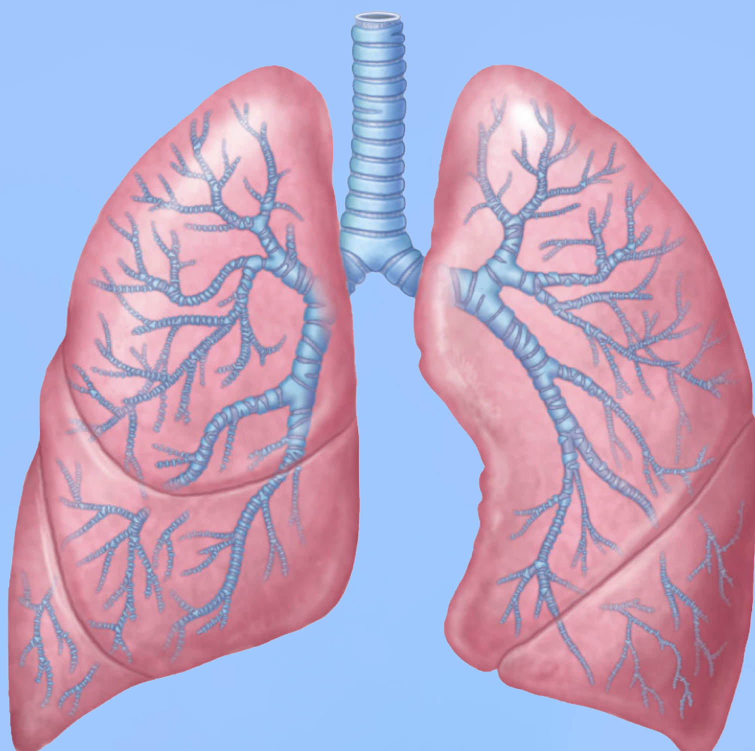
Physiology OSPE Revision



Respiratory Block

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Objectives:

- Use a spirometer and determine lung volumes and capacities
- Define and provide values for the various lung volumes and capacities
- Recognize the physiological and some pathological factors that modify lung volumes and capacities.

Spirometry

- Types
  - first: simple, static or student.
  - second: Dynamic
- it's a pulmonary function test measure volume and capacity.
- - determine cause of shortness of breath
  - rule out any kind of obstructive or restrectuve disease
  - diagnose and monitor lung problems
  - wellness of medicationes
  - The simple one is not a dignostic tool.

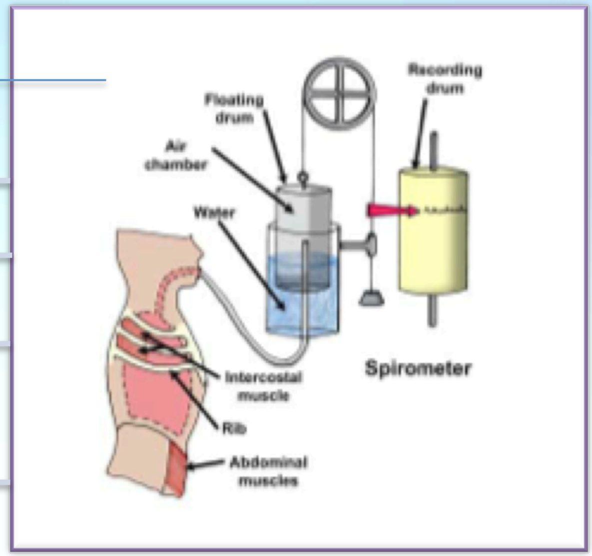
FIRST: SIMPLE SPIROMETER

Drum inverted over a chamber of water with the drum counter balanced by a weight

In the drum is air or Oxygen

A Tube connects the mouth with the gas chamber

When one breathes in and out of the chamber, the drum rises and falls and an appropriate recording is made on a moving paper



Method

the patient should be rested, then incerte sterilized mouthpiece → close the nose with nose clip → take a normal 3 breaths through the mouthpiece → then take a deep inspiration to fill the lung completely → then breath normally

Expire forcibly as completely as posible → then breath normally for a short time → take a deep forcful inspiration → and immediately expire forcibly ,then noramal breath → the spirogram is recorded on a moving drum

