Electrocardiography

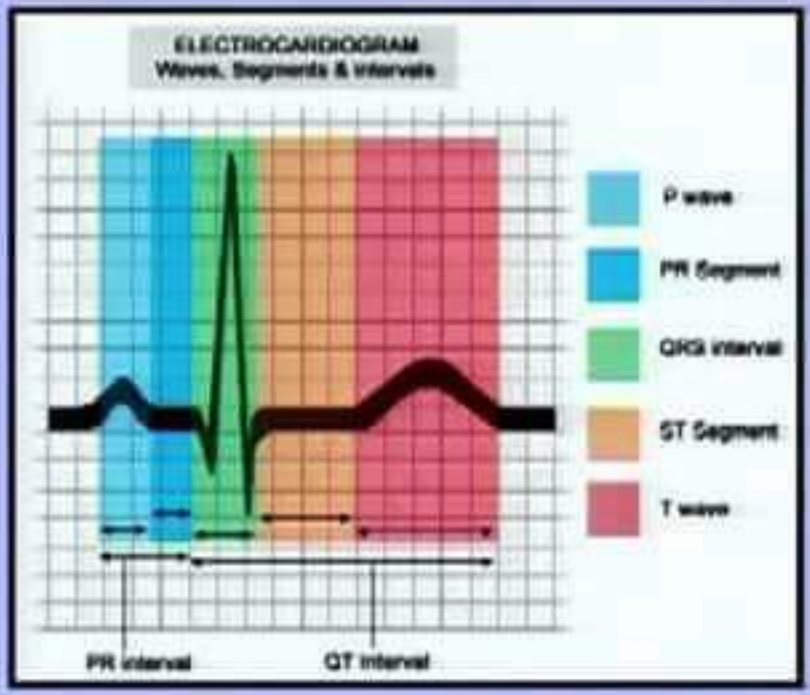
- *Electrocardiography:* **Technique of recording ("gram") of the electrical activity ("electro") generated by the cells of the heart ("cardio") that reaches the body surface.**

- *Electrocardiogram* **is the graph obtained by the above technique**

- *Electrocardiograph* **is the machine that records the ECG and consists of a sophisticated galvanometer that detects and records changes in electromagnetic potential between a positive and a negative pole.**

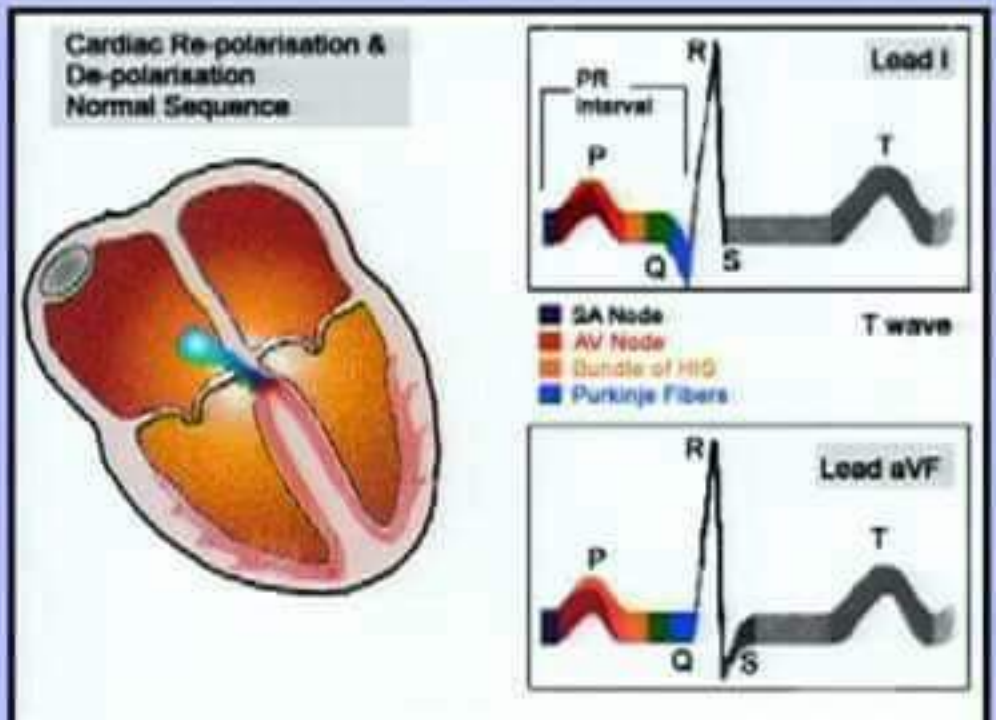
ECG - Description

- Rhythm
- Rate
- QRS axis
- P Wave
- P-R Interval
- QRS complex
- ST Segment
- T Wave
- U Wave
- Q-T Interval



