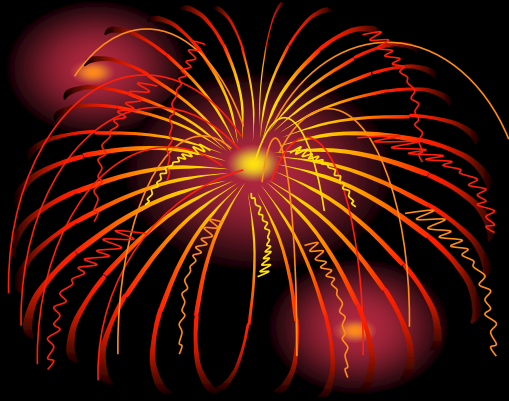
Student Spirometry



OBJECTIVES:

To be able to:

a. use a spirometer and determine lung volumes and capacities,
b. define and provide normal values for the various lung volumes and capacities and
c. recognize the physiological and some pathological factors that modify lung volumes and capacities.

What is *spirometry*?

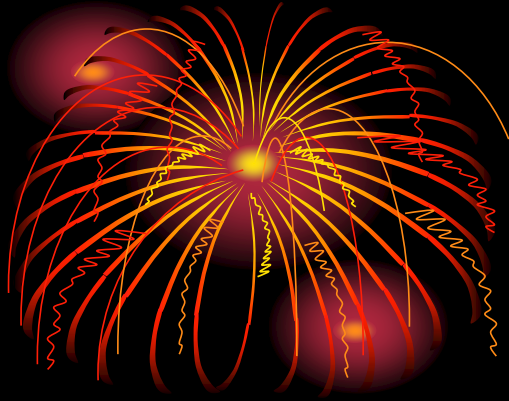
- means the measuring of breath.

- It is the most common of the Pulmonary Function Tests (PFTs), measuring lung function, specifically the measurement of the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled.

- It is helpful in assessing conditions such as asthma and COPD.

