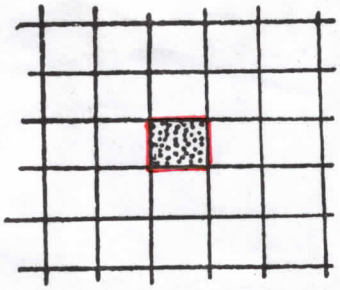
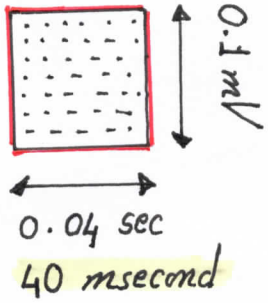
# Electro Cardio Gram  ECG or EKG

- **Def.:** Record of depol & repol of cardiac myocytes viz 2 skin electrodes i.e **Biphasic A.P.**
- **Recording:**
  - **Apparatus** (1) Monitoring machine: in ICU
    (2) Recording „ : Fed to heat stylus pen record. on a moving calibrated strip of paper.

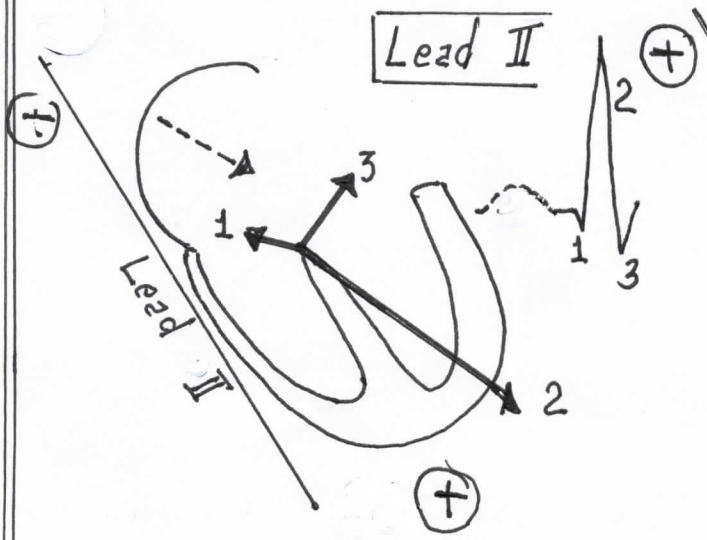


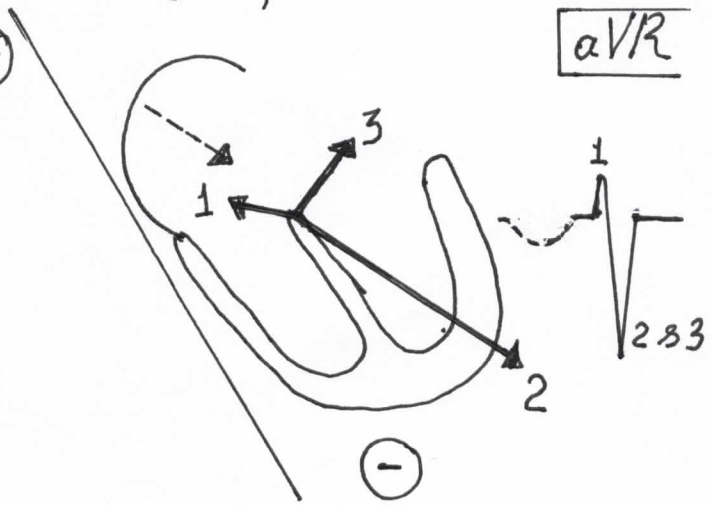



40 msecond

25 small square / second.
1500 „ „ / minute.

- **Vector:** An arrow represents sum of electrical activity.
  - **Mean electrical vector** = Sum of vectors
    - Atrial depol. One — Lt & downwards →
    - Vent. depol. Three — $V_1$ Lt to Rt — Septum
      $V_2$ Downwards & Lt — Lateral wall
      $V_3$ Upwards & Lt — Base of vent.



- Rules :

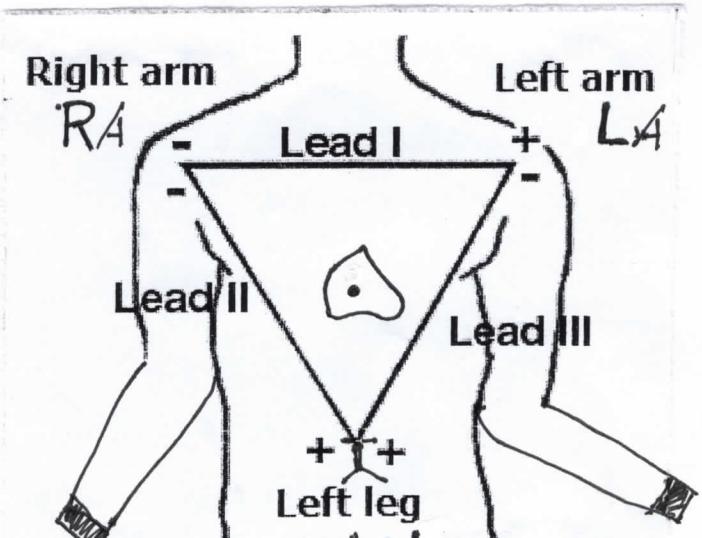
1. Voltage ∝ mass of tissue
2. Duration ∝ $\frac{1}{\text{velocity of conduction}}$
3. Polarity — Depol is directed towards +ve electrode → positive wave (upward) & vice versa
   Repol is directed towards +ve electrode → negative wave (downward) & vice versa
4. Vector — is parallel to lead → maximal recording
   · perpendicular to lead → no (0) recording

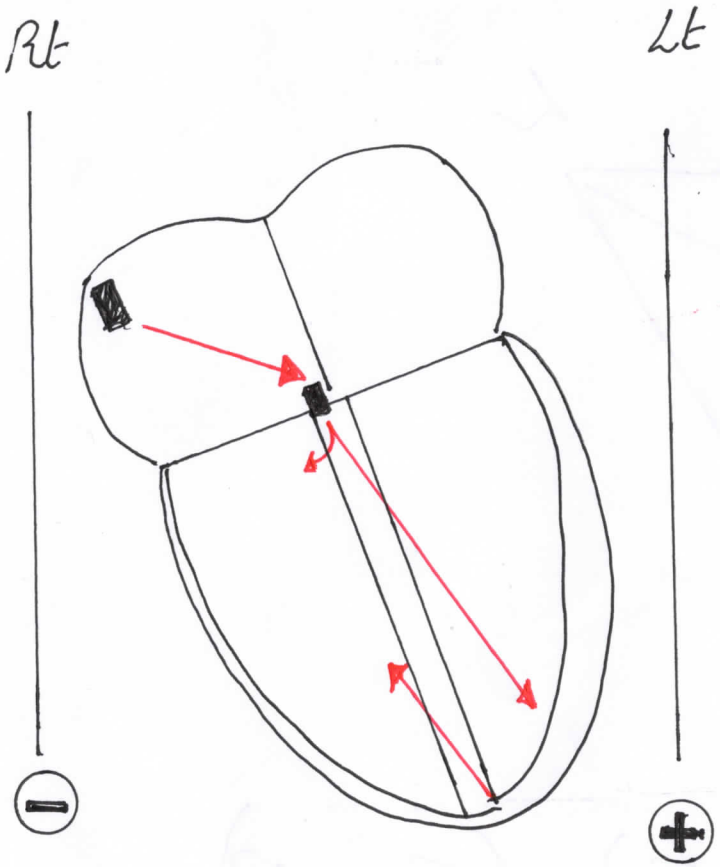
- Lead — Position of the TWO electrodes.
  Actual recording results from this position.

