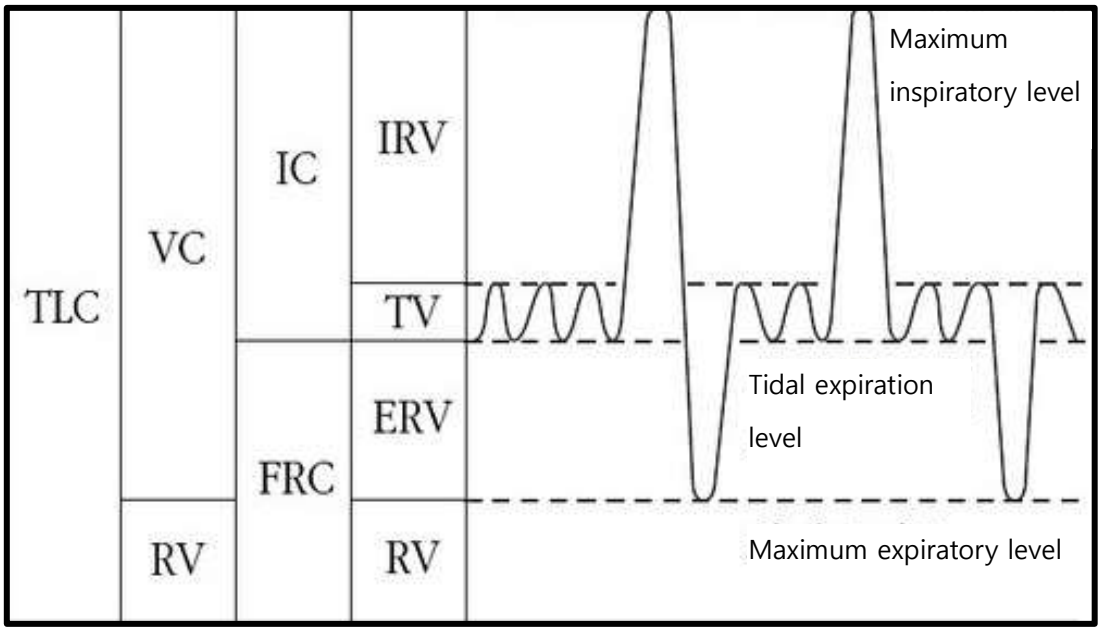
1. Respiratory Rate

The number of breaths (inhalation and exhalation combined) per minute, varying by age and affected by posture, body temperature, external temperature, exercise, and mental stress, and can also be altered consciously. It is controlled by the respiratory center in the medulla.

Age	Newborn	2 years	10 years	Adult
Respiratory Rate	40-50 breaths/min	30 breaths/min	25 breaths/min	12-20 breaths/min

2. Lung Volume Measurement

This is a test to measure the volume of the lungs. Lung volume is categorized into 4 lung volumes and 4 lung capacities. Commonly, lung volume measurement refers to tests measuring the total lung volume, including the residual volume. The most widely used method is body plethysmography.