APPARATUS: Spirometer

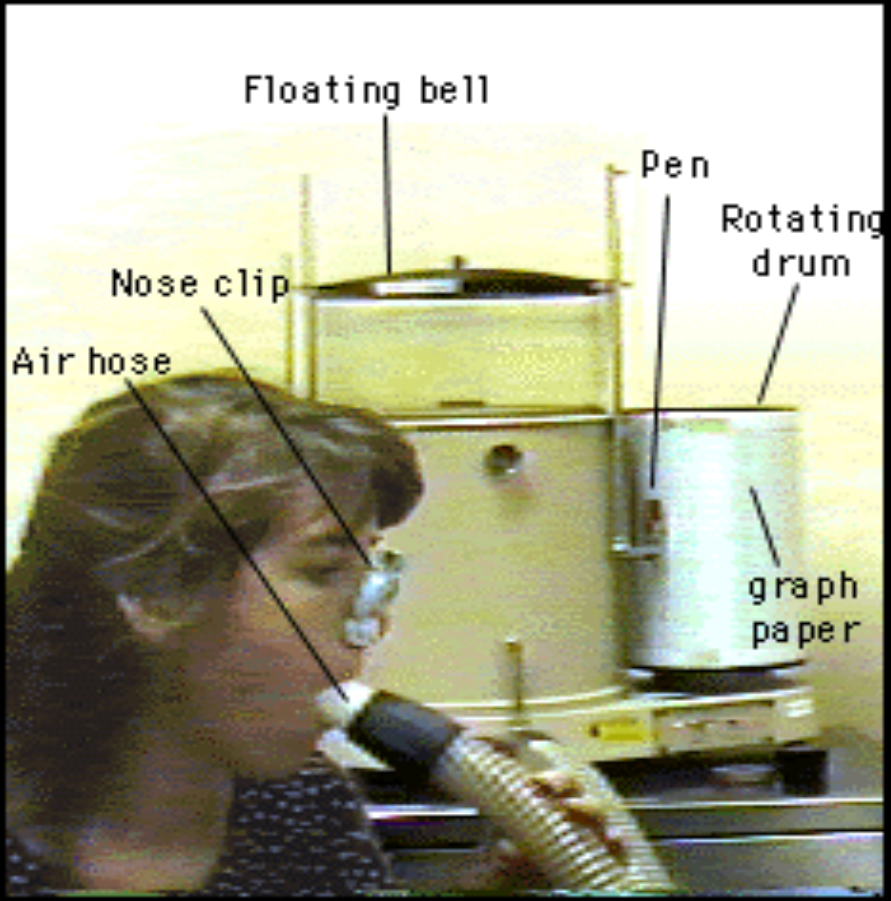
Cont... spirometer

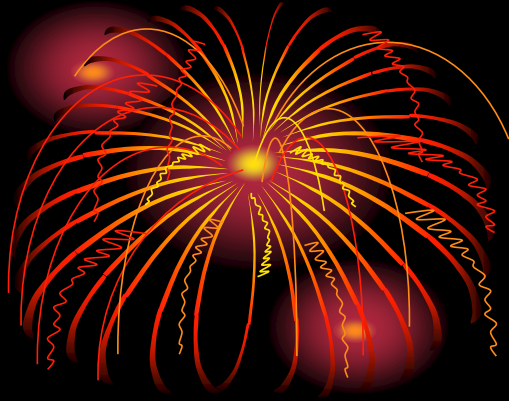


METHOD:

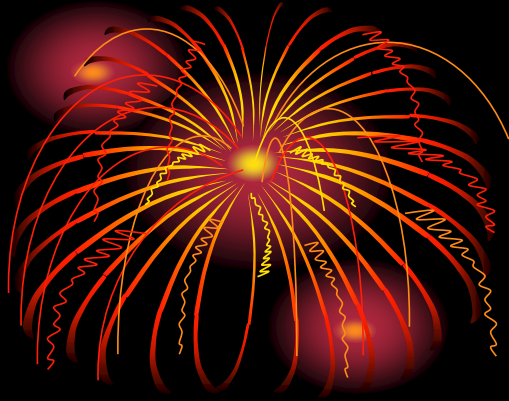
Insert a sterilized mouthpiece in such a way that the edges of it are between the subject's lips and gums.

1. Close the nose with the nose clip. Ask the subject to take normal breaths through the mouthpiece for a short time, then take a deep forceful inspiration to fill the lungs completely, then breath normally for a short time.


