ECG

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An ECG is a linear graphic recording of the electrical impulses generated in the heart during the cardiac cycle. The electrical impulses are measured by electrodes on the skin. Electrodes on different sides of the heart measure the activity of different parts of the heart muscle. The ECG displays the voltage between pairs of these electrodes, and the muscle activity that they measure. This indicates the overall rhythm of the heart and abnormalities in different parts of the heart muscle. It's the best way to measure and diagnose abnormal rhythms of the heart

Rhythm : **a strong, regular repeated pattern of movement or sound.**

In a 12 lead ECG, three groups of leads are used, each looking at different aspects of the heart:

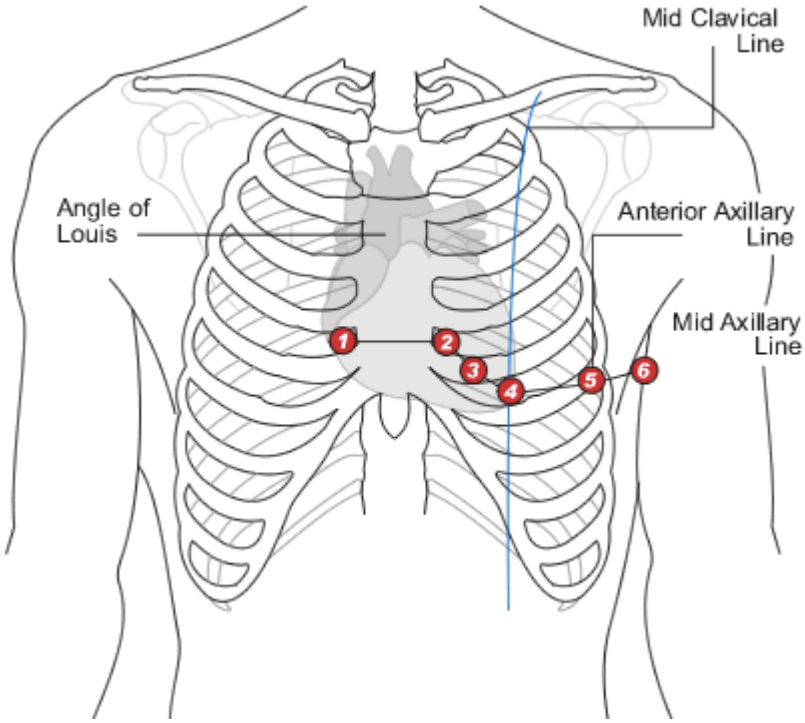
- **Bipolar limb leads**
- **Unipolar limb leads**
- **Unipolar precordial (chest) leads.**

Chest Leads

There are 10 wires on an ECG machine that are connected to specific parts of the body. These wires break down into 2 groups:

1. 6 chest leads
2. 4 limb or peripheral leads (one of these is "neutral")

The 6 chest leads are positioned as below



Each of the precordial, or chest leads, can be read as pairs looking at different views of the heart.

Leads V1 and V2 have a septal view.

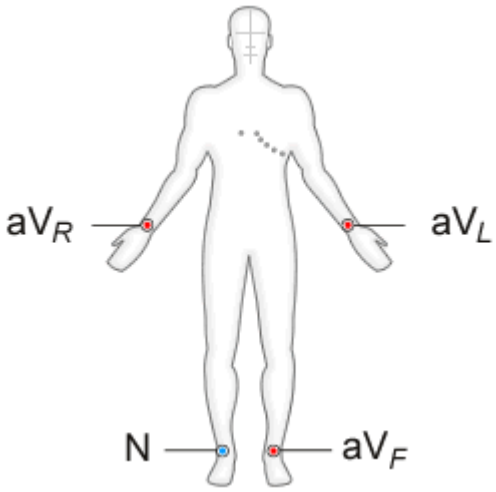
Leads V3 and V4 have an anterior view.

Leads V5 and V6 have a lateral view

Limb Leads

Limb leads are made up of 4 leads placed on the extremities: left and right wrist; left and right ankle.

The lead connected to the right ankle is a neutral lead, like you would find in an electric plug. It is there to complete an electrical circuit and plays no role in the ECG itself.



Unipolar Leads

But, wait a minute. That gives us nine wires and it is a 12-lead ECG. Where are the other 3?

Well, so far we have nine wires. They all look directly at the heart with tunnel vision. They only give information based on what is immediately in front of them. These nine wires are known as "unipolar leads".

The three active peripheral leads are AVr, AVL, and AVf.