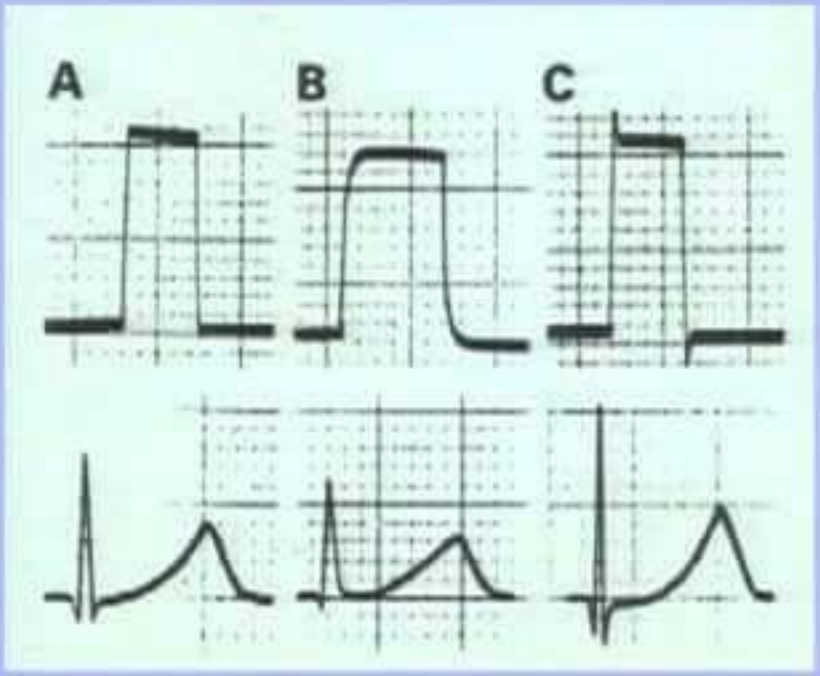
Basic Deflections and Intervals

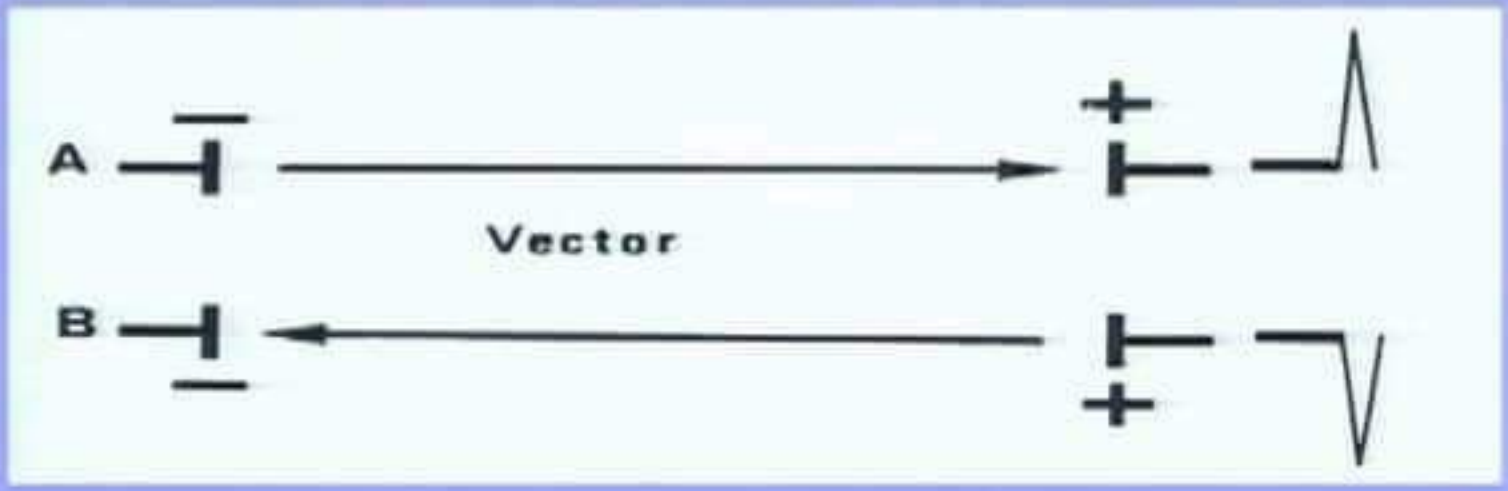
- **P wave** — Atrial depolarization
- **QRS** — Ventricular depolarization
- **T wave** — Ventricular repolarization
- **U wave** — Repolarization of purkinje fibres



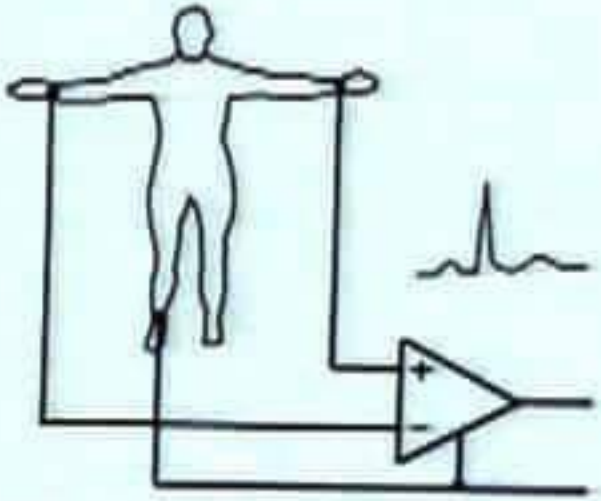
Standardisation

- Normal 1 mV = 10mm, the signal will have clear and perfect right angles to each other
- Over damping happens when the pressure of the writing stylus is too firm resulting in rounding at the edges, and diminished deflections amplitude.
- Under damping happens when the writing stimulus is too loose resulting in sharp spikes at the corners and increased deflections amplitude.