Floating bell
Pen
Rotating drum
Nose clip
Air hose
graph paper

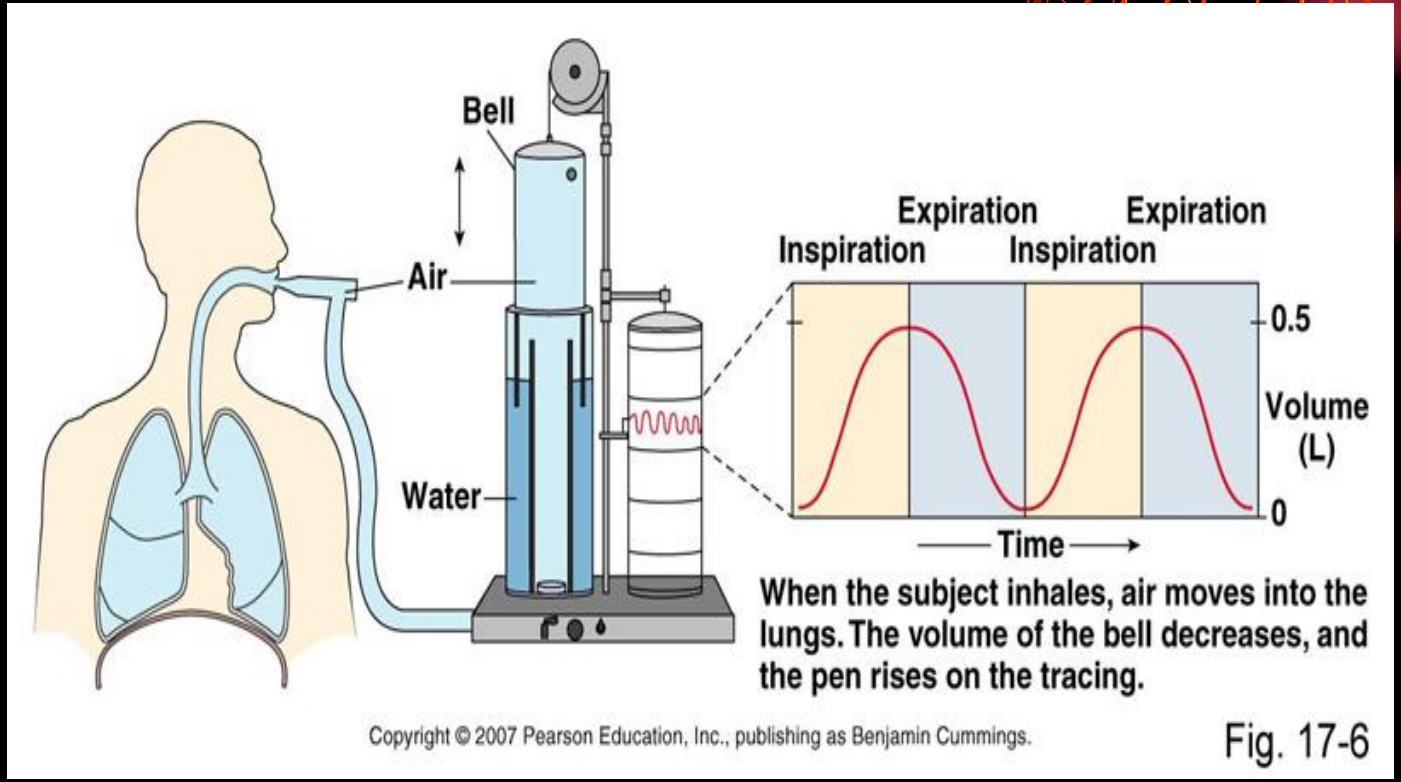


2. Ask the subject to expire quickly, forcibly and as completely as possible, then ask the subject to breath normally for a short time.



3. **Ask the subject to take a deep forceful inspiration and immediately to expire quickly, forcibly and as completely as possible, then ask the subject to breath normally for a short time.**

The spirogram is recorded on a moving drum.



When the subject inhales, air moves into the lungs. The volume of the bell decreases, and the pen rises on the tracing.

Fig. 17-6

LUNG VOLUMES AND CAPACITIES:

1. **TIDAL VOLUME (TV)**
   - volume of air inspired or expired with each normal breath.
   - N = 500 ml (male and female)

2. **INSPIRATORY RESERVE VOLUME (IRV)**
   - the extra volume of air that can be inspired by a maximal inspiratory effort after normal inspiration.
   - N = 3.3 L (male)
     1.9 L (female)