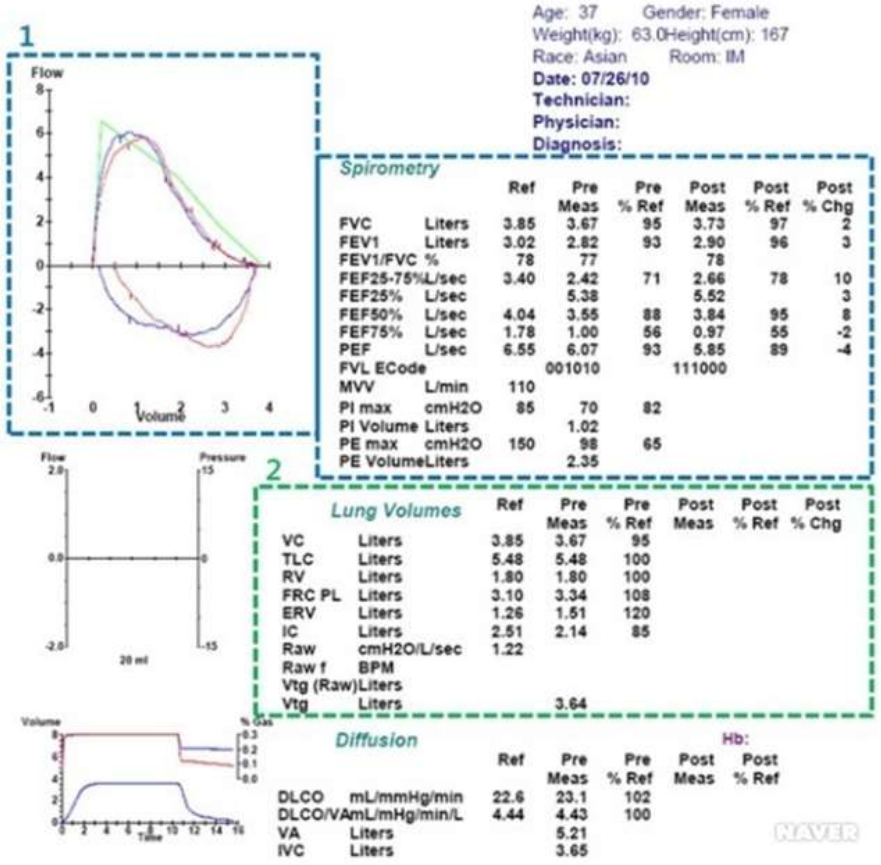
1) 4 Lung Volumes

- Residual Volume (RV): Volume of air remaining in the lungs after maximum exhalation.
- Tidal Volume (TV): Volume of air inhaled or exhaled during a normal breath.
- Expiratory Reserve Volume (ERV): Additional volume of air that can be exhaled after normal exhalation.
- Inspiratory Reserve Volume (IRV): Additional volume of air that can be inhaled after normal inhalation.

2) 4 Lung Capacities: Volumes Composed of Lung Volumes

- Total Lung Capacity (TLC): The sum of the four lung volumes.
- Vital Capacity (VC): The volume of air exhaled after a maximal inhalation, or the volume of air inhaled after a maximal exhalation. It is calculated as total lung capacity minus residual volume, or as the sum of expiratory reserve volume, tidal volume, and inspiratory reserve volume.
- Functional Residual Capacity (FRC): The volume of air remaining in the lungs after a normal exhalation, calculated as the sum of residual volume and expiratory reserve volume.
- Inspiratory Capacity (IC): The maximum volume of air that can be inhaled after a normal exhalation, calculated as the sum of tidal volume and inspiratory reserve volume.

3. Lung Function Test Report



Example of pulmonary function test (normal case)

The graph and table labeled 1 on the test report show the results of the spirometry test. The left graph shows the flow-volume curve, and the numbers on the right show the predicted values (Ref), measured values (Meas), and the percentage of the predicted value (%Ref) for each lung function parameter. Post-bronchodilator measurements are distinguished from pre-bronchodilator measurements by the term "Post."

In obstructive ventilatory defects, the FEV1/FVC% ratio decreases significantly. Patients with asthma or chronic obstructive pulmonary disease show reduced airflow early in exhalation, reducing the volume of air exhaled in the first second. Severe obstructive defects can increase residual volume and total lung capacity.

Restrictive ventilatory defects reduce vital capacity, total lung capacity, and functional residual capacity..

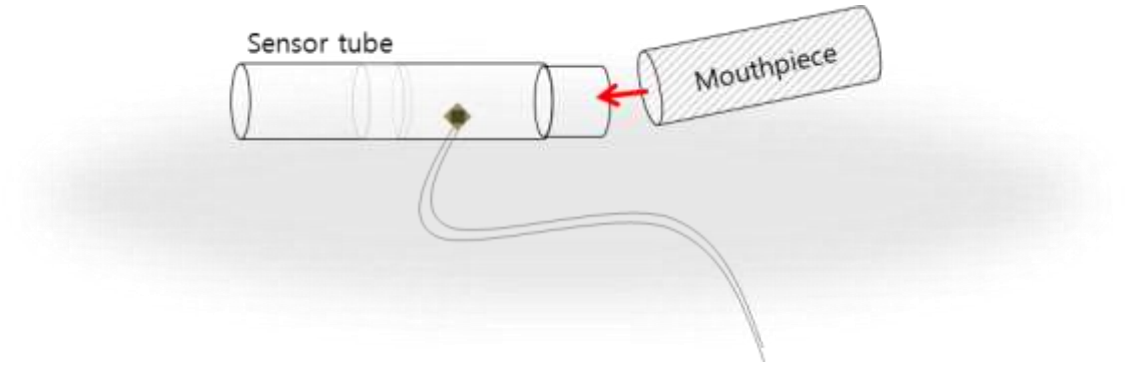
Experiment

Materials Needed

Interface, Science# program, Spirometer sensor (including sensor tube and mouthpiece)