The air in the lungs can be subdivided on into 4 volumes and 4 capacities:(explained in the next page)

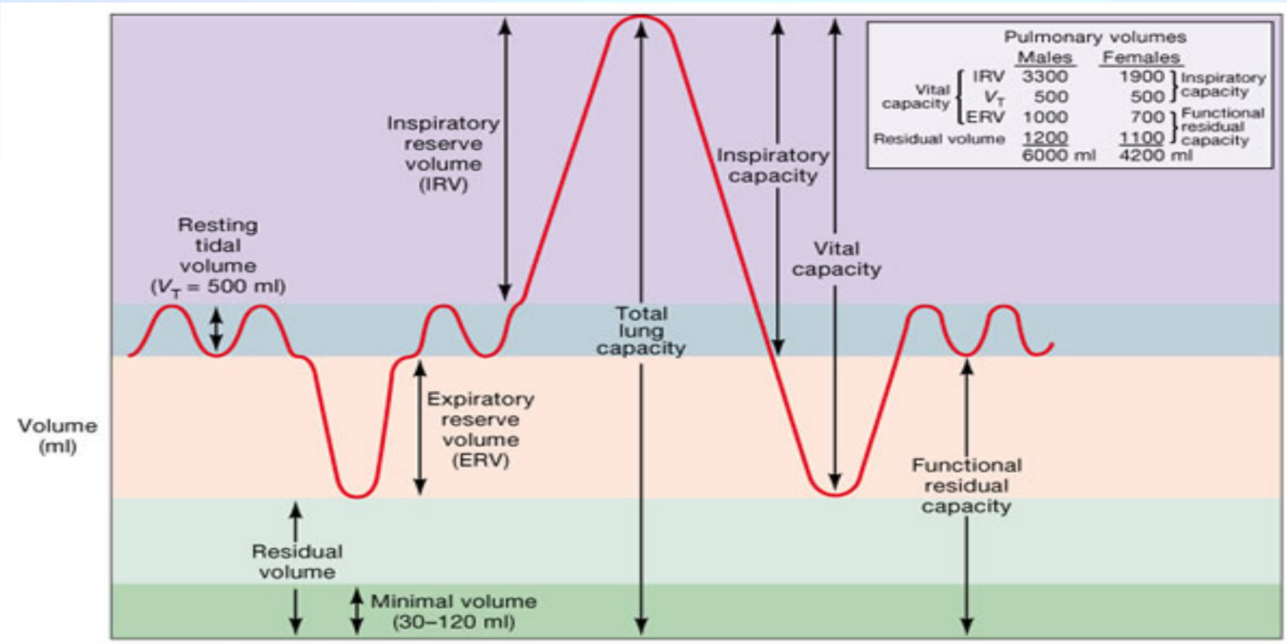
PHYSIOLOGICAL FACTORS INFLUENCING LUNG VOLMES AND CAPACITIES :

1. Sex: female 20-25% less
2. Age: less in older people
3. Obesity: more width less in lung function
4. Height: more height more lung function
5. Athletes
6. Posture: if the patient was sitting or running.

PATHOLOGICAL FACTORS

Vital capacity is decreased with :	
Cause	Example
↓ lung volume:	• Surgical removal of lung tissues • Large tumors
Restrictive lung disease:	Pneumonia, pulmonary edema, broken ribs
Obstructive lung disease	Chronic bronchitis, asthma, foreign body
Loss of elastic recoil	Emphysema

Spirogram



Lung Volumes		
Tidal volume [TV]	Normal inspiration and expiration	= 500 ml
Inspiratory reserve volume [IRV]	Extra volume of air, that **inspired** forcefully beyond the normal	= 3000 ml
Expiratory reserve volume [ERV]	Extra volume of air that **expired** forcefully beyond the normal	= 1100 ml
Residual volume [RV]	It is the volume of air still **remaining** in the lungs after forceful expiration	= 1200 ml