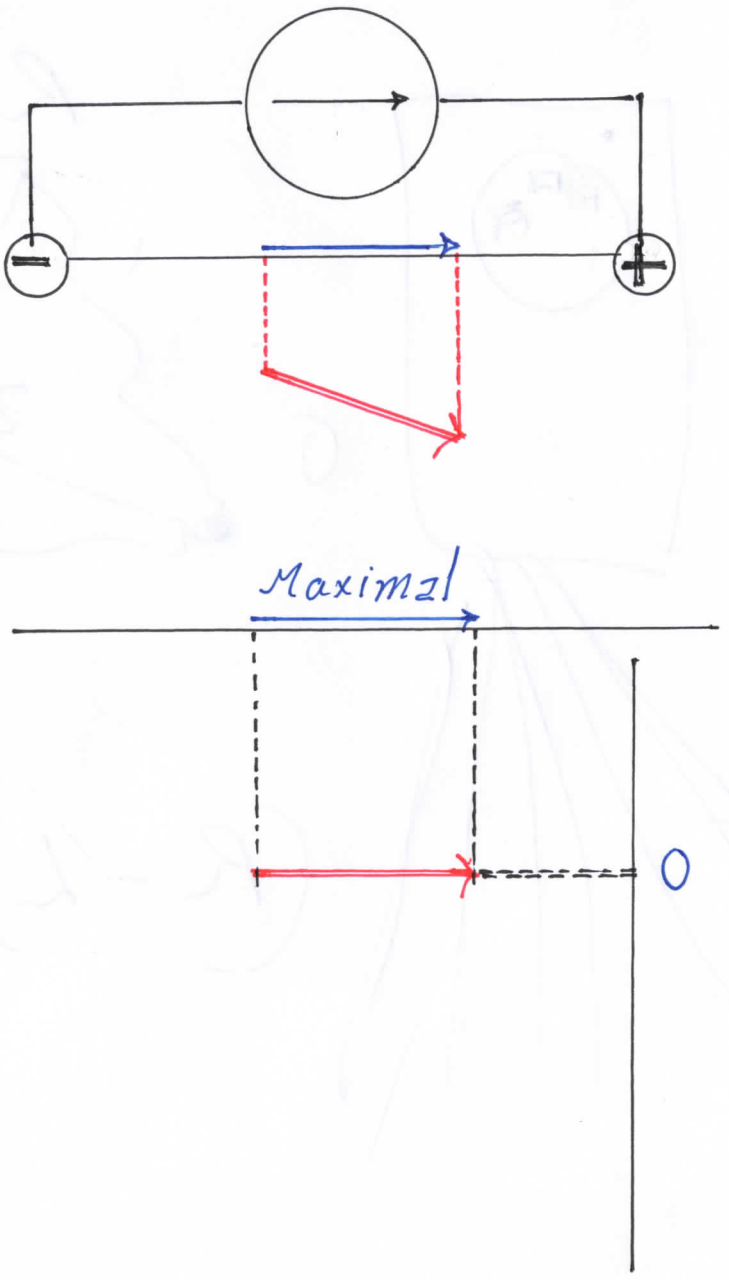
Placement — 4 on 2 arms & 2 legs (Rt leg ground electrode)
6 on defined locations on chest.

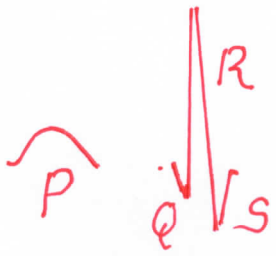
- According to SITE (placement) of electrodes :
  1. Limb leads : Lead I, II & III and aVR, aVL, aVF.
  2. Chest leads : $V_1$, $V_2$, $V_3$, $V_4$, $V_5$ & $V_6$.
- According to TYPE of electrodes :
  1. Bipolar lead : TWO electrodes exploring (+ve & -ve)
  2. Unipolar lead : One exploring (+ve) & One indifferent (0 -ve)

Standard limb leads & Einthoven's triangle



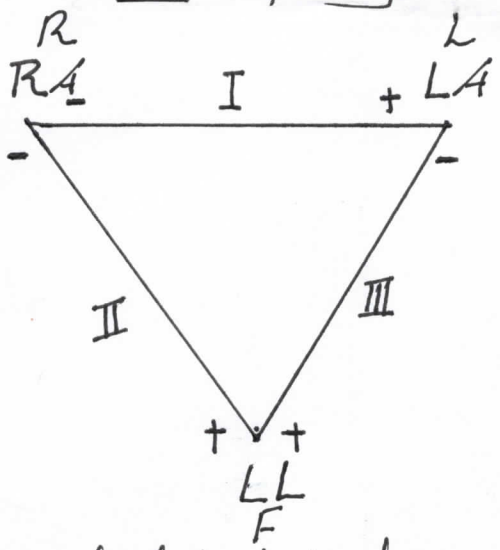

Rt
Lt


Maximal
0


P
Q
R
S

## Bipolar limb leads

TWO exploring elect.

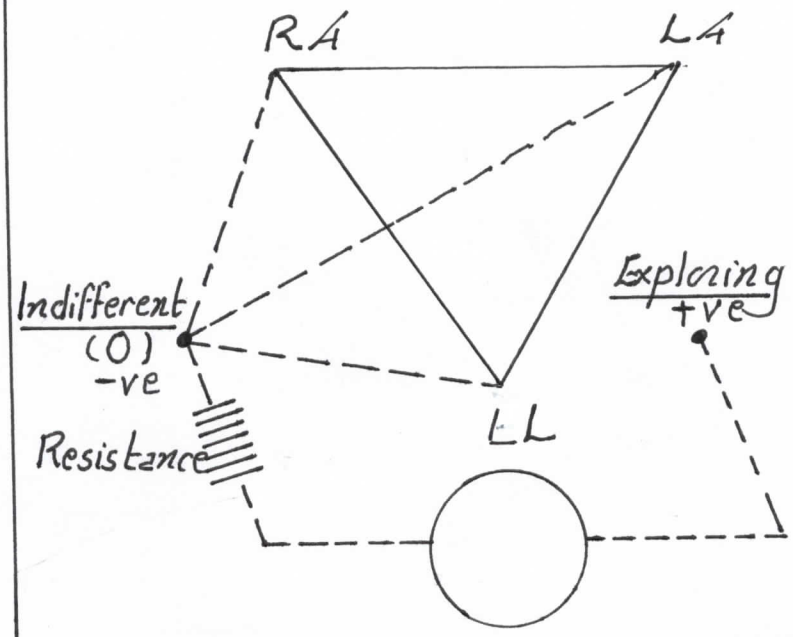



Standard limb leads

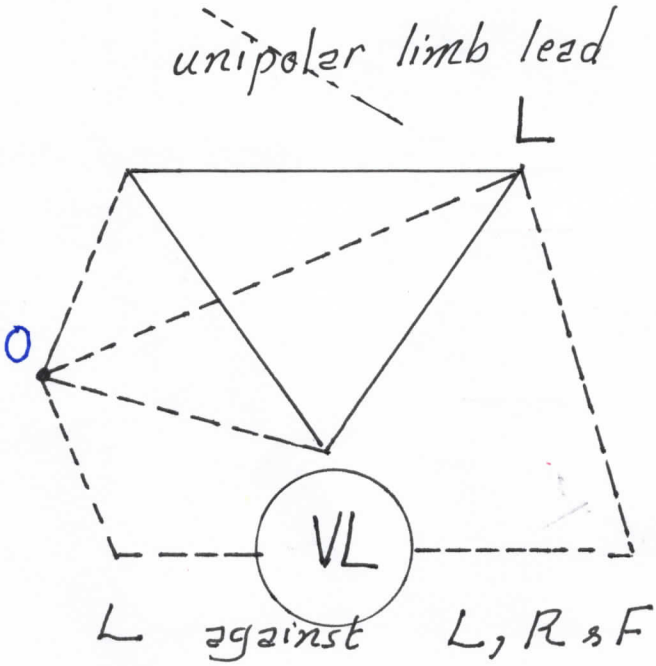
I, II, III

## Unipolar leads

ONE exploring (+ve) elect.