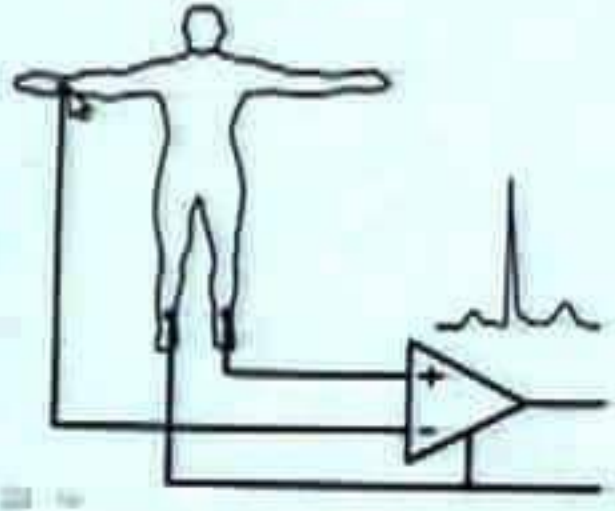



A
Vector
B

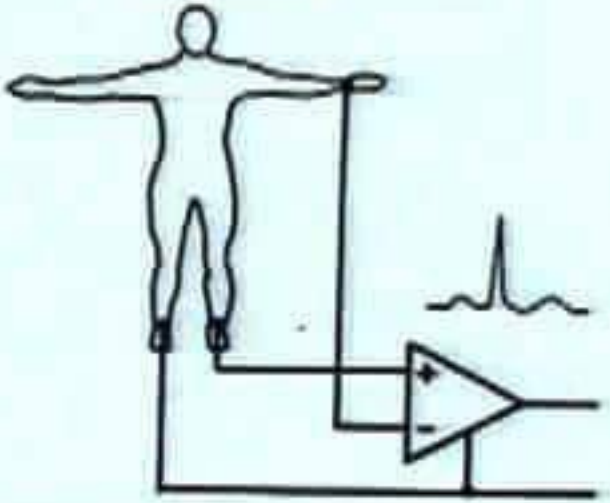
Lead I



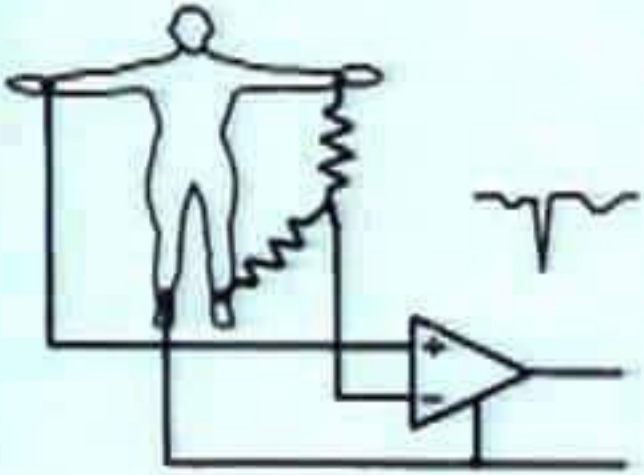
Lead II



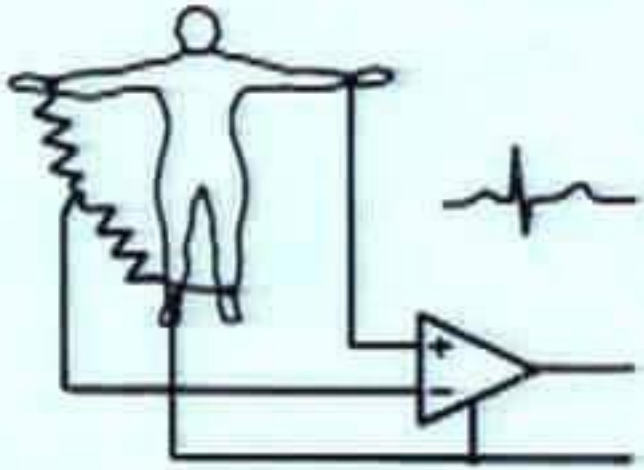
Lead III



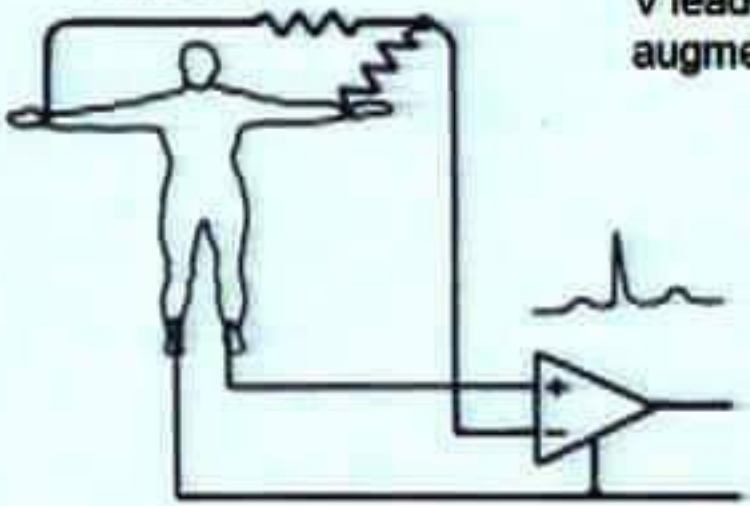
Lead aVR



Lead aVL



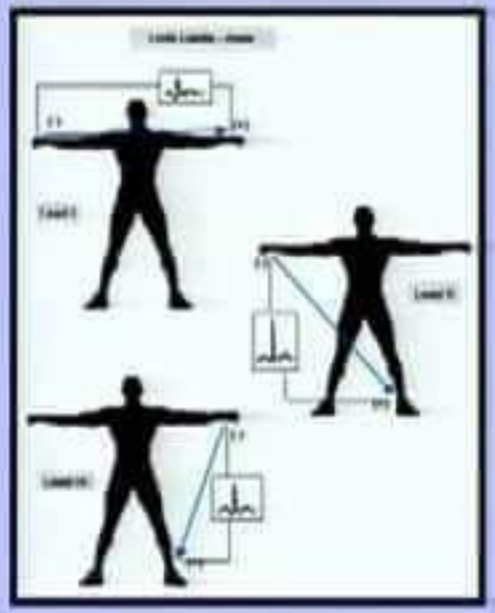
Lead aVF



Exploring electrode
V lead- zero potential
augmentation

Electrode Placement

- Right arm, Left arm, Left leg
- Right leg – for earthing
- Precordial leads – V 1 to V 6
  - V1 Right 4th ICS parasternal
  - V2 Left 4th ICS parasternal
  - V3 Midway between V2 and V4
  - V4 Left 5th ICS MCL
  - V5 Left Ant axillary line, same level as V4
  - V6 Left mid axillary line, same level as V4