Lung Capacities		
The functional residual capacity [FRC]	**This is the amount of air that remains in the lungs at the end of tidal expiration. FRC = ERV + RV**	**= 1100 + 1200 ≈ 2300 ml**
FORCED Vital Capacity [FVC]	This is the maximum amount of air that a person can expire forcefully after taking a deep inspiration. **FVC = TV + IRV + ERV**	**500 + 3000 + 1100= 4600 ml**
Total lung capacity [TLC]	The maximum volume of air that can fill the lungs where they can expend with the greatest possible effort. **TLC=all the volumes.**	**500 + 3000 + 1100 + 1200 = 5800 ml**
Inspiratory capacity [IC]	Is the amount of air a person can breathe in, beginning at the **normal expiratory level** and **distending** the lungs to the maximum amount. **IC= TV+ IRV**	**500+ 3000= 3500 ml**

Important to remeber these values

SECOND :DYNAMIC SPIROMETRY

spirometry	It provides an objective measurement of lung function
	It analyzes volume and velocity of expired air
	Important of spirometry: 1. Assess physical fitness 2. Diagnosis of pulmonary diseases (obstructive or restrictive) 3. Follow disease progression

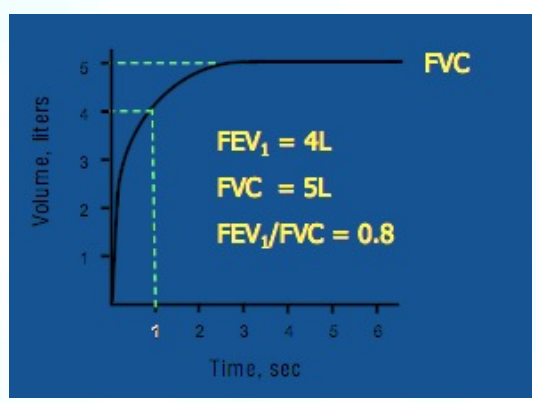
	Static test	Dynamic test
Time	Performed without regard to time	Performed at forcible and max effort against time
Measures	**Relaxed Vital capacity:** Volume of expired air measured after a maximal inspiration	-the rate at which the lung changes volume during forced breathing. **Forced vital capacity** The maximum amount of air that a person can expire

Two types of curves can be obtained

A-Forced Expiratory Curve

B-Flow-volume Curve

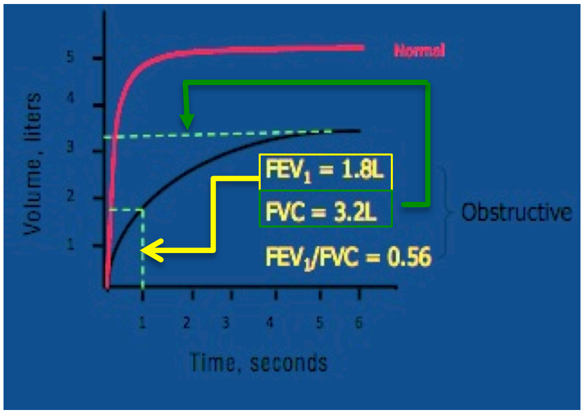
How it can be obtained	This subject takes a maximal inspiration and then exhales as rapidly as maximally as possible



A- FORCED EXPIRATORY RATIO (FEV1/FVC):

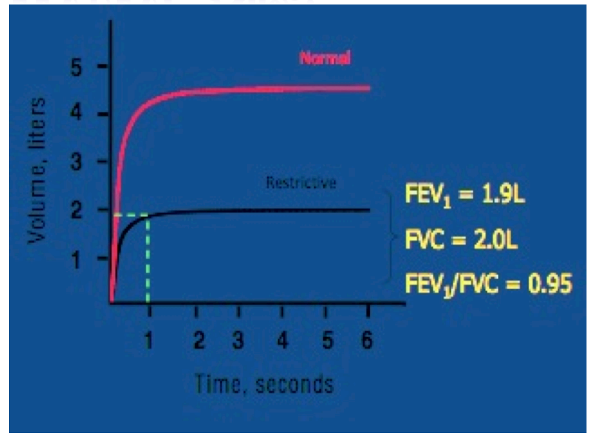
HOW TO DIAGNOSE IF IT'S RESTRICTIVE OR OBSTRUCTIVE LUNG DISEASE

OBSTRUCTIVE LUNG DISEASES: FEV1/FVC < 80%



FEV1	↓↓
FVC	*slight* ↓ *OR* ↔
$\left(\frac{\text{FEV1}}{\text{FVC}}\right)$	↓ 50% or less