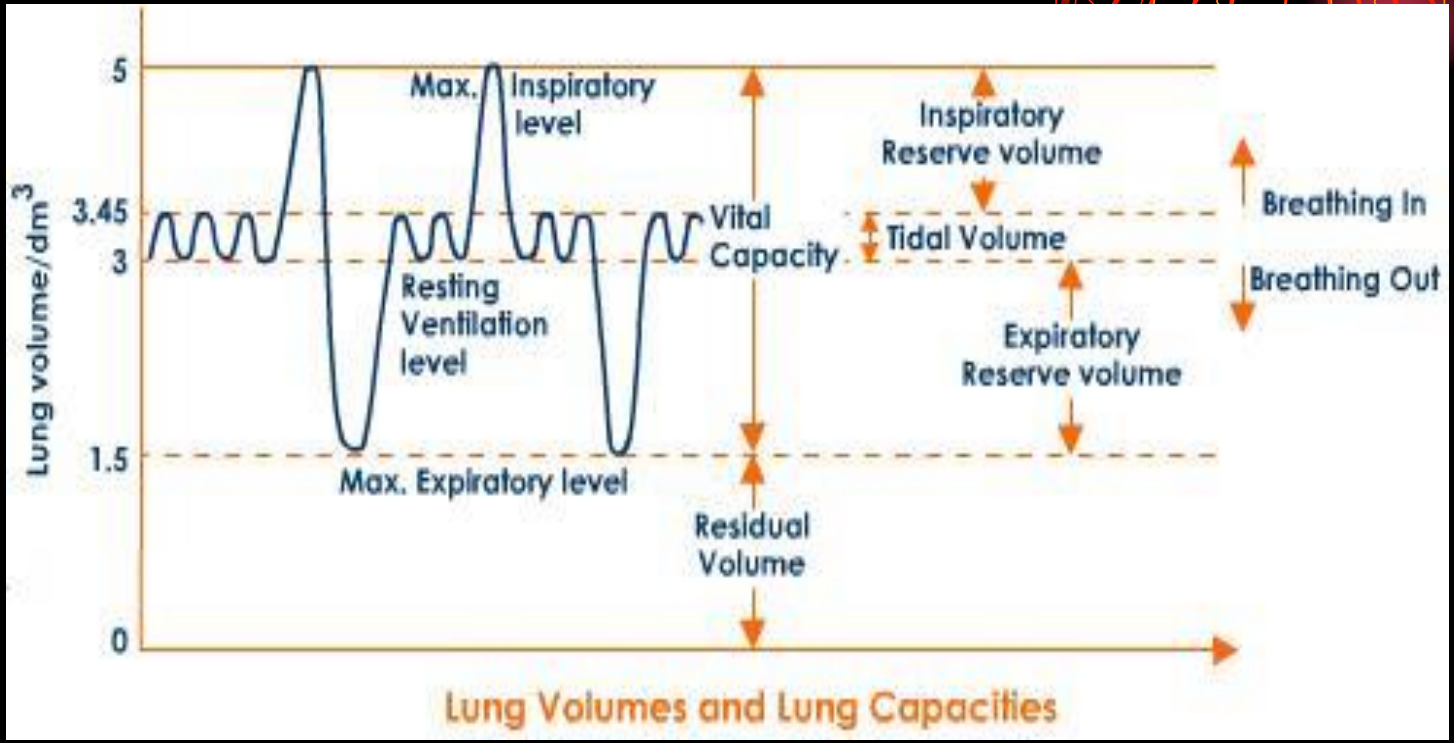
3. **EXPIRATORY RESERVE VOLUME (ERV)**
   - the extra volume of air that can be expired by forceful expiration after the end of a normal tidal expiration.
   - N = 1 L (male)
     700 ml (female)

4. **VITAL CAPACITY (VC)**
   - maximum amount of air a person can expel from the lungs after first filling the lungs to their maximum extent and then expiring to the maximum extent.
     = TV + IRV + ERV
   - N = 4.8 L (male)
     3.1 L (female)

5. **INSPIRATORY CAPACITY (IC)**
   - volume of air inspired by a maximal inspiratory effort after normal expiration.
   - TV + IRV
   - N = 3.8 L (male)
     2.4 L (female)

6. **FUNCTIONAL RESIDUAL CAPACITY (FRC)**
   - the amount of air that remains in the lungs at the end of normal expiration.
   - ERV + RV
   - N (average) = 2.3 L

7. **RESIDUAL VOLUME (RV)**
   - the volume of air remaining in the lungs after the most forceful expiration.
   - N (average) = 1.2 L