Conventionally 12 leads

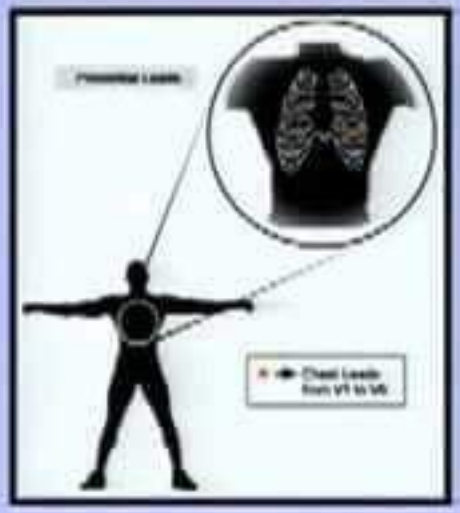
Frontal plane leads

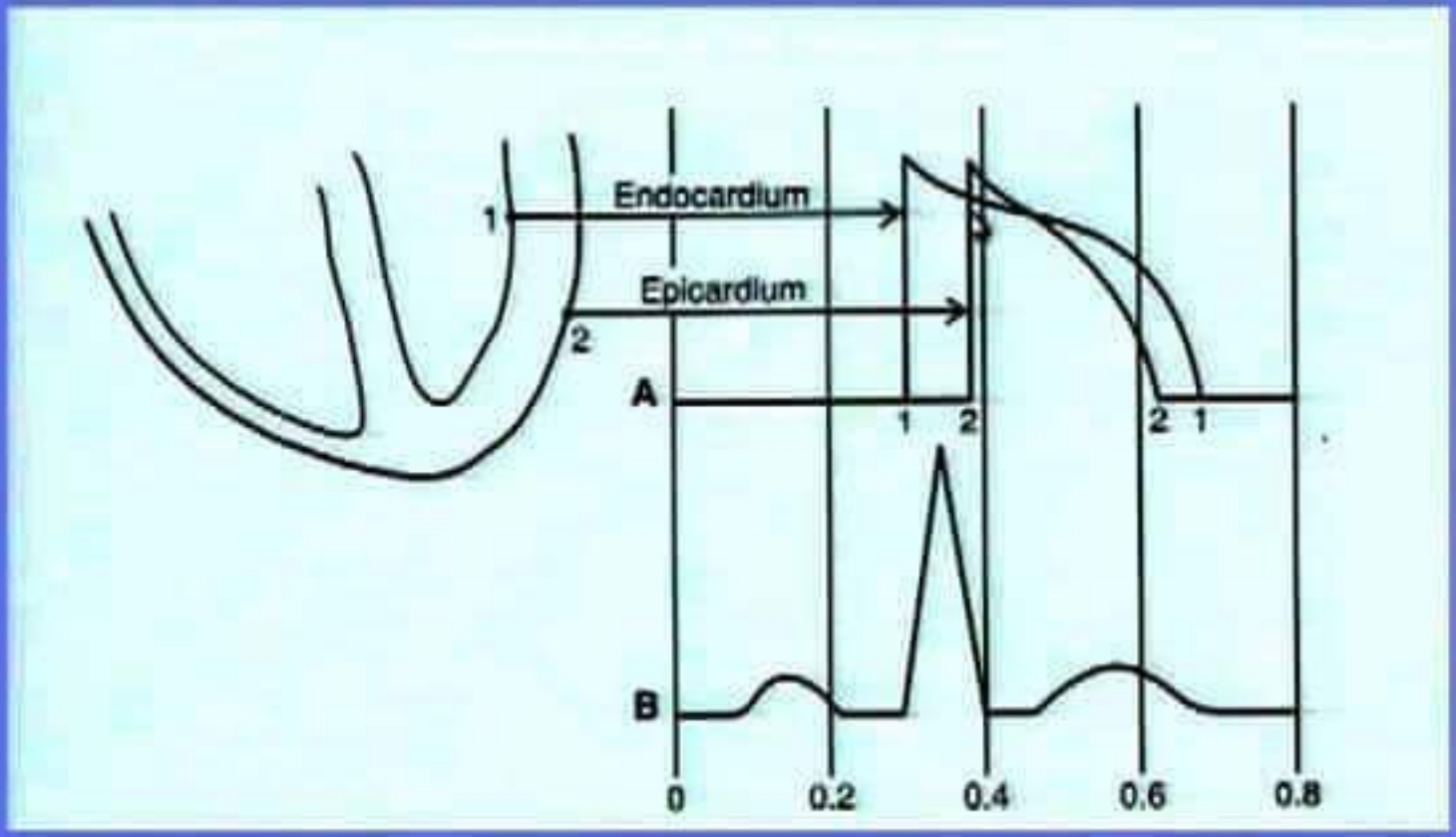
Bipolar limb leads – I, II, III

Modified unipolar leads – aVr, aVl, aVf

Horizontal plane leads

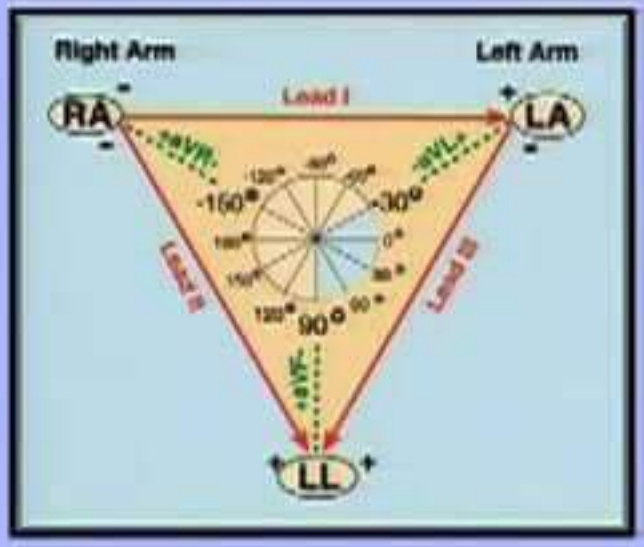
Unipolar precordial leads – V1 to V6

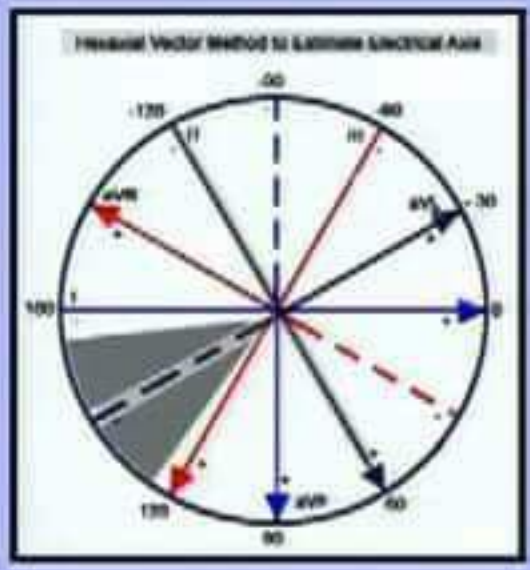


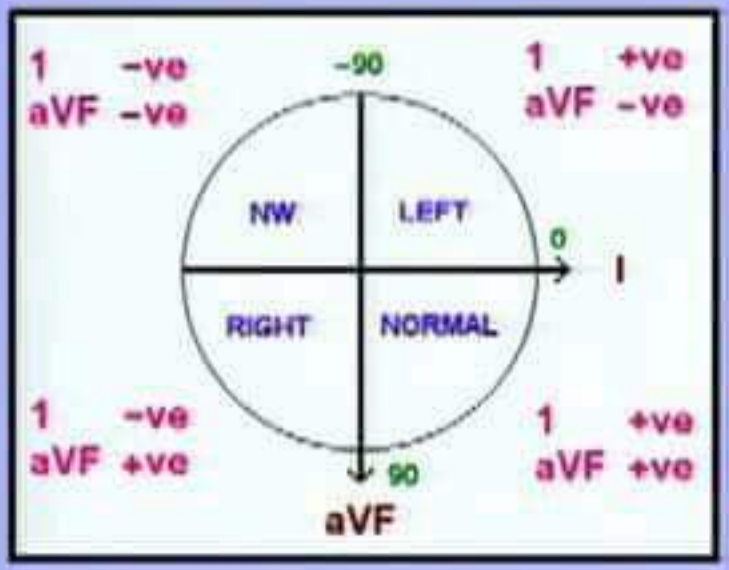

Endocardium
Epicardium
1
2
A
B
1
2
2
1
0
0.2
0.4
0.6
0.8

- These changes are recorded on a graph paper as a plot of voltage on the vertical axis against time on the horizontal axis

- Each lead provides a view of the electrical activity as seen from its particular position on the body surface. A combination of leads allows us to see the electrical activity from various viewpoints.

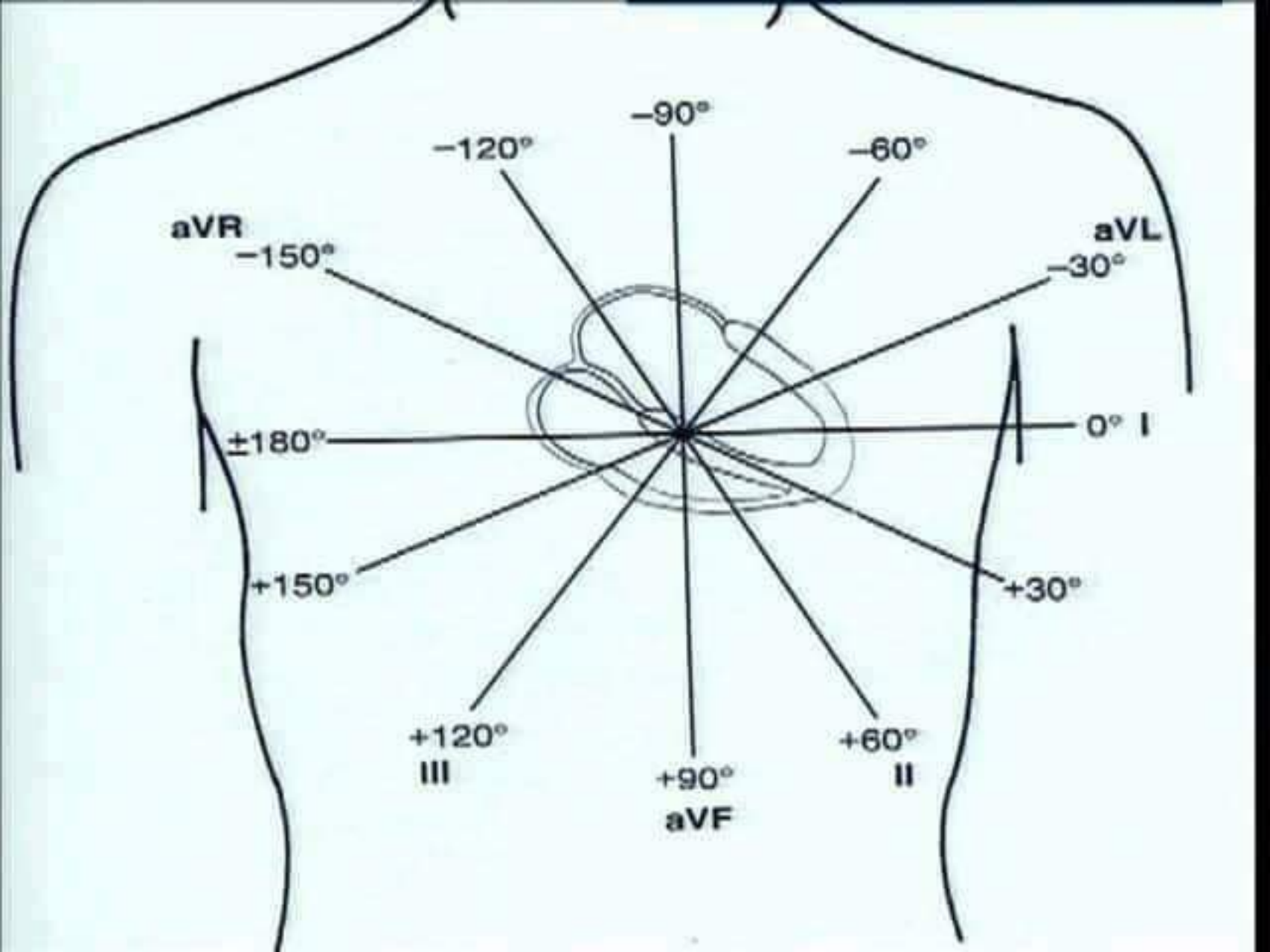






The QRS Axis

Normal:	**-30 to +90**
Right axis deviation:	**+90 to +180**
Left axis deviation:	**-30 to -90**
Northwest axis:	**-90 to -180**


−90°
−120°
−60°
aVR
aVL
−150°
−30°
±180°
0° I
+150°
+30°
+120°
III
+60°
II
+90°
aVF