RESTRICTIVE LUNG DISEASES: FEV1/FVC ≥ 80%:



FEV_1	↓↓
FVC	↓↓
$\left(\frac{\text{FVE1}}{\text{FVC}}\right)$	↑ *OR* ↔

Note

↔It means equal or close to the normal ratio

RESULTS INTERPRETATION

Volume	Normal	obstructive	restrictive
FVC	5L	less or =5	less
FEV_1	4L	less	less
$\left(\frac{\text{FVE1}}{\text{FVC}}\right)$ or FVE1 %	%80	less	= 80% 0r more

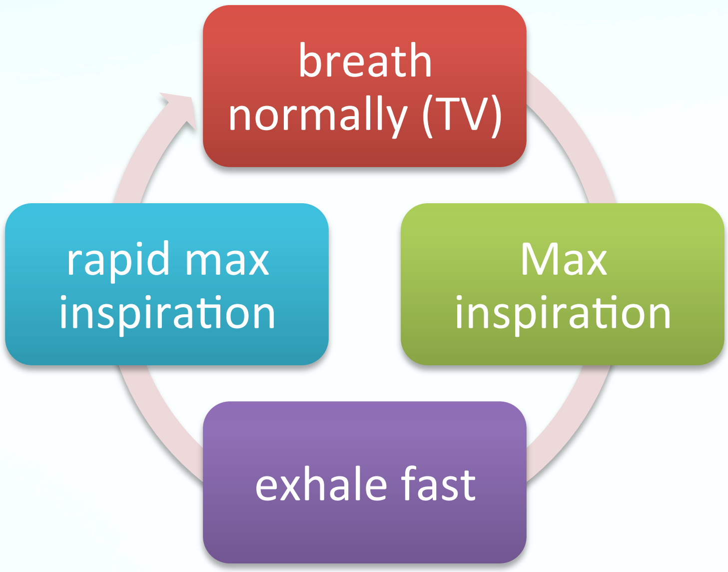
3 things you have to look for it in FEV1 graph:

1. Enough air get into the lungs (amount of air) (**FVC**).
2. Within the time of 3 sec the graph should be straight (**FEV1**).
3. **FEV1 ratio** should be 80% or close.