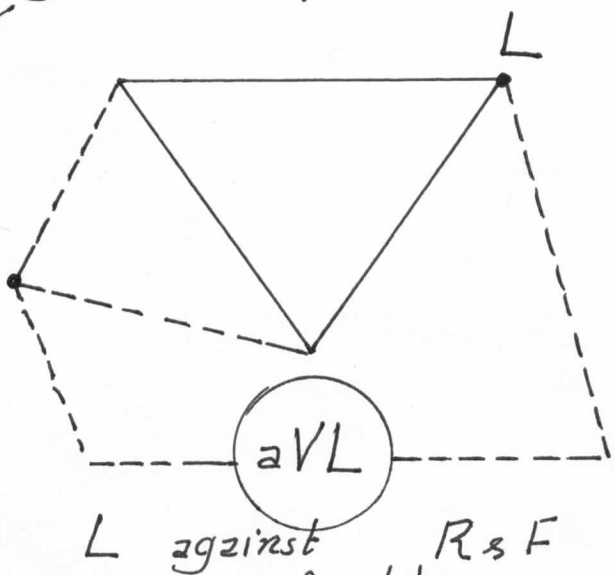



## unipolar limb lead




L against L, R & F

## Augmented unipolar limb lead

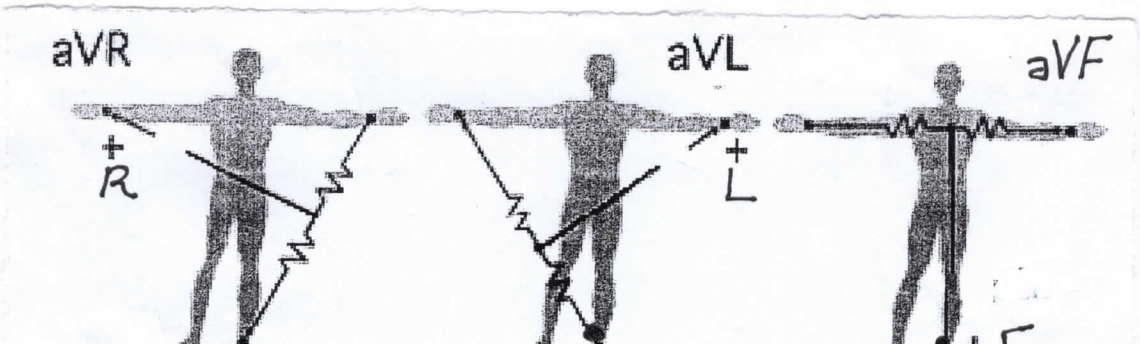



L against R & F

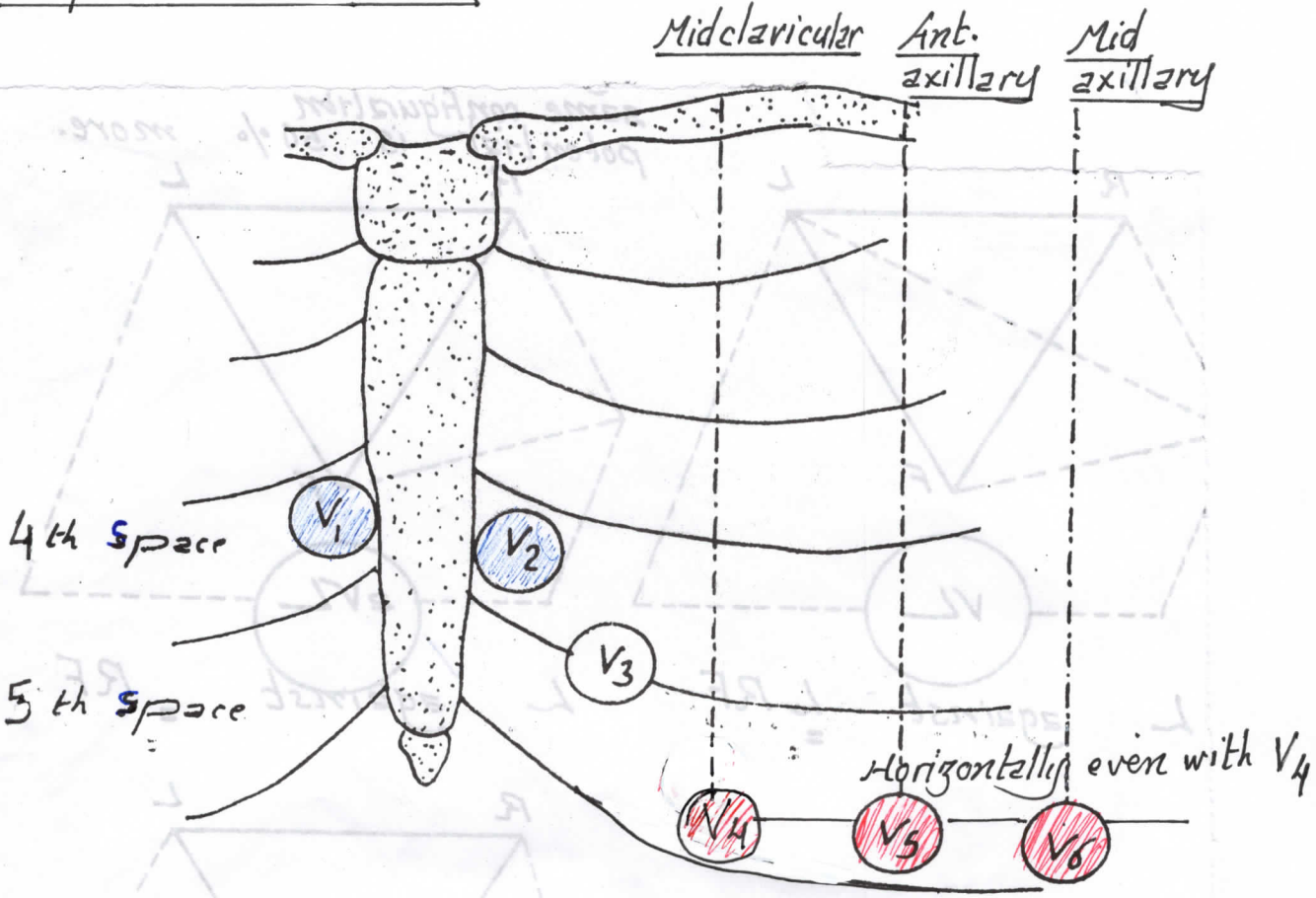
Same configulation

Potential 50% more

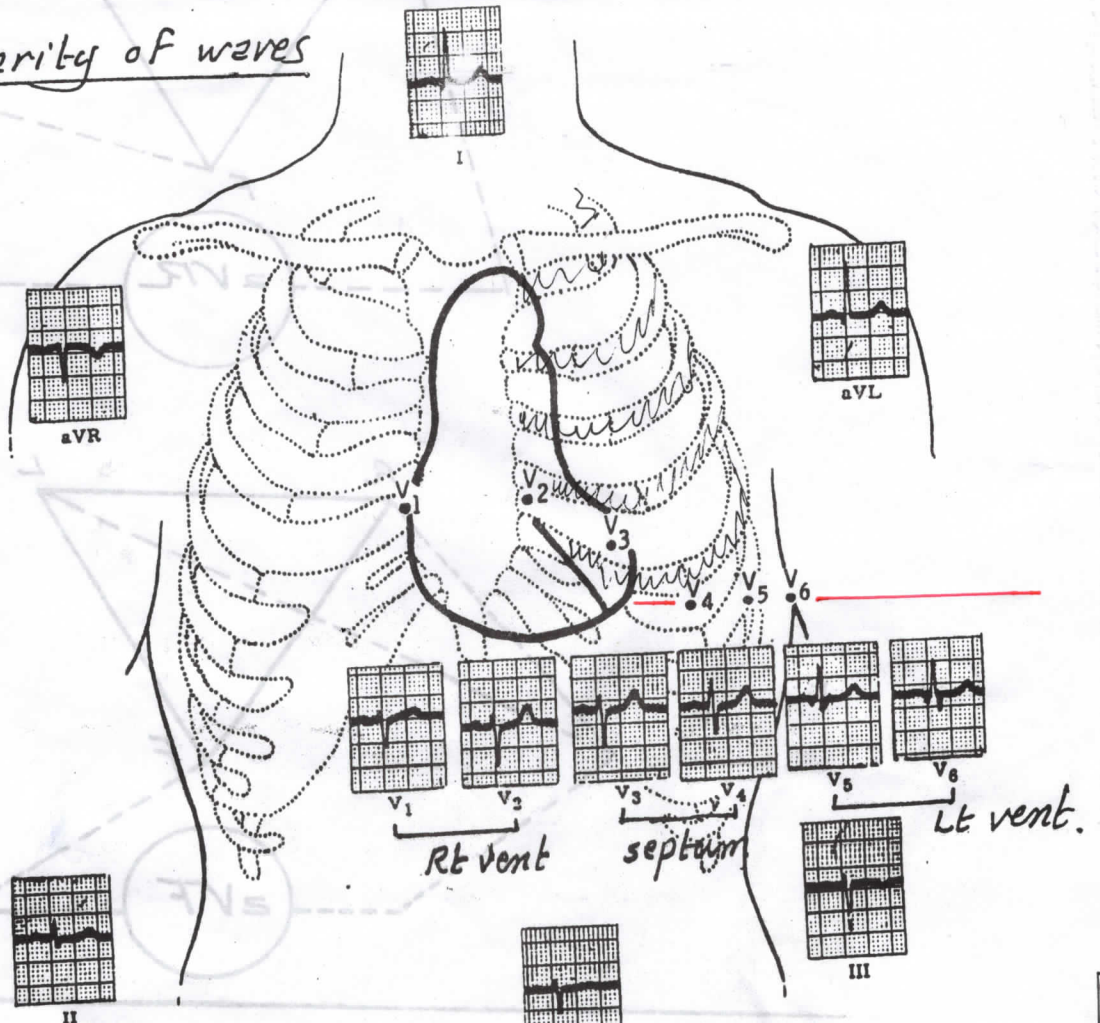
## augmented unipolar limb leads



# Unipolar chest leads

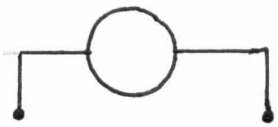



## Polarity of waves



## Leads

Position of 2 electrodes



### Bipolar limb leads :

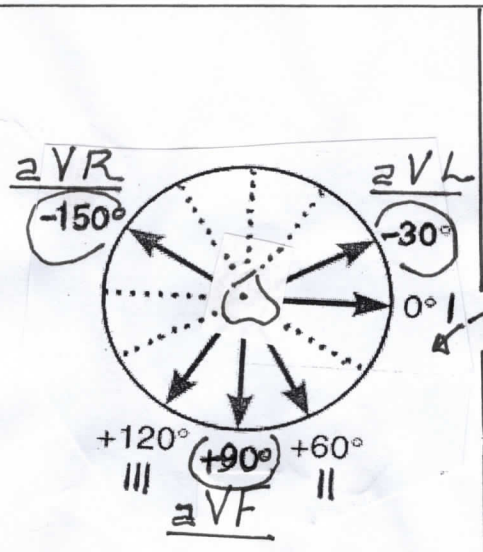
| | | Exp. | Exp. |
|---|---|---|---|
| Frontal | I | R | L +ve |
| | II | R | F +ve |
| | III | L | F +ve |

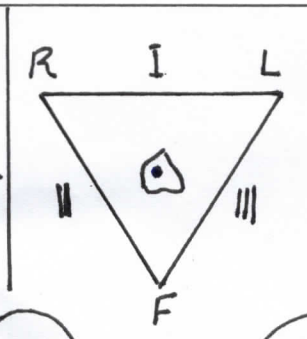
### Augmented unipolar limb leads :

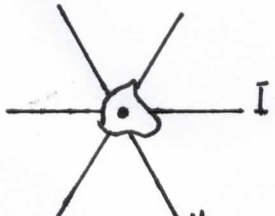
| | | Indifferent | Exp. +ve |
|---|---|---|---|
| Frontal | aVL | RF | L |
| | aVR | LF | R |
| | aVF | RL | F |

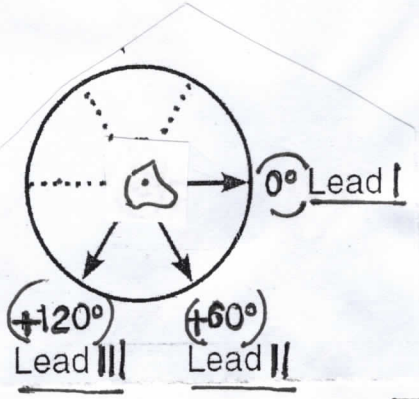
### Unipolar chest leads :

| | | | Indiff. | Exp. +ve | |
|---|---|---|---|---|---|
| RV | Septum | $V_1$ | RLF | Rt 4th space | parasternal |
| | | $V_2$ | RLF | t 4th space | parasternal |
| | | $V_3$ | RLF | t Between $V_2$ & $V_4$ | |
| | | $V_4$ | RLF | t 5th space | midclavicular line |
| LV | Horizontal | $V_5$ | RLF | t Horizontally even with $V_4$ | ant. axillary line |
| | | $V_6$ | RLF | t | mid axillary line |