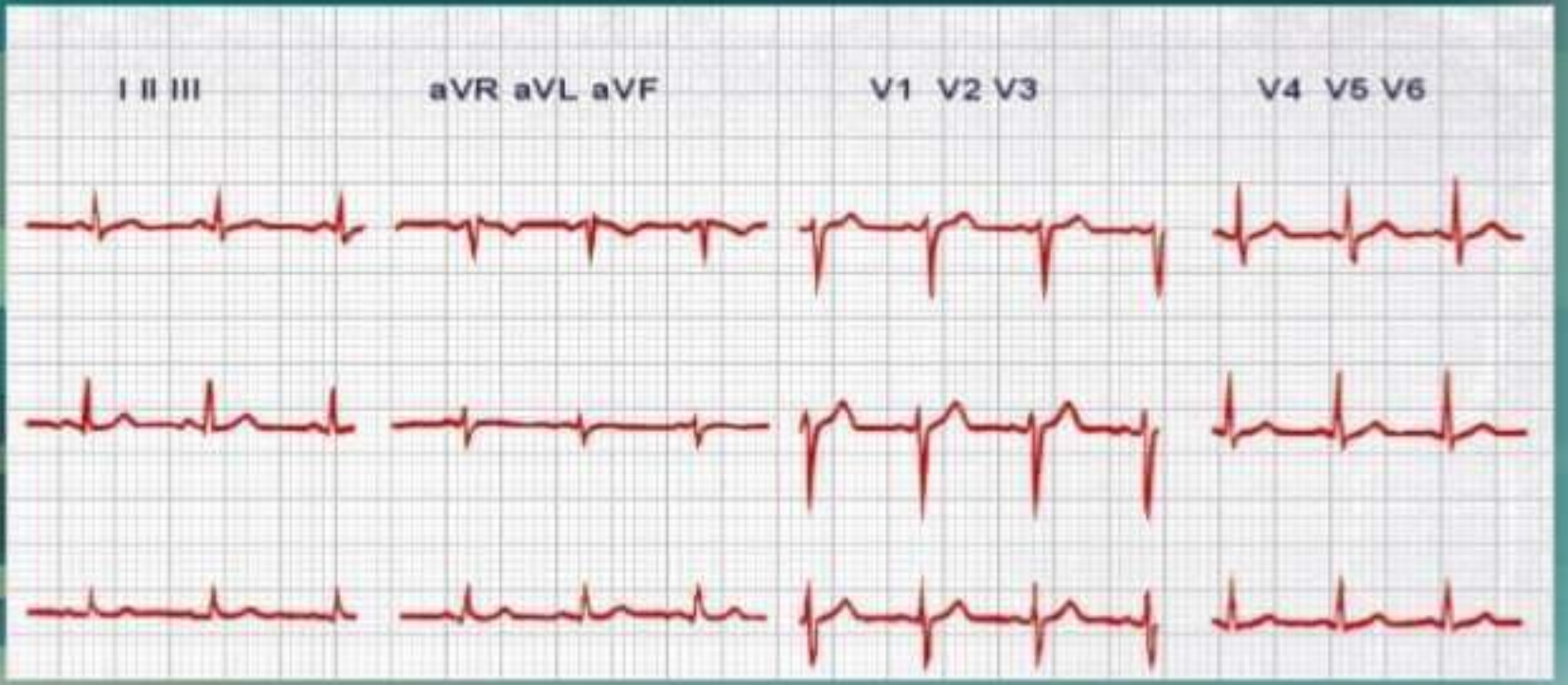
- Calibration 1 mV = 10mm can be reduced to 5mm when QRS complexes are big
- ECG paper speed 25mm/s, fastest speed for clear depiction of wave form morphology
- Reduced electrical artifacts - external or internal
- Supine position while recording ECG

Practical Points for Recording ECG

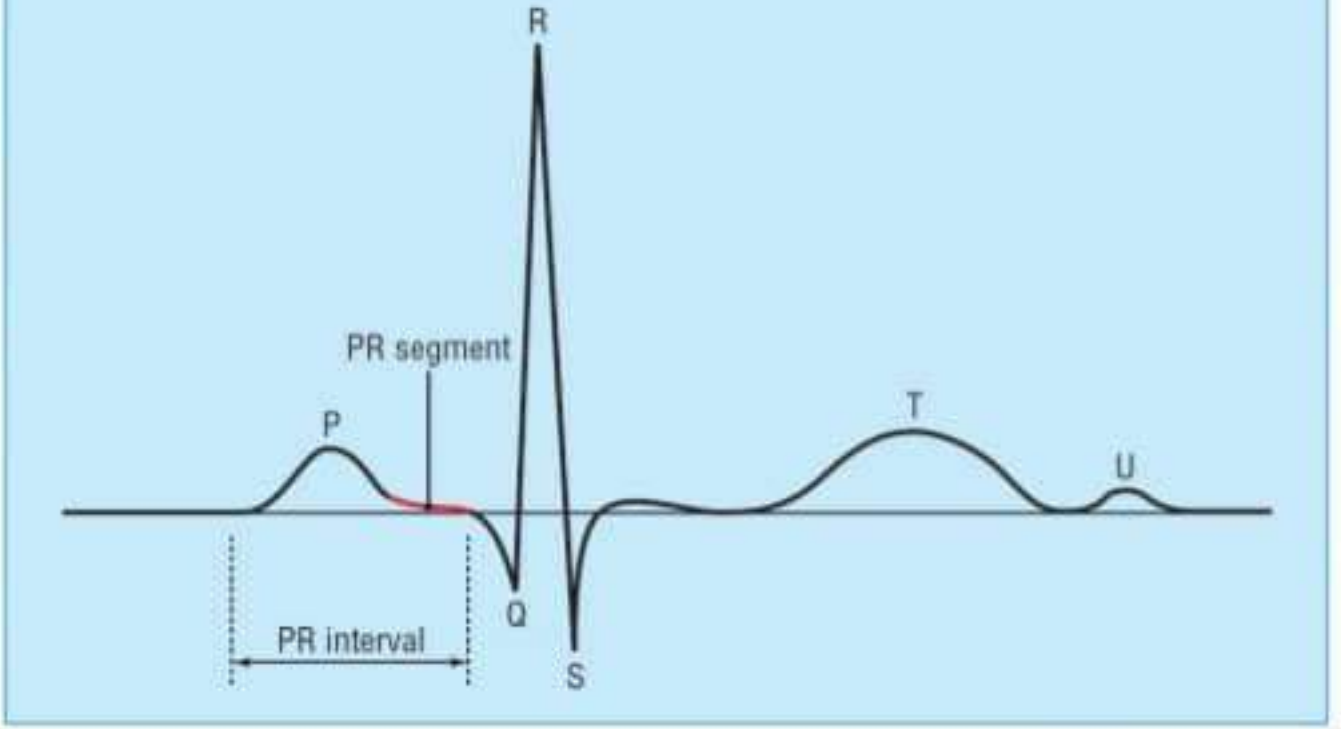
- Electrodes should be selected for
  maximum adhesiveness and
  minimum discomfort, electrical noise and
  skin – electrode impedence.
- Effective contact between electrode and skin essential
- Skin should be clean only with a dry wipe to prevent
  Base line wander when shift occurs gradually
  Shifting baseline when shifting occurs abruptly