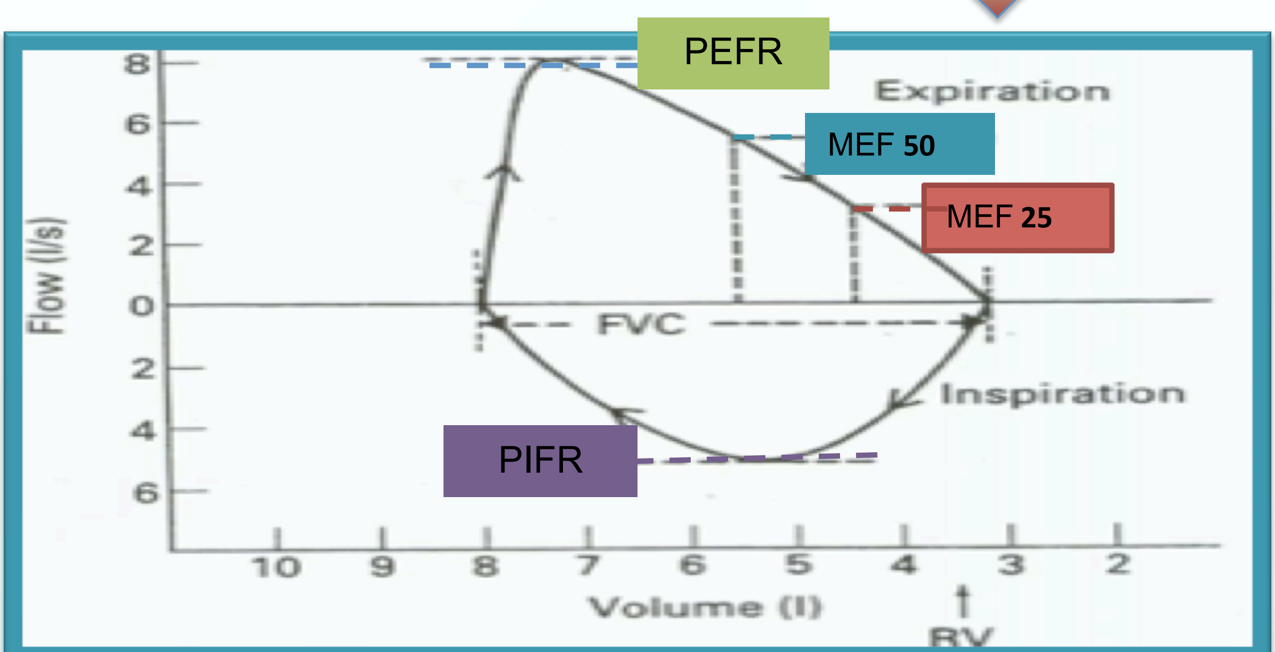
Example: Patient: 45 years old women, height 5'3"			
	FEV1	**FVC**	***FVE1/FVC***
Reading	1.43	2.5	$\frac{1.43}{2.5} = 0.57$
Predicted value	2.60	3.03	
	$\frac{1.43}{2.60}\times 100 = 55\%$	$\frac{2.5}{3.03}\times 100 = 82.5\%$	
Interpretation	Patient has miled air way obstructive. (How?) • FEV1 is between 50% and 80% of predicted normal. • FEV1/FVC = .57 which is < 0.8		

B- Flow volume

Flow volume loop



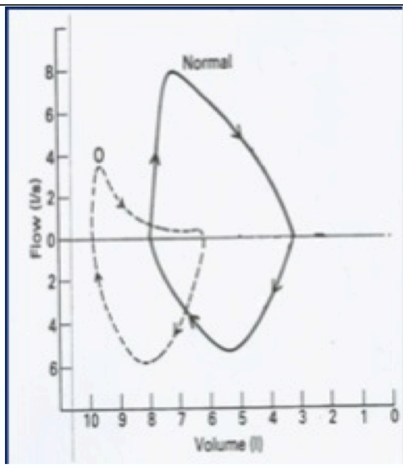
This measures expiration & inspiration flow as a function of exhaled volume rather then against time		
MEASUREMENTS ON FLOW VOLUME LOOP		
PEFR	Greatest flow achieved during the maneuvre	= 6-12 L/sec
PIFR	= 6 L/sec	
MEF50	Max expiratory flow at 50% of FVC	=4-6 L/sec
MEF25	=2.5 L/sec	



B- Flow volume

How to diagnose if it’s restrictive or obstructive lung disease

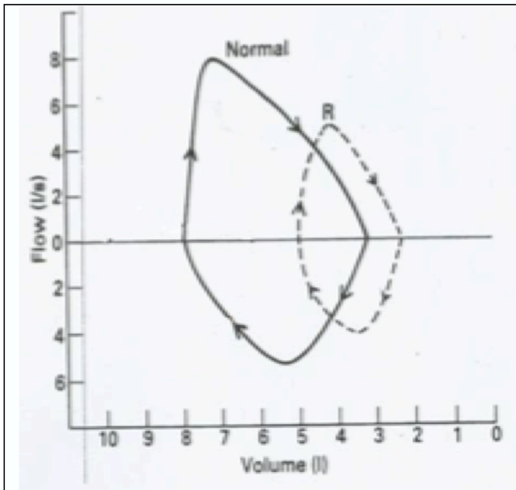
OBSTRUCTIVE LUNG DISEASE



MEF **50**	↓
PEFR	↓
Effort independent part of curve: concave	
Inspiratory loop Normal	

The shape is **Curved**, but the size didn’t change.