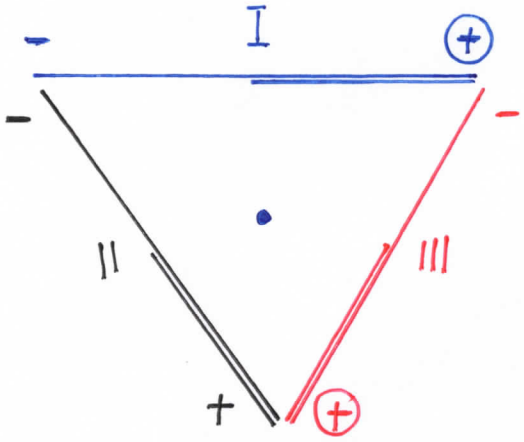


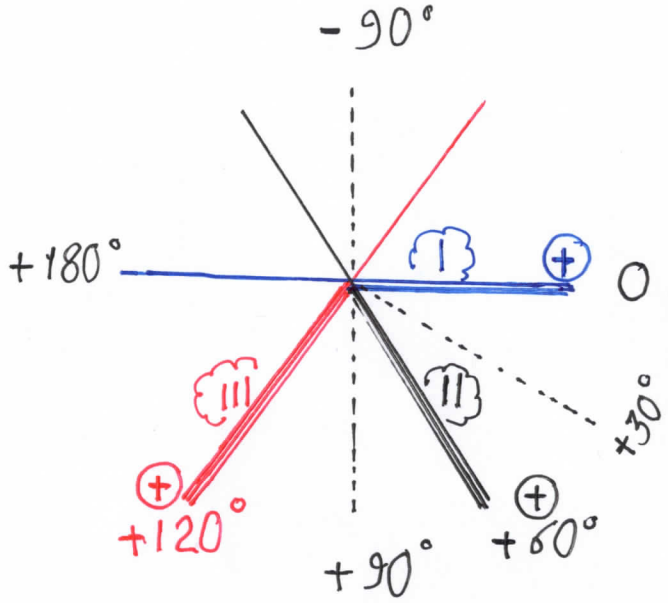



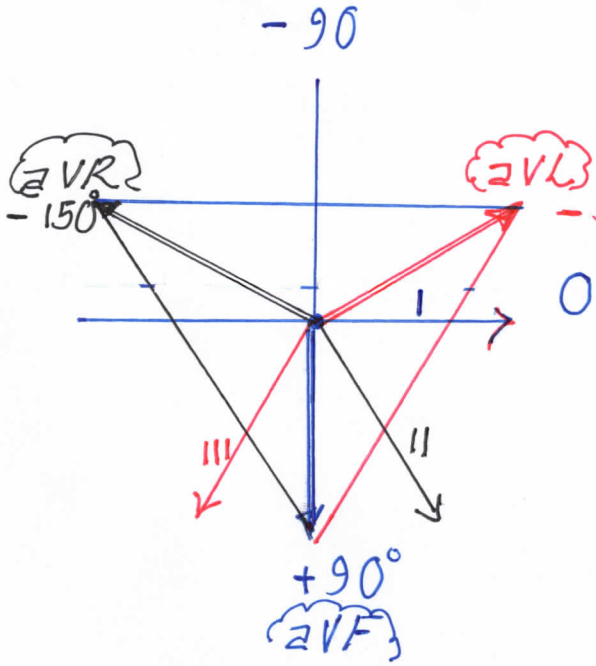




Hexaxial reference system




Axial
reference system

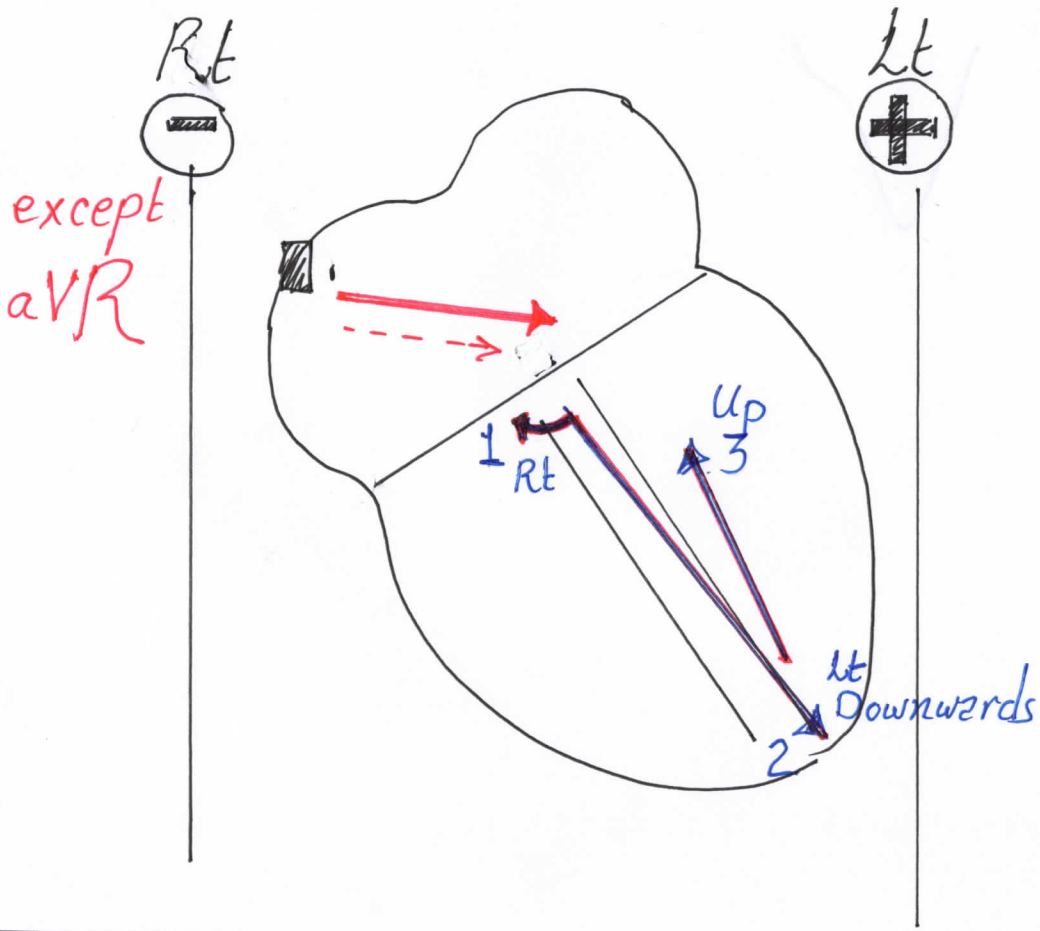


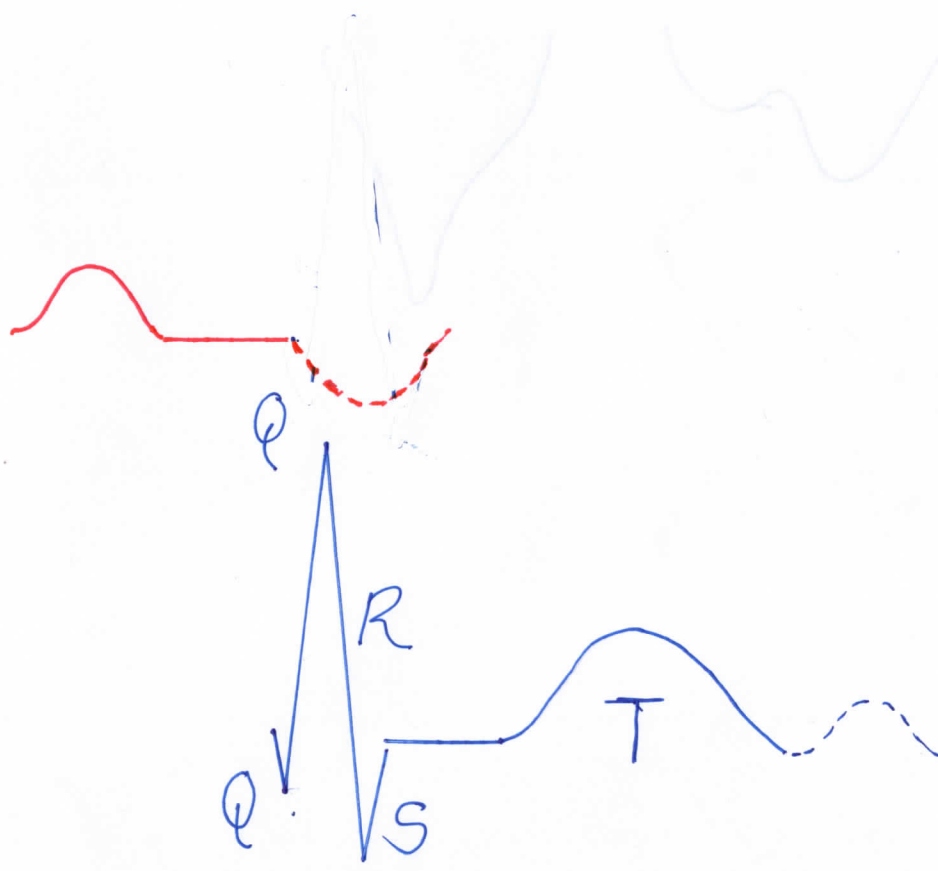

Hexaxial
reference system

# ECG

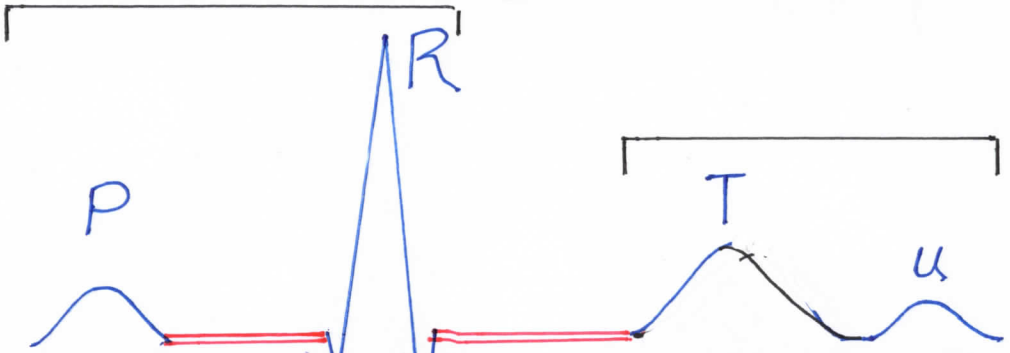
Two Electrical activity
- Depol
- Repol

Two syncitia
- Atria
- Ventricles



# Normal ECG : Waves + Segments = Intervals




## Waves

| | P | Q R S | T | U |
|---|---|---|---|---|
| Represents | Atrial Depol | Vent. Depol | Vent. Repol | Papillary ms Repol |
| Duration | < 80 ms = 0.08 s | 80 ms | 160 ms | 0.05 ms. |
| Voltage (Heigh) Limb leads | ¼ mV 0.25 mV | 1 mV | < ½ mV | Usually not recorded. |
| Chest leads | | 3-4 mV | | |
| Shape | 1st half Rt atrium<br>2nd half Lt atrium | V1 & V2 small R large S<br>V5 V6 large R small S | Slightly rounded<br>Assymmetrical | |
| Direction | Upright in most leads<br>Inverted in aVR | R always +ve<br>Q -ve before, S -ve after R | Inverted in aVR | |
| Clinical | Absent in A fibrillation<br>Long in A enlargment<br>If inverted in other leads ectopic A pacemaker | >120 ms BBB, vent ectopic focus, ↑K+ or TCA overdose<br>Unusually tall Lt vent enlarg<br>Very low pericardial effusion infiltrative myo disease | Inverted sign of myocard ischemia<br>Tall Peaked sign of ↑K+ or early myo infarction<br>Flat ↓K+ | Very prominen ↓K+, ↑Ca++ hyperthyr |