Experimental Setup

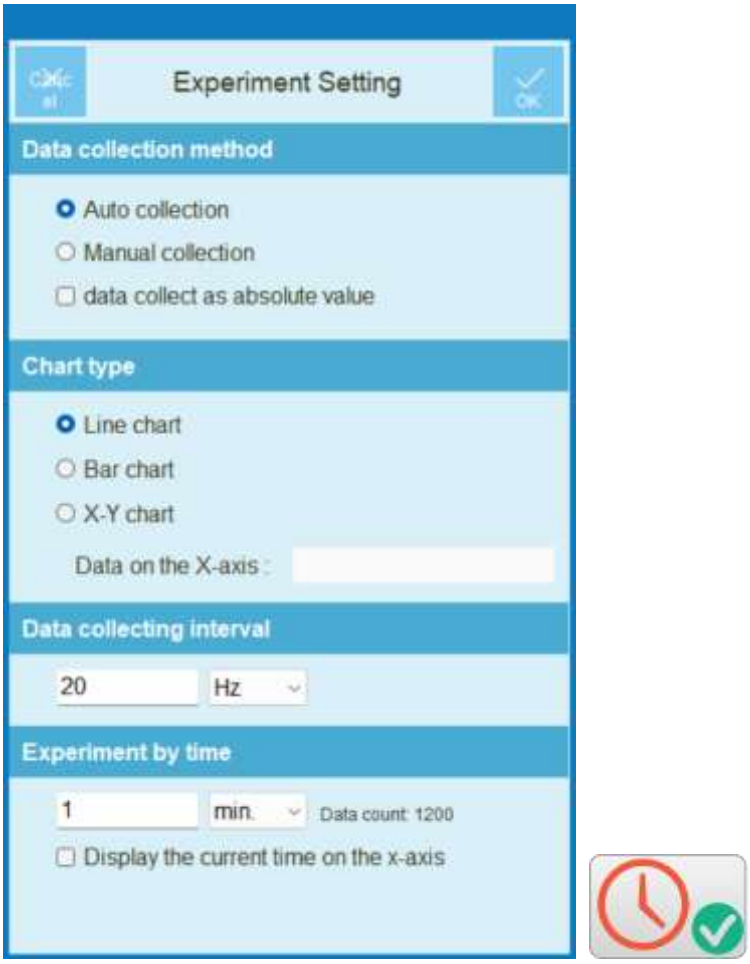
1. Attach the mouthpiece to the spirometer sensor tube.



2. Connect the spirometer sensor to the sensor tube as shown below.

Interface Setup

1. Run Science#.
2. Connect the spirometer to the interface.
3. Click "Settings" and configure the experiment environment as shown or click "Auto Setup."



Data Collection

[Measuring Respiratory Rate]

1. Click "Start" to begin data collection.
2. Insert the mouthpiece into your mouth and breathe normally for 1 minute.
3. Perform 20 jumping jacks, click "Stop," then breathe normally for 1 minute.
4. Measure and record the respiratory rate for different ages, genders, and postures.

[Measuring Lung Volumes]

5. Click the button, then insert the mouthpiece into your mouth and breathe normally for about 3 seconds. After that, inhale as deeply as possible and then exhale as much as possible.
6. Click the button again to stop data collection..

[Lung Function Test]

1.  Click the button,  then insert the mouthpiece into your mouth and inhale as deeply as possible and then exhale completely.
2.  Click the button again to stop data collection..

Data Analysis

Recording Data

[Breathing Rate Measurement]

1. Draw a graph of the breathing rate for 1 minute in a relaxed state.

2. Draw a graph of the breathing rate for 1 minute after exercise.

[Measurement of Lung Volumes]

3. Draw a graph showing the lung volumes, including the amount of air exhaled normally and the maximum amount of air that can be exhaled after a normal exhalation, as well as

the total lung capacity.

4. Using the spirometer, measure the air flow rate while taking a deep breath and exhaling. Integrate this data to create a volume graph and a flow-volume graph.