ECG RULES

- Professor Chamberlains 10 rules of normal:-



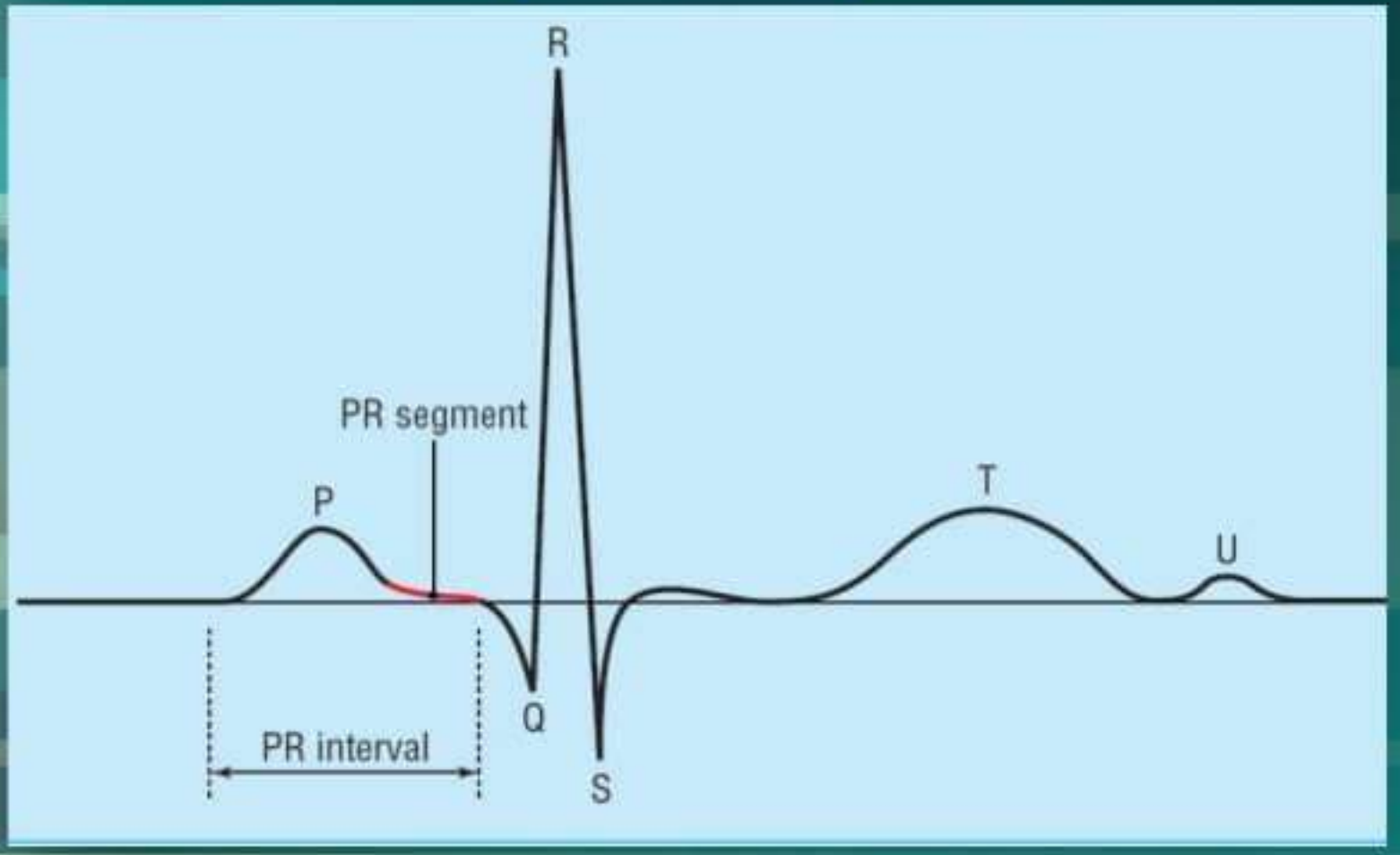
RULE 1



Normal duration of PR interval is 0.12-0.20 s (three to five small squares)

PR interval should be 120 to 200 milliseconds or 3 to 5 little squares

RULE 2

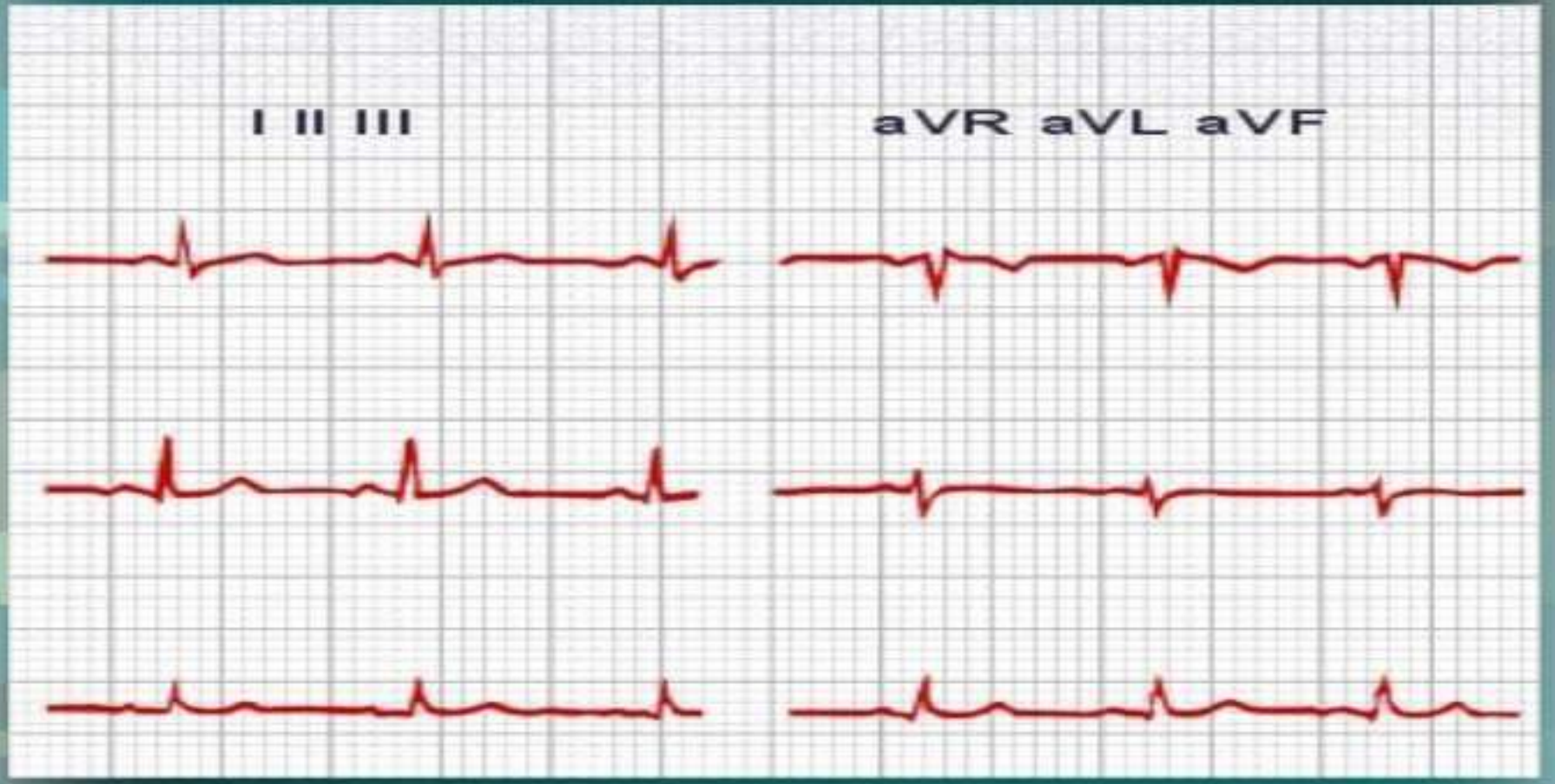


The width of the QRS complex should not exceed 110 ms, less than 3 little squares