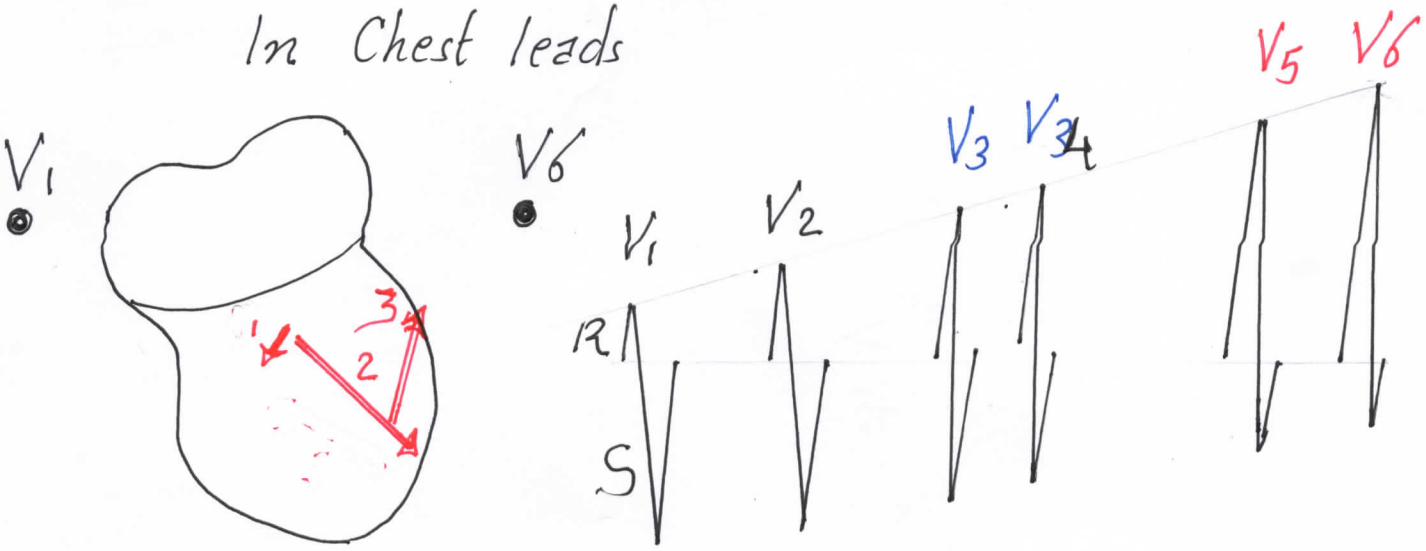
# Notes 4

- A repol not recorded — Masked by QRS complex; Very low voltage
- SAN, AVN & Purkinje depol not recorded. Small mass of tissue.

**QRS complex** R 1st +ve wave

Q -ve before S -ve after R

In Chest leads

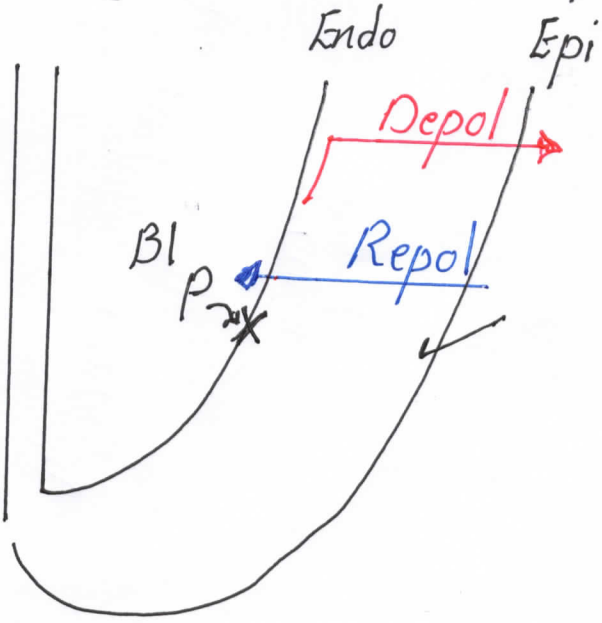



T vent repol. in same direction R vent depol !

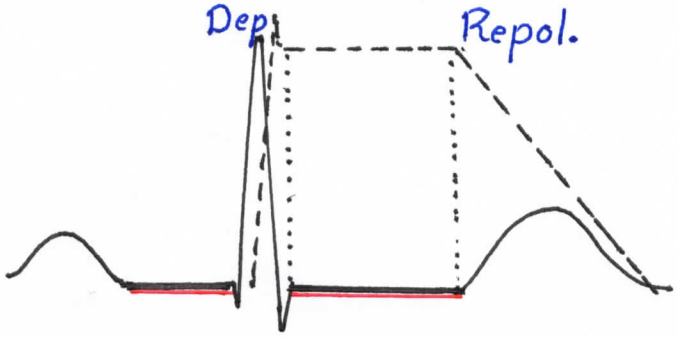
last part to be depol
1st part to be repol

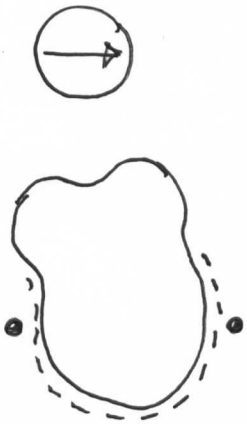
or

1st part to be depol
last part to be repol



## Segments

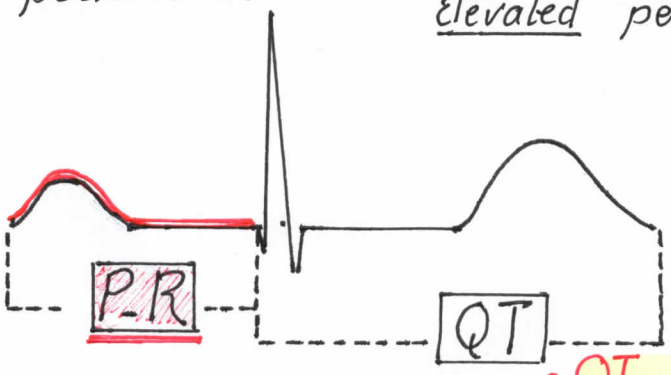


**Measurement**
- P-R: end of P to beginning of QRS
- S-T: end of QRS to beginning of T

**Importance**
- P-R: Conduction AVN; 0.06 - 0.1 s; Typically flat; If depressed in pericarditis
- S-T: Isoelectric segment; Corresponds to plateau of Vent. AP; Elevated or depressed in MI & ischem; Depressed LVH or digoxin drug; Elevated pericarditis.

## Interval




& $QT_c$ ie corrected QT

**Measurement**
- P-R: beginning of P wave to beginning of QRS
- QT: beginning of QRS to END of T wave

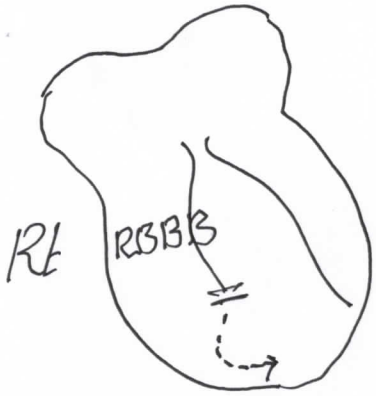
**Represents**
- P-R: A depol + AVN cond.
- QT: V. depol. plus V. repol.