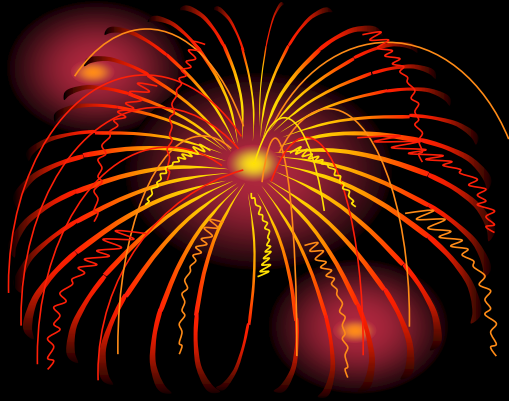

5
3.45
3
1.5
0
Lung volume/dm3
Max. Inspiratory level
Resting Ventilation level
Max. Expiratory level
Vital Capacity
Residual Volume
Inspiratory Reserve volume
Tidal Volume
Expiratory Reserve volume
Breathing In
Breathing Out
Lung Volumes and Lung Capacities

Physiological factors that influence lung volumes and capacities:

1. **Age**
   - ↓ VC with age

2. **Sex**
   - females have 20 – 25% less values in all pulmonary volume and capacities than males.

3. **Body size**



Thank you!

Practical 1. Simple Spirometry (Lung Volumes and Capacities)

1.1. Objectives

At the end of this session, students are expected to:

- Describe how a bell-type spirometer is used to measure lung volumes and capacities.
- List and define the different lung volumes and capacities.
- State the normal values of each lung volume and capacity.
- Discuss the physiological and pathological factors that may affect the different lung volumes and capacities.

1.2. Equipment

- Simple spirometer (many types are available, Bell-type spirometer or water-gauge spirometer), Fig-7. It would be best if students acquaint themselves with the type used in the lab.
- Nose clip.
- Disposable mouth piece.

Figure 7. Simple (volumetric) spirometer.

1.3. Procedure

1. Insert the mouthpiece in the subject's mouth so that its edges lie between the subject's lips and gums.
2. Place the nose clip on the subject's nose to avoid air escaping through the nose.
3. Ask the subject to take normal breaths through the mouthpiece for a short while.
4. After recording few normal breaths, ask the subject to take a deep forceful inspiration filling their lungs to their maximum ability followed by gentle exhalation. After that, the subject can resume normal breathing.
5. After a few normal breaths, ask the subject to expire quickly, forcibly and as completely as possible. Once this forceful expiration is complete, the subject inhales and resumes normal breathing.
6. Finally, ask the subject to take a deep forceful inspiration followed immediately by a maximum, quick and forceful expiration. Once this is complete, ask the subject to breath normally for a short time.
7. The spirogram is recorded on a moving drum, Fig-8. An example of how the recording is done is shown in Fig-9.