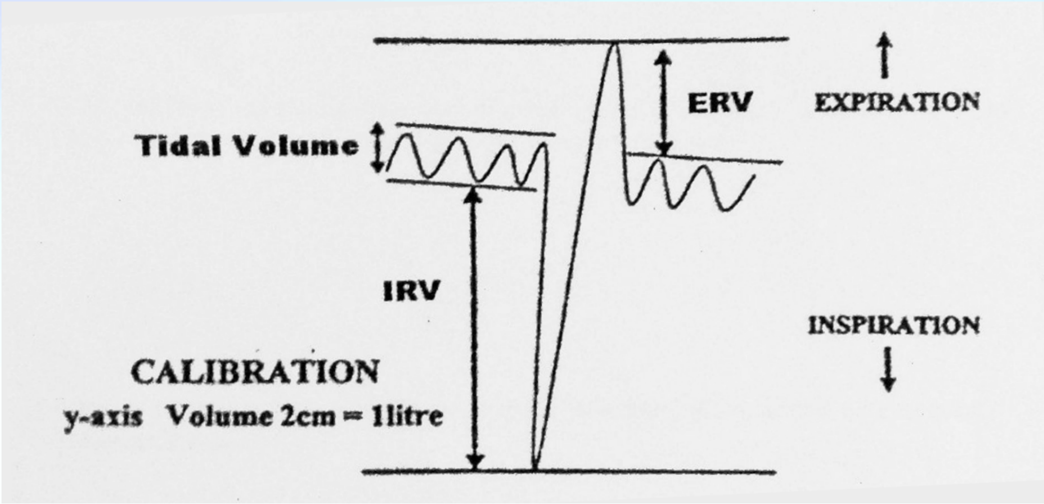
RESTRICTIVE LUNG DISEASE



Miniature loop (elliptical)	
PEFR	↓
PIFR	↓
MEF50	↓
MEF25	↓

The shape is same as normal, but it shrank and became **smaller**.

Quiz yourself



ملاحظة: الأرقام الموجودة ليست دقيقة ، لكن في الاختبار الدقة مطلوبة فلا تنسى إحضار مسطرة وحاسبة

Q1: Define the following terms and calculate their values: If (TV = 1 cm, IRV = 6 cm, ERV = 2 cm) note: 2 cm = 1 L

1) Tidal Volume
   1 cm = 0.5 L (500 ml)

2) Inspiratory reserve volume
   6 cm = 3 L (3000 ml)

3) Expiratory reserve volume
   2 cm = 1 L (1000 ml)

4) Vital capacity
   VC = TV + IRV + ERV
   VC = 0.5 + 3 + 1 = 4.5 L (4500 ml)

5) Inspiratory capacity
   IC = TV + IRV
   IC = 0.5 + 3 = 3.5 L (3500 ml)

Q2: A number of physiological factors influence lung volumes and capacities. What are they and how do they exert their effects?

1- Sex: female 20-25% less
2- Age: less in older people
3- Obesity: more width less in lung function
4- Height: more height more lung function

Q3: Lung volumes and capacities are altered in variety of pathological conditions. Name few of them and explain how these changes are produced.

1. Lung tumors: will lead to decrease lung volumes by effect on normal function of lung.
2. Pneumonia: Restrict lung expansion, resulting in a decreased total lung capacity.
3. Chronic bronchitis: block airflow and make breathing difficult by mucus hyper-secretion and sub mucosal gland hypertrophy.
4. Emphysema: Abnormal dilation of air space lead to reduced in elasticity.

Q4: What is the physiological significance of Residual Volume and Functional residual volume?

Residual Volume: Prevents collapsing of lungs.