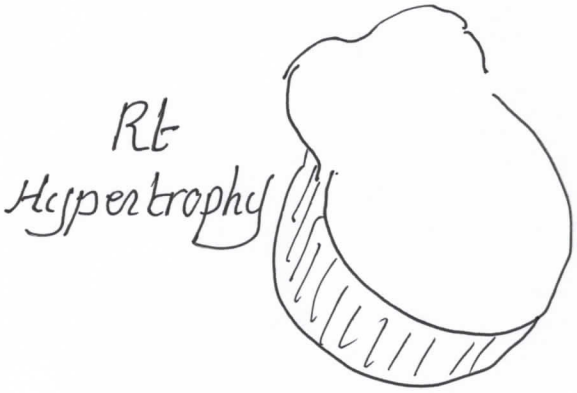
**Normal**
- P-R: 0.12 to 0.20 second.
- QT: 0.2 - 0.4 second

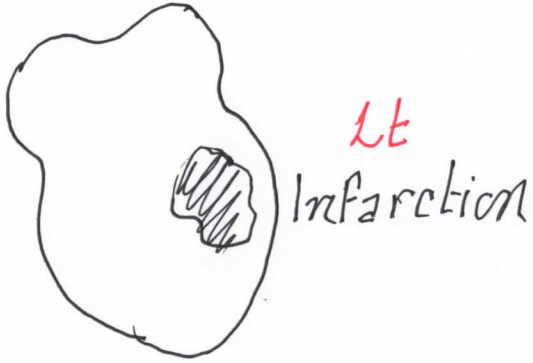
**Prolonged**
- P-R: A-V block; 1st degree Heart block; Atrial enlargement; Vagal stim..
- QT: -- HR; Prolonged $QT_c$ ($QT/\sqrt{PR}$) risk factor for Vent tachyarrhythmia & sudden death (genetic - medication)

**Shortened**
- P-R: A-V nodal rhythm; Wolf Parkinson White syndrome (by passing AV node)
- QT: ++ HR; Severe hypocalcemia