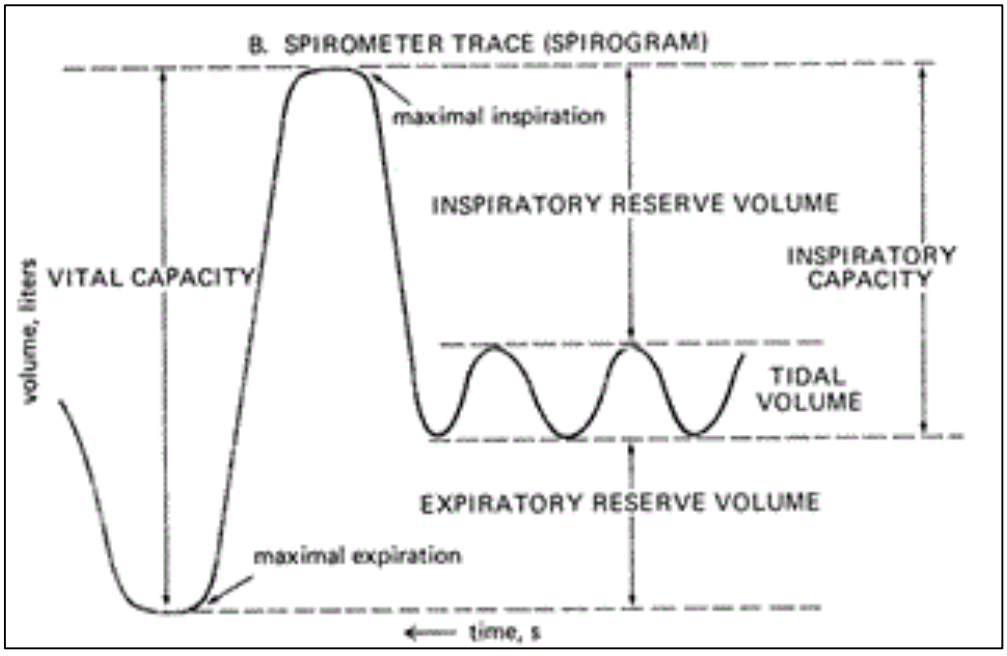


Figure 8. A spirogram recording. The deflection of the pen upwards or downwards with each phase of respiration is dependent on machine mechanics and is subject to variability.

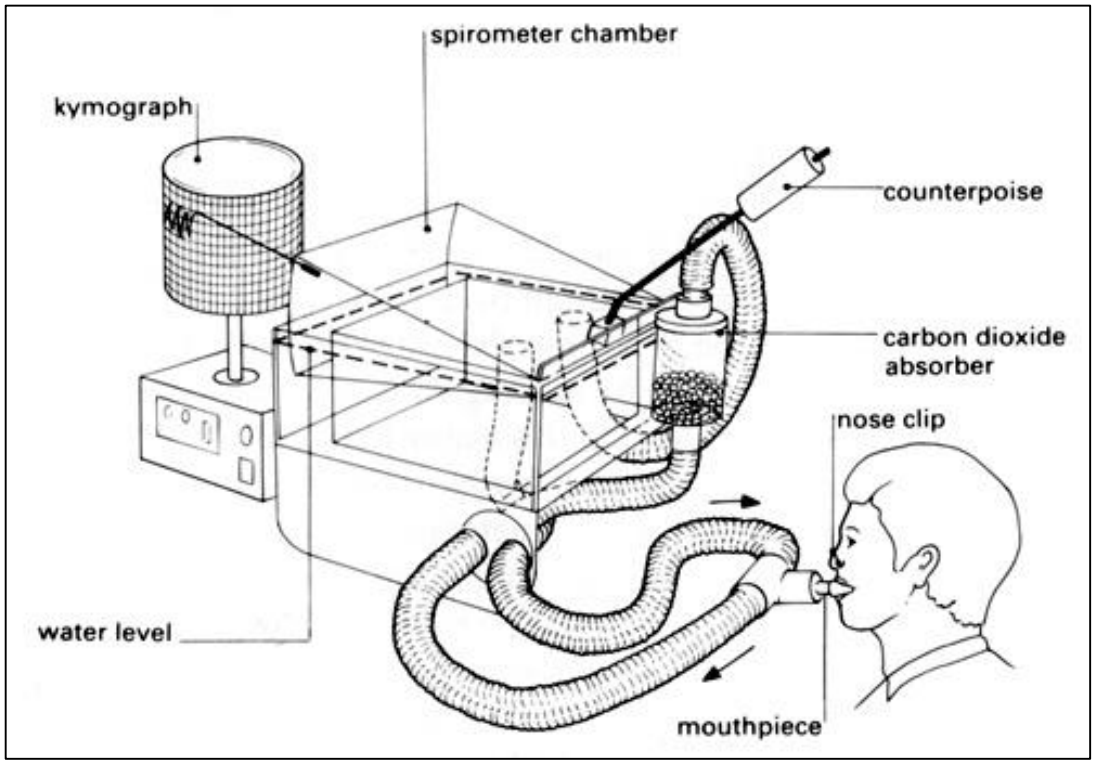


Figure 9. Simple lung volumes. The subject breaths through a mouthpiece while a nose clip is placed on the nose to avoid air escaping through it. While breathing, air moves in and out of the spirometer chamber causing displacement in the pen attached to it surface. The moving pen draws the spirometry graph on the kymograph. The degree of displacement is proportional to the volume of air moving in and out of the lungs. With proper calibration, the volume of air moving in and out of the lungs can be calculated.