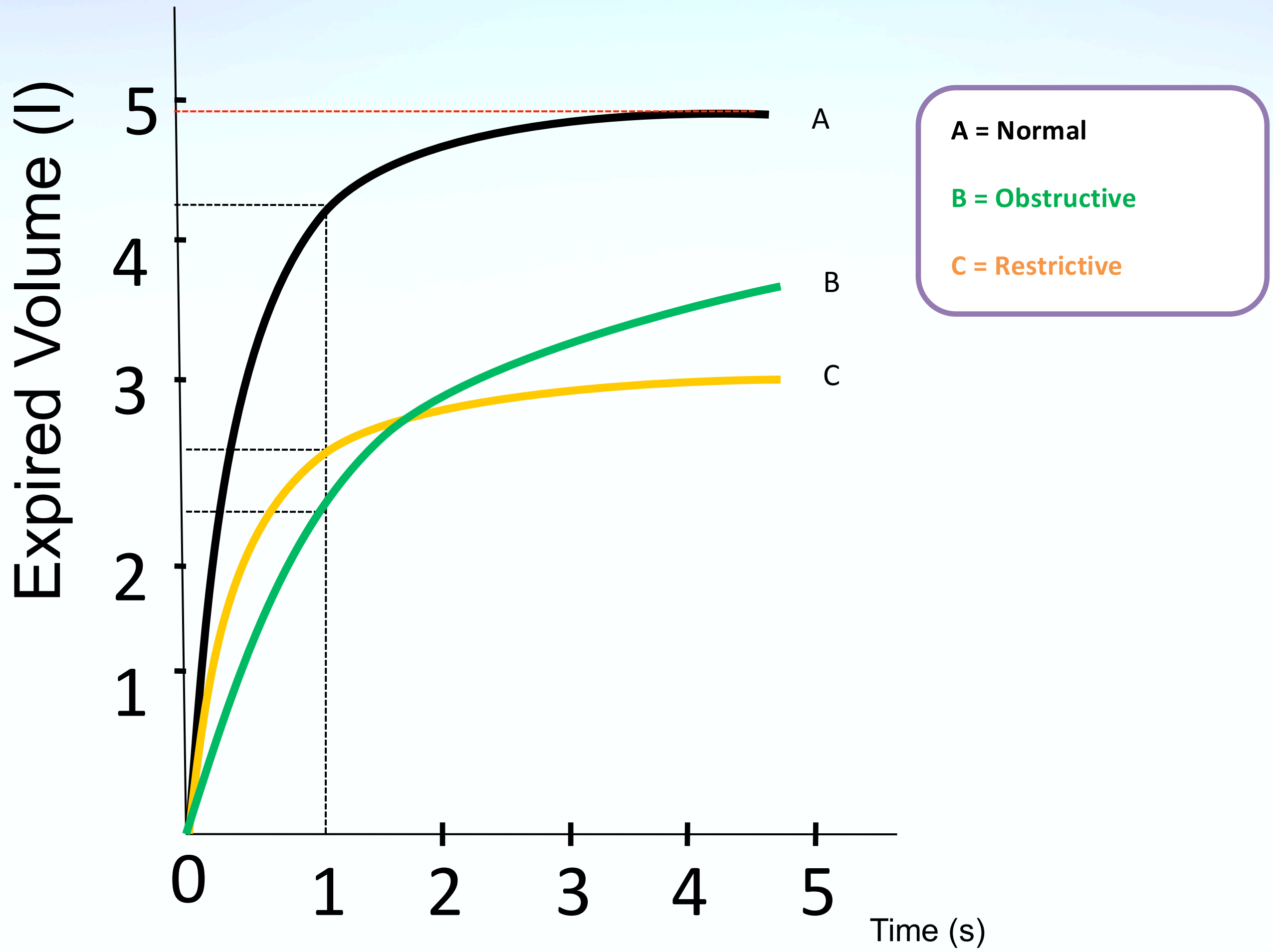
Functional Residual Volume: Helps to determine obstructive and restrictive pulmonary diseases.

Q5: Functional residual volume cannot be measured directly by spirometry. If residual volume is given (1200 ml), calculate FRV.