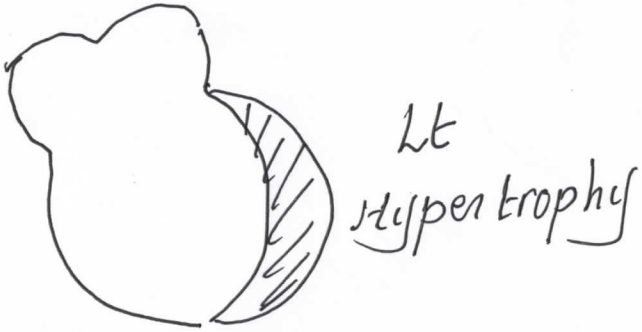
# Rt axis deviation



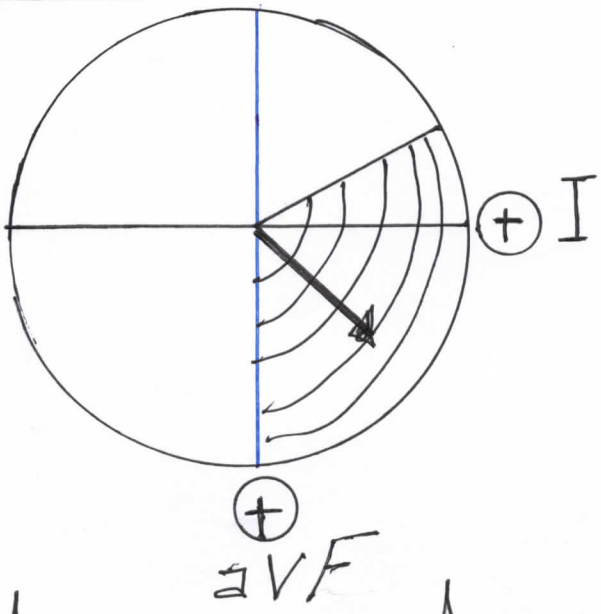



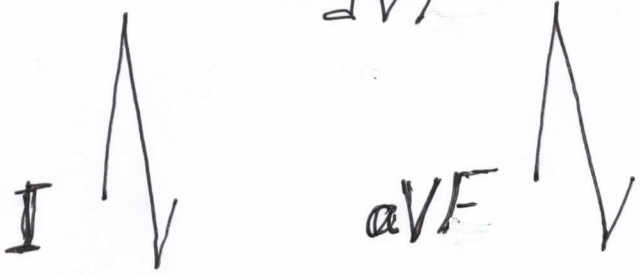




# Lt axis deviation

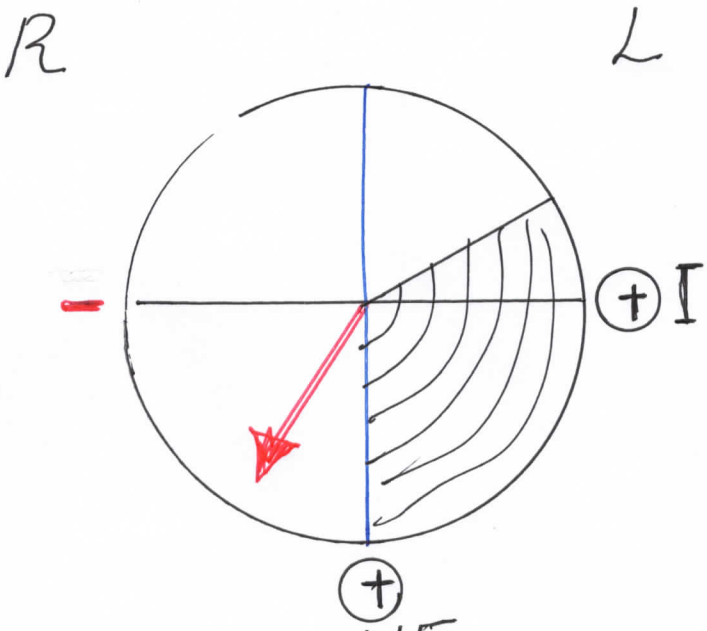



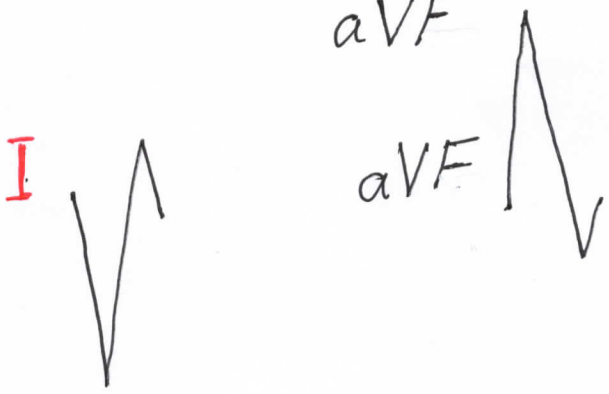

Normal



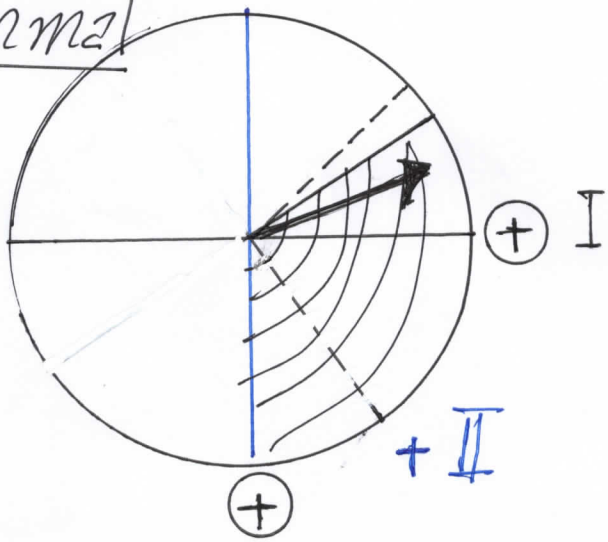




Rt axis deviation



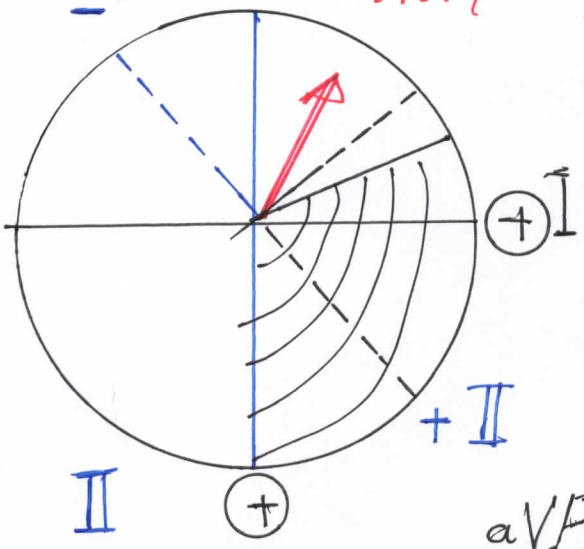



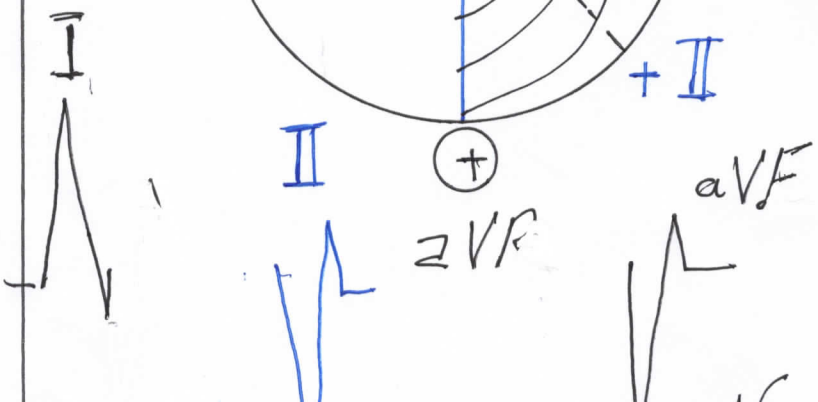

Normal





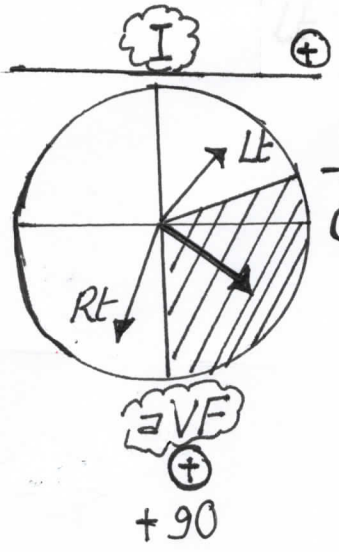
Lt axis deviation



# Electrical Axis of the heart — Mean QRS Cardiac Vector

- **Def** Mean Value of V. depol. QRS
- **Represented by** Vector (Direction & Amplitude)
- **Normal direction** $-30°$ to $+90°$




**Rt axis deviation**

**QRS** -ve in Lead I
+ve in aVF

**Axis** More than $+90°$

**Physiol.** Long selender

**Path.** RVH
RBBB

**Lt.** ventricular infarction

**Lt axis deviation**

**QRS** +ve in lead I

-ve in aVF & lead II

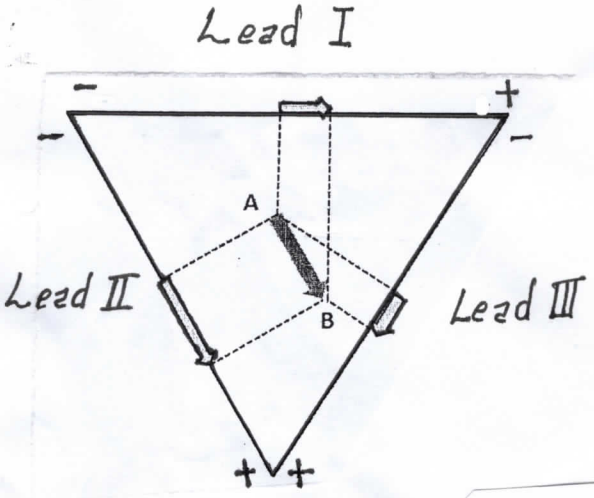
**Axis** Less than $-30°$

Short stunted person.
Full term pregnancy
LVH
LBBB

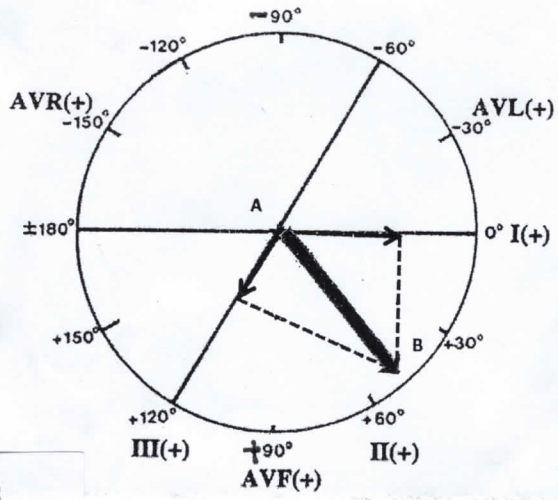