Note to students

Depending on the mechanics of the machine used for simple spirometry measurements, the inspiratory/expiratory curves may be recorded upwards or downwards. The direction of inspiration and/or expiration will always be highlighted in any simple spirogram recording.

1.4. Practice questions

1. Define the following terms and state/calculate their values from the data collected in the lab:
    a. Tidal volume (TV).
    b. Expiratory reserve volume (ERV).
    c. Inspiratory reserve volume (IRV).
    d. Vital capacity (VC).
    e. Inspiratory capacity (IC).

2. Name a few physiological factors that may influence lung volumes and capacities and how do they exert their effects?

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3. Lung volumes and capacities are altered in a variety of pathological conditions. Name a few and explain how do these conditions bring about the changes are in lung volumes and capacities.

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4. What is the physiological significance of the residual volume and the functional residual capacity?

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5. Residual volume cannot be directly measured by spirometry. What is the technique that is used to measure it? Explain how it works.

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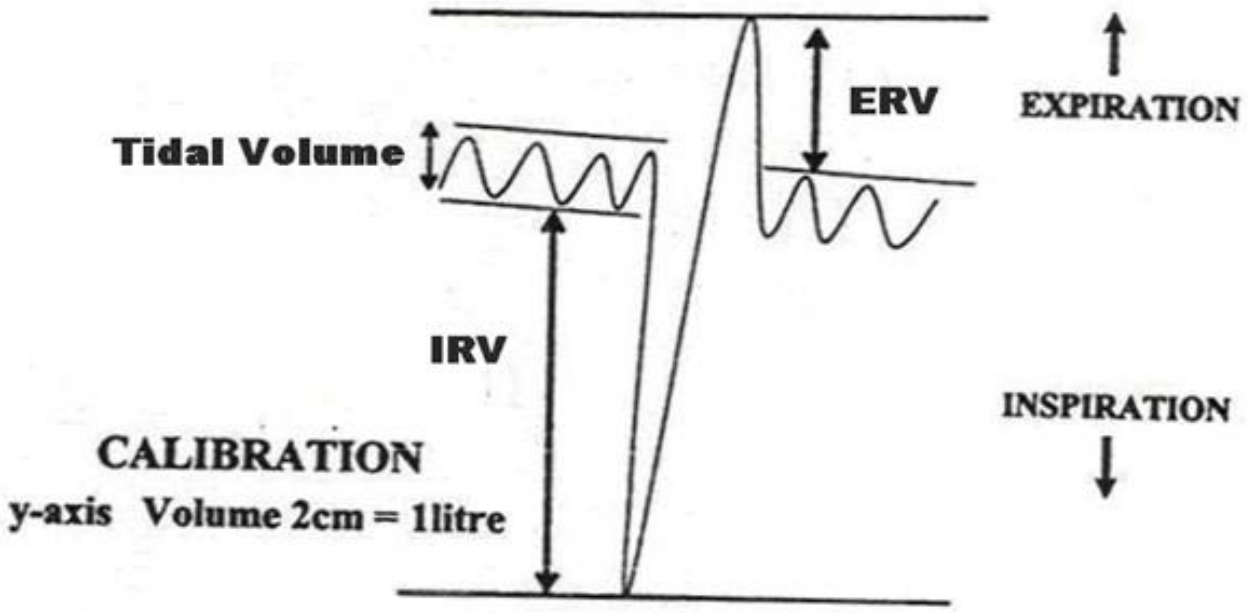
6. Using a simple ruler and the calibration provided in the graph, calculate the TV, IRV, ERV and VC from the graph below.



Parameter	Volume in liters
TV	
IRV	
ERV	
VC	