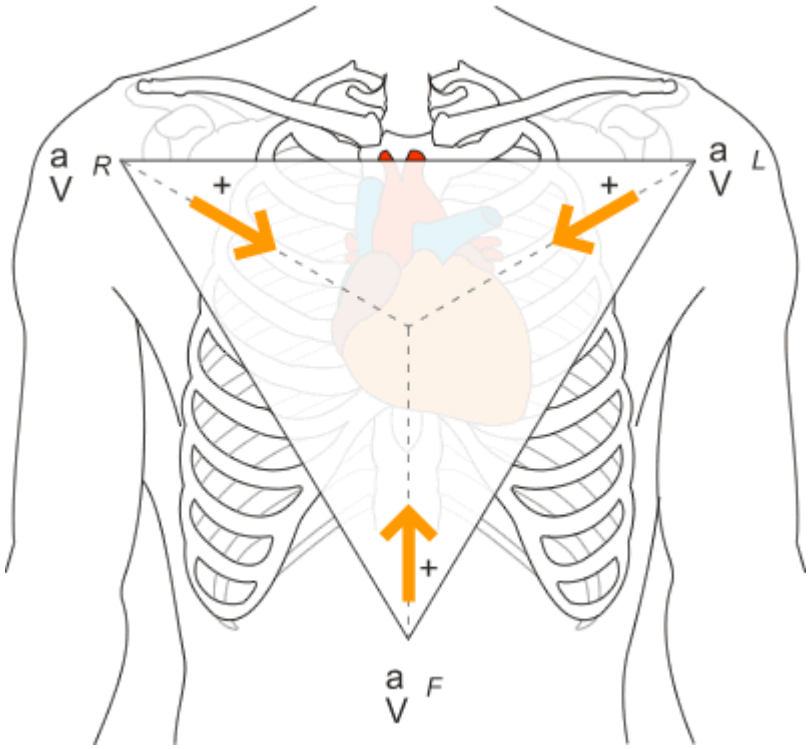
The "AV" stands for "Augmented Vector". The last letter refers to position, which are as follows:

table displaying the label of the bipolar lead, its meaning and its location on the body

Label	Meaning of label	Position of lead on body
AVr	Augmented vector right	Right wrist
AVL	Augmented vector left	Left wrist
AVf	Augmented vector foot	Left foot

These 3 leads create a triangle with the heart in the middle, as below. The lines into the centre indicate the line of sight of these leads.

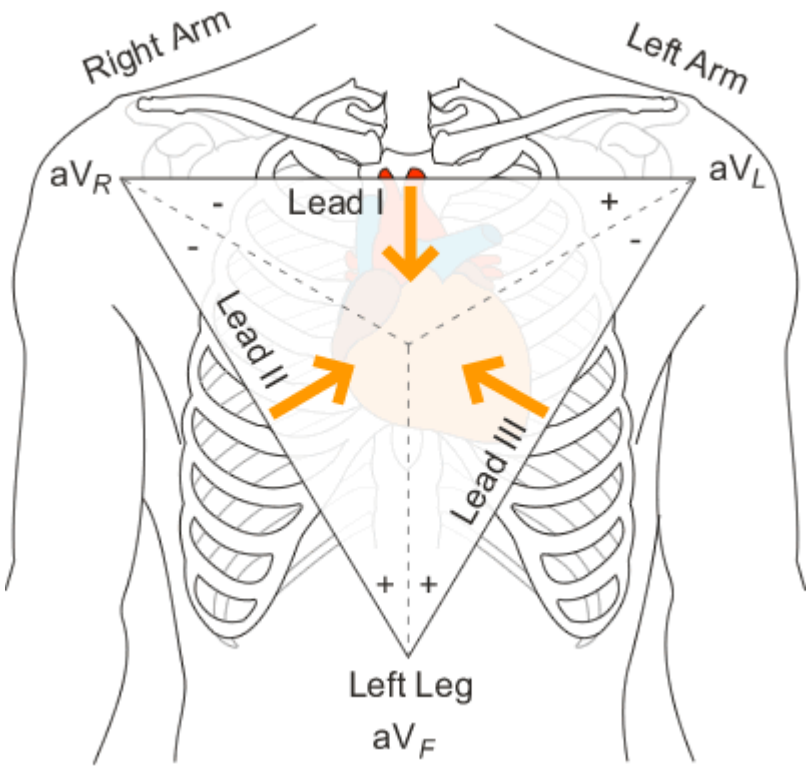
Image: Line of site of the unipolar lead