RULE 3

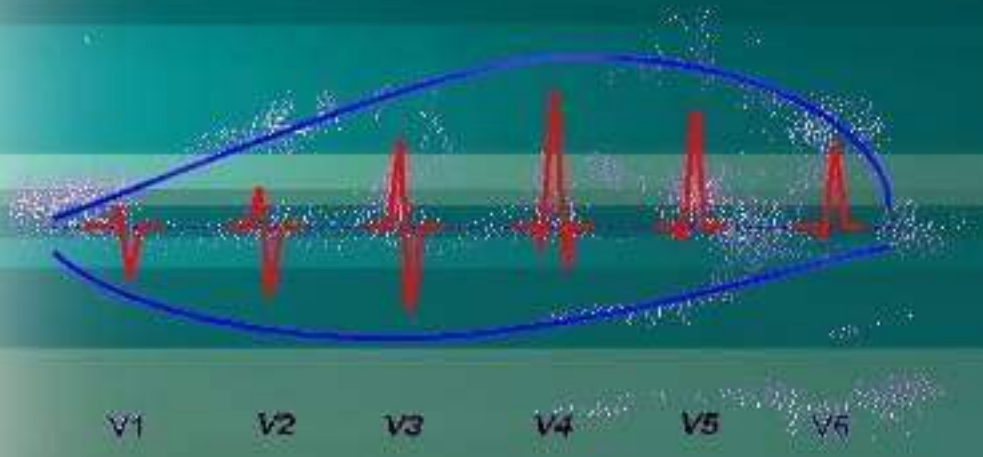
The QRS complex should be dominantly upright in leads I and II

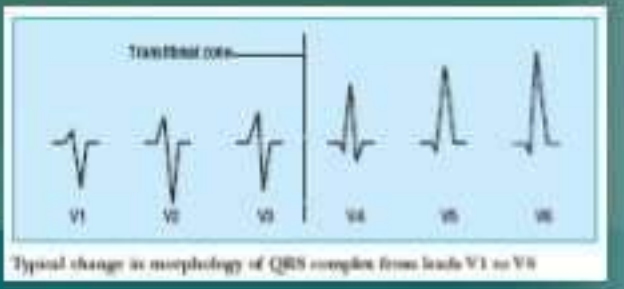
RULE 4



QRS and T waves tend to have the same general direction in the limb leads

RULE 6





Typical change in morphology of QRS complex from leads V1 to V6

The R wave must grow from V1 to at least V4

The S wave must grow from V1 to at least V3 and disappear in V6

RULE 7

The ST segment should start isoelectric except in V1 and V2 where it may be elevated

RULE 8

The P waves should be upright in I, II, and V2 to V6

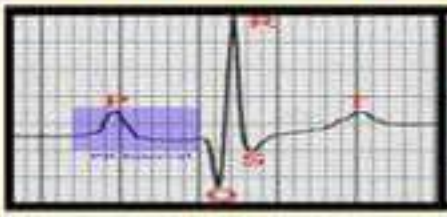
RULE 9

There should be no Q wave or only a small q less than 0.04 seconds in width in I, II, V2 to V6

RULE 10

The T wave must be upright in I, II, V2 to V6

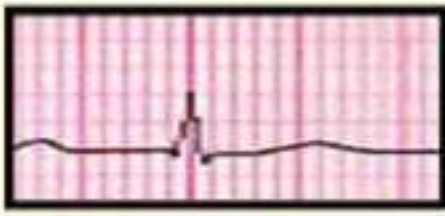
PR interval (interval before ventricular depolarization)



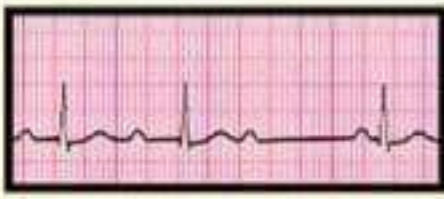
*** Normal :**
* from start of P to start of Q
* length : 3 - 5 mm

*** Short with normal P :**
* length < 3 mm
* normal P
* in preexitation
* delta wave in WPW
* no delta wave in LGL

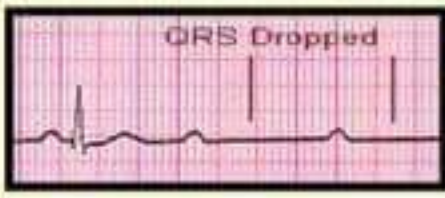
*** Short with inverted P :**
* length < 3 mm
* inverted P
* in nodal rhythm



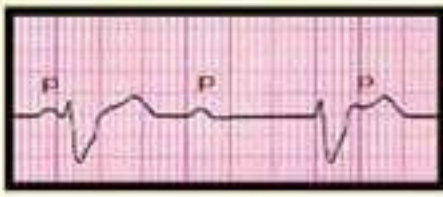
*** Fixed long :**
* fixed length > 5 mm
* in 1st degree heart block



*** Progressive long :**
* progressive long till QRS dropped
* in 2nd degree heart block (type 1)

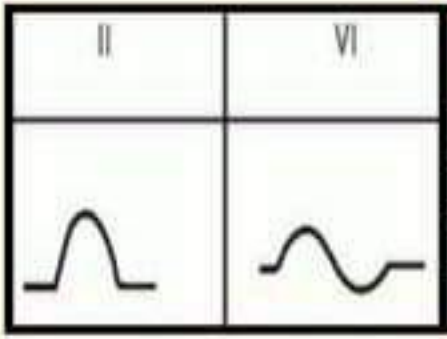


*** Fixed with dropped beats :**
* fixed normal or long with QRS dropped
* in 2nd degree heart block (type 2)



*** Variant :**
* complete dissociation between P & QRS
* in 3rd degree heart block

P wave (atrial depolarization)



*** Normal :**

* first + ve deflection
* upright in II / inverted in aVR
* monophasic in II / biphasic in V1
* size : 2.5 × 2.5 mm

*** Absent :**

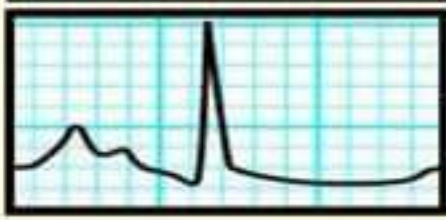
* non sinus rhythm

*** P pulmonale :**

* tall peaked P wave
* right atrial enlargement

*** P mitrale :**

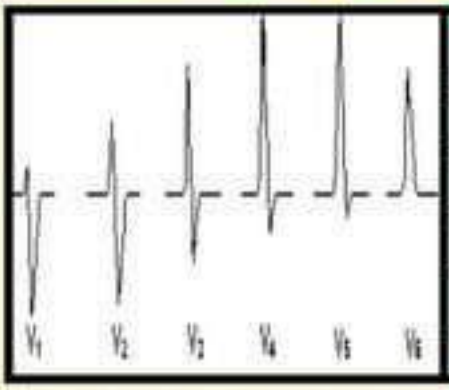
* wide notched P wave
* left atrial enlargement



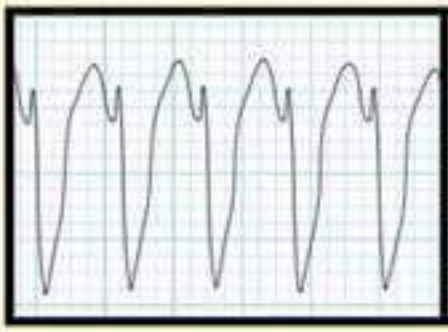
*** Double lesion :**

* tall & wide P wave
* biatrial enlargement

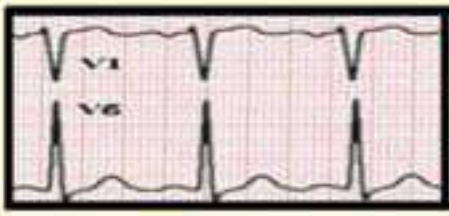
QRS complex (ventricular depolarization)