**Rt** ventricular infarction

- **Determination of electrical axis :**

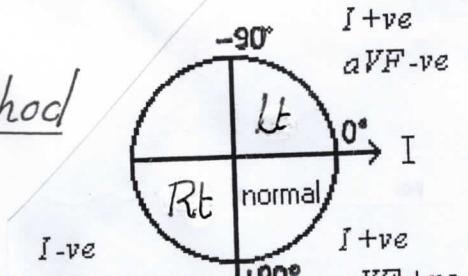
**1** Standard limb leads and Einthoven's tringle

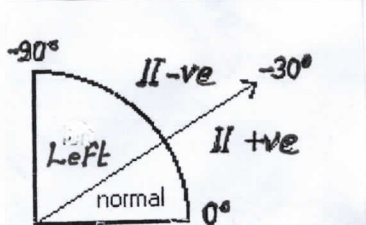



**2** Lead I and lead III in hexaxial reference system




**3** Quick method



# Effect of myocardial ischemia on ECG

**A** less severe or short duration ischemia : **ST segment** Elevated or Depressed.

Injury current from ischemic depol area to surrounding normal area

Due to ↓ Membrane depol caused by ↑↑ $K^+$ in ECF

-- ATP < opening of $K_{ATP}$ channels
-- $Na^+$- $K^+$ pump

2 -- slope of phase 0 & -- conduction velocity.

**a** Transmural ischemia

Elevation

Away from overlying electrode

**ST segment**

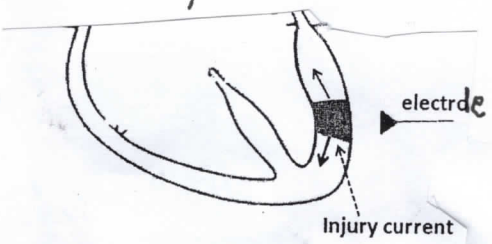
Injury current

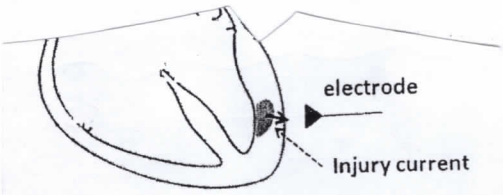
**b** Subendocardial ischemia

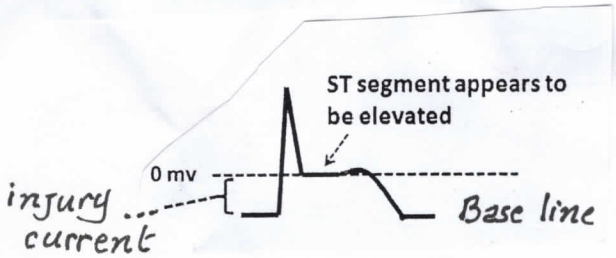
Depression

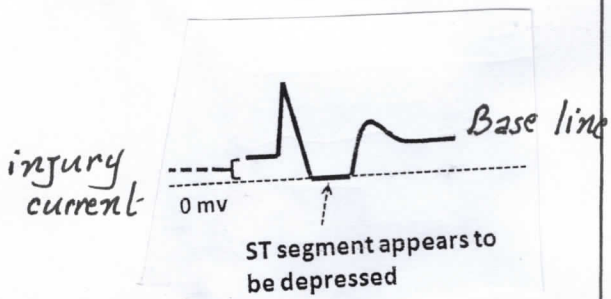
Towards overlying electrode

Depression Base line Elevation




**B** Severe & prolonged ischemia : **Pathological Q**

Pathological Q i.e larger & longer i.e > 25% of its R

> 0.04 sec