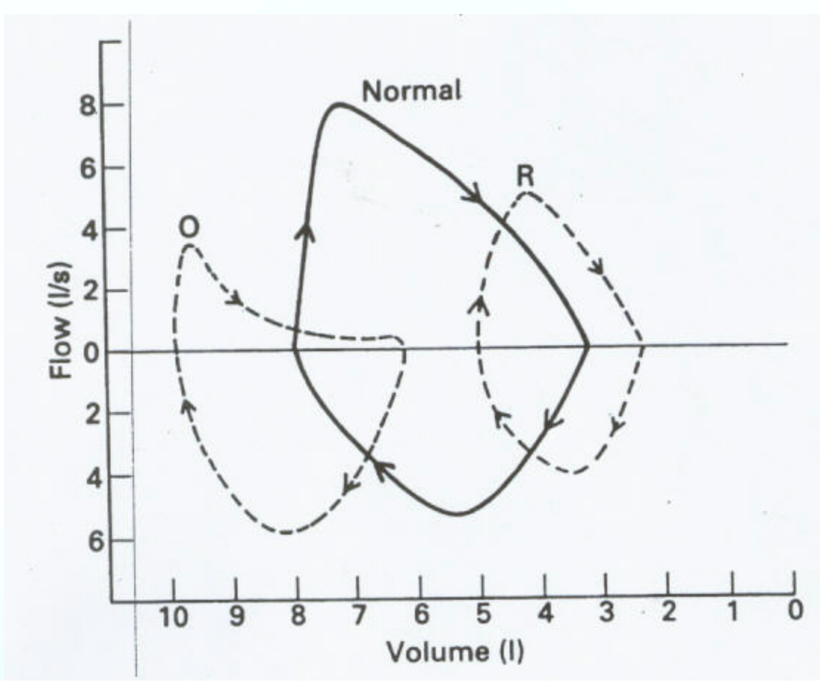
FRV = Residual Volume + ERV

FRV = 1200 + 1000 = 2200 ml (2.2 L)

FEV1 Curve



Flow-Volume loop



Q1: From the FEV1 curve produced, calculate for each one:-

a) Forced vital capacity

Normal FVC = 5 L

Obstructive FVC = 3.5 L

Restrictive FVC = 2.8 L

b) Forced expiratory volume in the first second

Normal FEV1= 4.3 L

Obstructive FEV1= 2.4 L

Restrictive FEV1= 2.5 L

c) FEV1 % = FEV1 * 100 / FVC

Normal FEV1%= 4.3/5 =0.86

Obstructive FEV1% = 2.4/3.5 =0.68

Restrictive FEV1%= 2.5/2.8 =0.89

Q2: The FEV1 is a good index of airway resistance while expiring.

a) What values would be expected for a normal person?

Normal FEV1 = 4L

Normal FVC = 5L

Normal FEV1% = 80%

b) How long does it take for a healthy people to expire their vital capacities?

1 Second OR 3 seconds

c) Explain what happens to FEV1 and FEV1 % measurements in patients with obstructive and restrictive diseases?

Obstructive diseases: FEV1 decreased - FEV1% <80%

Restrictive diseases: FEV1 decreased – FEV1% >= 80%

Q3: From the Flow-volume loop produced, calculate for each one:-

a) Vital Capacity

Normal FVC = 3.3 L/s

Obstructive FVC = 2.6 L/s

Restrictive FVC = 1.9 L/s

b) Peak expiratory flow rate (PEFR)

Normal PEFR= 8 L/s

Obstructive PEFR = 2.9 L/s

Restrictive PEFR = 5 L/s

c) Peak inspiratory flow rate (PIER)

Normal PIFR= 5L/s

Obstructive PIFR = 6 L/s

Restrictive PIFR= 4L/S

d) MEF50 (maximum expiratory flow at 50% vital capacity)

Normal MEF50 = 6 L/s

Obstructive MEF50 = 1 L/s

Restrictive MEF50= 5 L/S

e) MIF25 (maximum inspiratory flow at 25% vital capacity)

Normal MEF25 = 4.9L/s

Obstructive MEF25= 0.7 L/s

Restrictive MEF25=2.9 L/S

Q4: What is importance of flow-volume loop in healthy person?

This measure expiration and inspiration flow as a function of exhaled volume rather than against time.

5. Why is the force-independent part of the expiratory loop curvilinear in obstructive lung disease?

Because the smaller airways are narrowed due to either spasm or accumulation of secretions, they

provide resistance to the airflow during expiration; therefore, the airflow slows down and the

force-independent part of the expiratory loop becomes curvilinear.

6. What is the clinical significance of MEF50 measurements?

MEF50 becomes greatly reduced in obstructive lung diseases (less than 4 L/sec).

FVC is the Main marker for restrictive