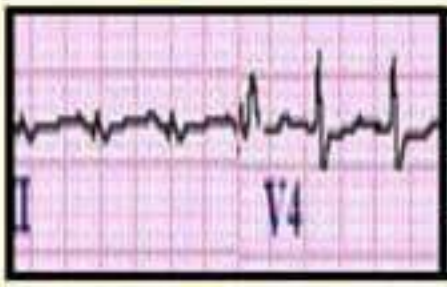
*** Normal :**
* width : < 2.5 mm
* height : I + II + III > 15 mm
* supraventricular rhythm
* dominant S in V1
* dominant R in V6



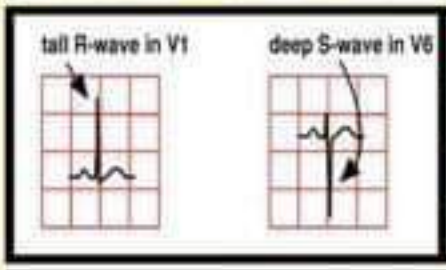
*** Broad Complex :**
* width : > 2.5 mm
* in ventricular rhythm
* incomplete BBB : 2.5 - 3 mm
* complete BBB : > 3 mm



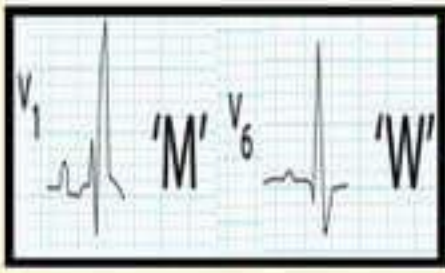
*** High voltage :**
* S in V1 + R in V6 > 35 mm
* in LVH



*** Low voltage :**
* height < 5 mm in limb leads
* height < 10 mm in chest leads
* in damping state as COPD & effusion



*** Dominant R in V1 :**
* dominant R in V1
* deep S in V6
* in RVH



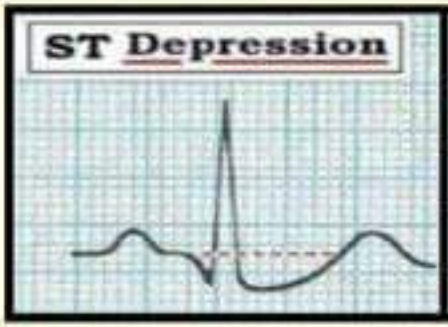
*** MarroW pattern :**
* terminal large R in V1 (R - rsR - qR)
* W shape in V6
* in RBBB

*** WiliaM pattern :**
* terminal large S in V1 (QS - rS)
* M shape in V6
* in LBBB

ST segment (interval before ventricular repolarization)

*** Normal :**
* from end of S to start of T
* slight concave upward
* isoelectric
* J point is junction between QRS & ST

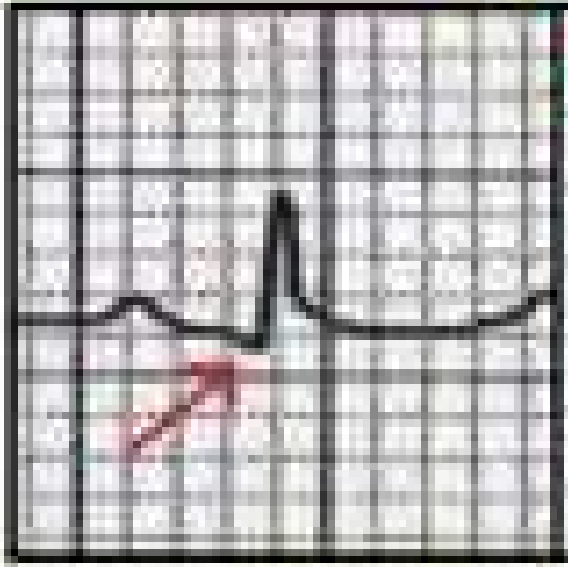
*** Elevation :**
* > 1 mm in limb leads after J
* > 2 mm in chest leads after J
* in STMI - pericarditis - LVH - LBBB
* reciprocal depression if MI



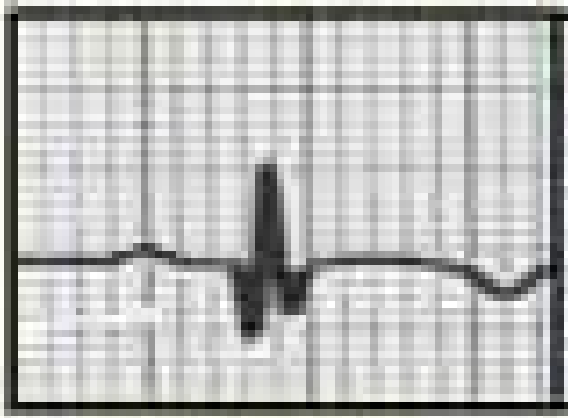
*** Depression :**
* > 1 mm in limb leads after J
* > 2 mm in chest leads after J
* in ischemia - posterior MI - RVH - RBBB
* reciprocal elevation if MI

*** J wave (Osborn wave) :**
* + ve deflection at J point
* in hypothermia - hypercalcemia - CNS insults (injury - hemorrhage)

Q wave (septal depolarization)

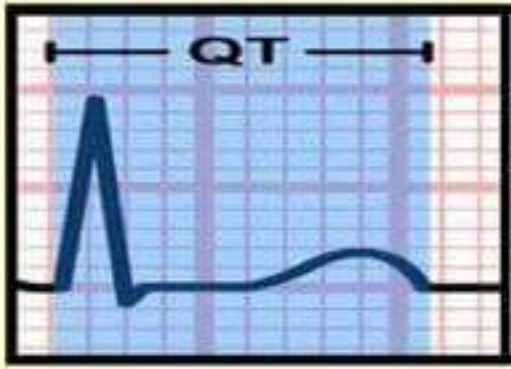


* Normal :
* - ve deflection before R
* present in left leads V5 - V6
* absent in right leads V1 - V3
* width : < 1 mm
* height : < 2 mm
* size : < 25 % of R



* Pathological :
* width : > 1 mm
* height : > 2 mm
* size : > 25 % of R
* In myocardial infarction

QT interval (all ventricular action)

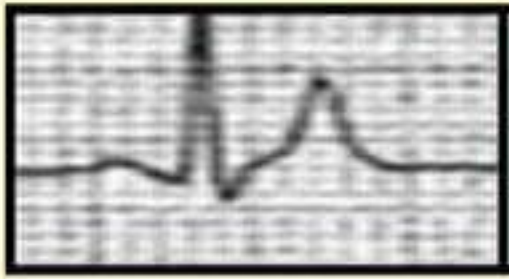


*** Normal :**

* from start of Q to end of T
* best in II - V5 - V6
* length inversly with HR
* lenght : 9 - 12 mm

*** Long :**

* > 12 mm
* risk of torsades de pointes
* in congenital cases - antiarrhythmics - hypokalemia - hypocalcemia - ischemia



*** Short :**

* < 9 mm
* in congenital - digitalis - hypercalcemia

U wave (repolarization of purkinji fibres)

*** Normal :**

* follows T in same direction
* best in V1 - V1
* seen in young athletes
* seen if HR < 65 bpm
* height inversly with HR
* height : < 2 mm or < 25 % of T wave

*** Large :**

* in bradycardia - hypokalemia - hypocalcemia - hypothermia

*** Inverted :**

* in CAD - HTN