- Air flow rate (The basic data measured by the spirometer represents the air flow rate in L/s.)

- Air volume graph (Integrating the air flow rate (L/s) graph results in the air volume graph.)

- Volume (X) - Flow rate (Y) graph (Using the two graphs above, plot a graph with air volume on the x-axis and air flow rate on the y-axis.).

Applying Data

1. Record and explain how the breathing rate changes before and after exercise..

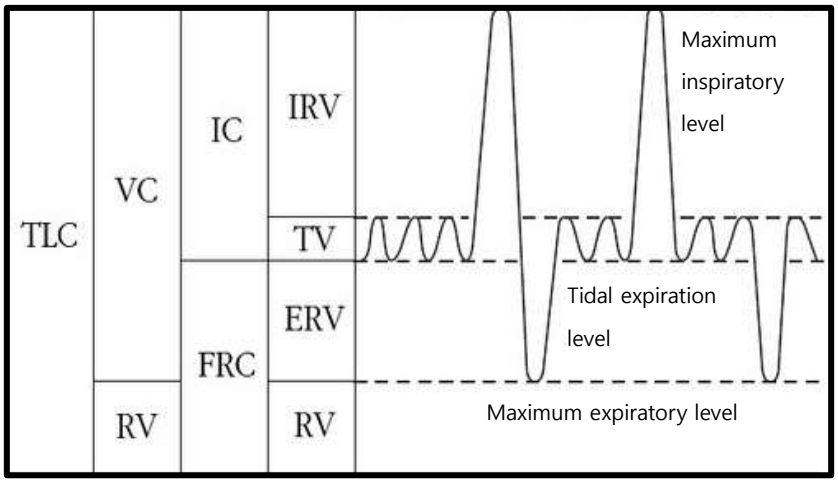
State	Before Exercise	After Exercise
Respiratory Rate		

2. Measure and explain the respiratory rate for different ages, genders, and postures..

Age				
Respiratory Rate				

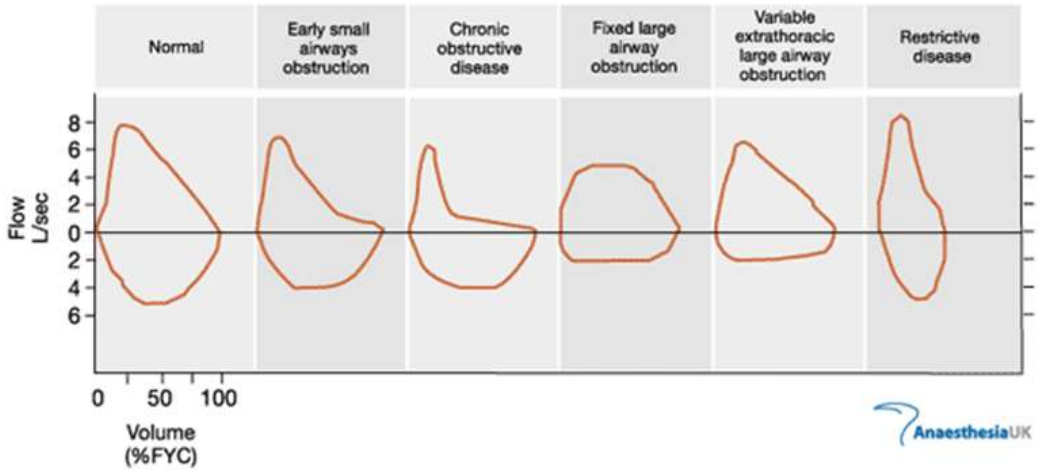
3. Use the lung capacity graph obtained by integrating the measured data to complete the following table.

   (Note: The normal values for lung capacity measurements can vary based on age, gender, and height.)



Term	VC	IC	IRV	TV	ERV
Value(L)					

4. The following figure is an example of analyzing the volume-flow graph from a lung function test. Review and explain your own lung function test graph.


Normal
Early small airways obstruction
Chronic obstructive disease
Fixed large airway obstruction
Variable extrathoracic large airway obstruction
Restrictive disease
Flow L/sec
8
6
4
2
0
2
4
6
0
50
100
Volume (%FYC)
AnaesthesiaUK


Report
(For Teachers)
Report
(For Students)