Bipolar Leads

Well, the 2 leads situated on the right and left wrist (or shoulders), AVr and AVL respectively, and the lead situated on the left ankle (or left lower abdomen) AVf, make up a triangle, known as "**Einthoven's Triangle**". Information gathered between these leads is known as "bipolar". It is represented on the ECG as 3 "bipolar" leads. So,

- information between AVr and AVl is known as lead l.
- Information between AVr and AVf is known as lead ll
- Information between AVl and AVf is known as lead lll

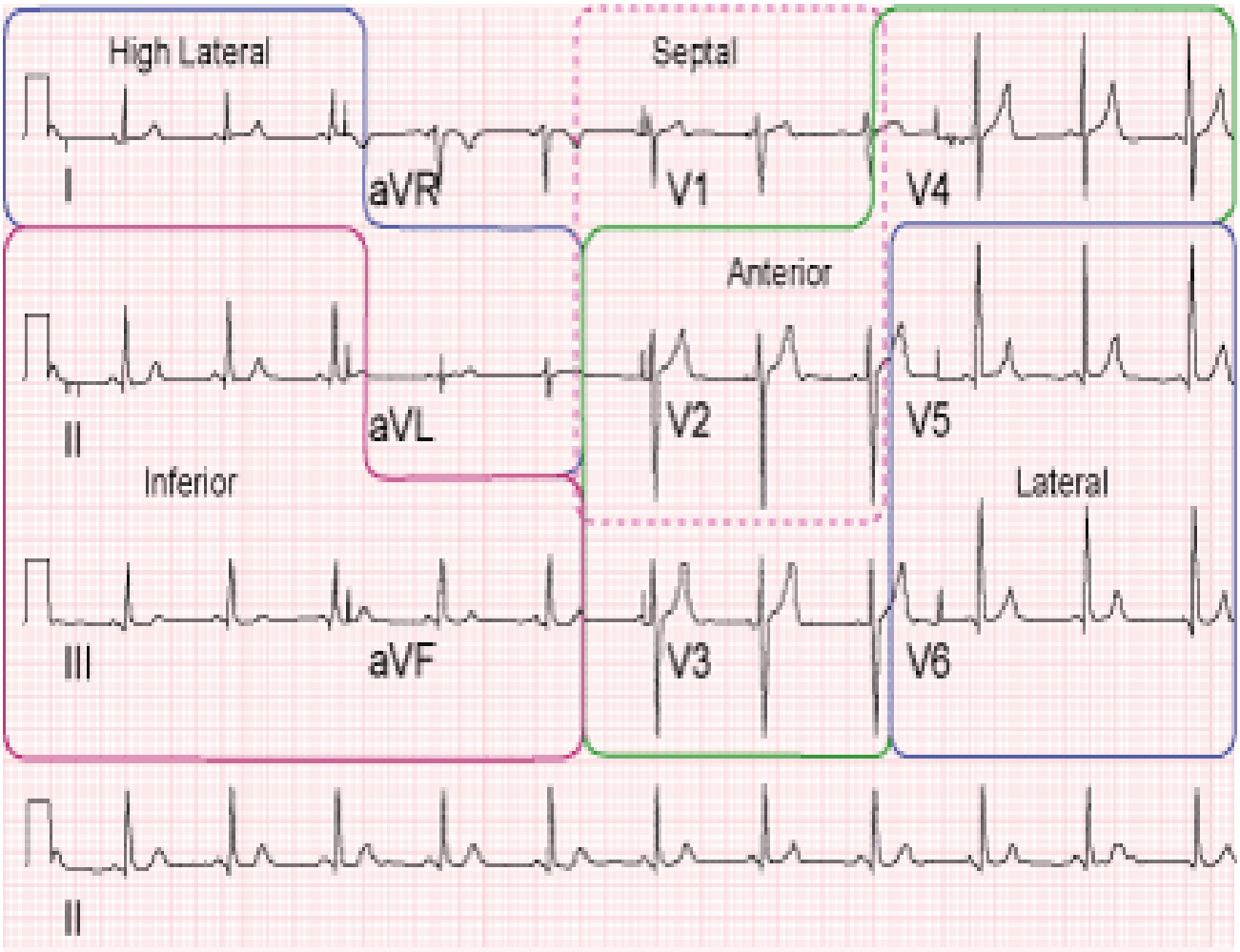


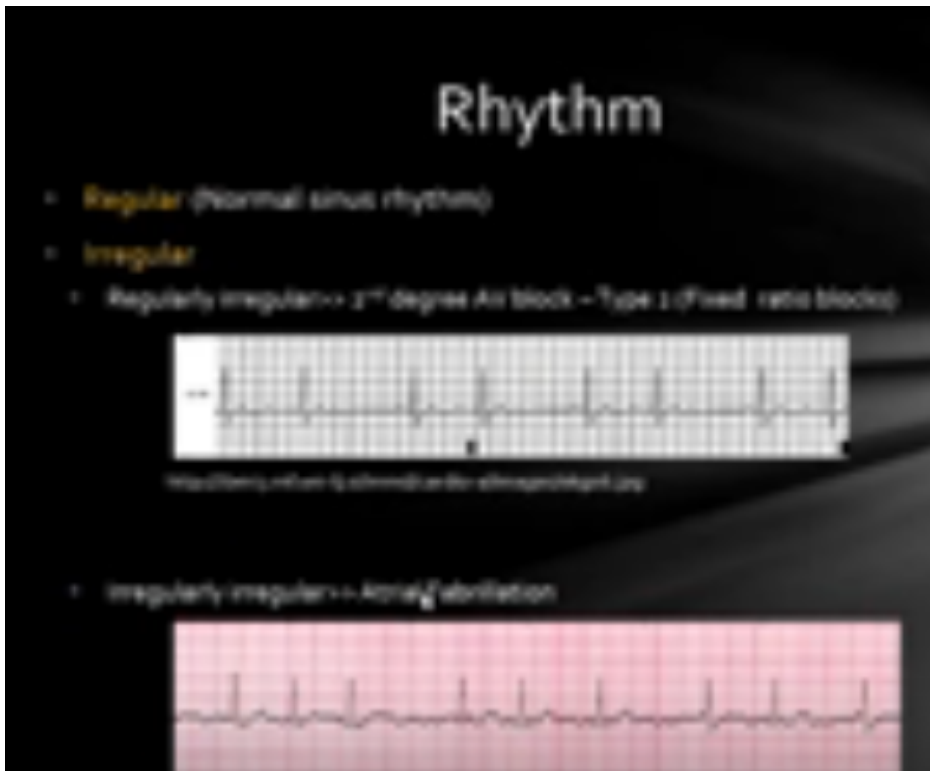
Now we have 12 leads, we need to know which regions of the heart each lead is looking at and what groups they make up.

Regions of the Heart

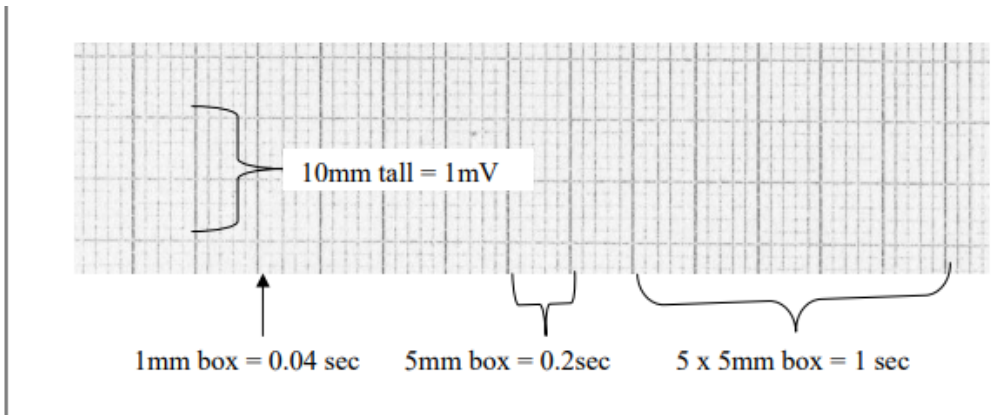
- AVL is on the left wrist or shoulder and looks at the upper left side of the heart.
- Lead l travels towards AVL creating a second high lateral lead.
- AVf is on the left ankle or left lower abdomen and looks at the bottom, or inferior wall, of the heart.
- Lead ll travels from AVr towards AVf to become a 2nd inferior lead
- Lead lll travels from AVL towards AVf to become a 3rd inferior lead.
- V2 V3 and V4 look at the front of the heart and are the anterior leads.
- V1 is often ignored but if changes occur in V! and V2 only, these leads are referred to as Septal leads.
- V5 and V6 look at the left side of the heart and are the lateral leads.

The ECG below shows where these leads are when printed


High Lateral
Septal
I
aVR
V1
V4
Anterior
II
aVL
V2
V5
Inferior
Lateral
III
aVF
V3
V6
II


Rhythm
Regular (Normal sinus rhythm)
Irregular
Regularly irregular-> 2nd degree AV block -> Type 1 (Fixed ratio blocks)
Irregularly irregular-> Atrial fibrillation

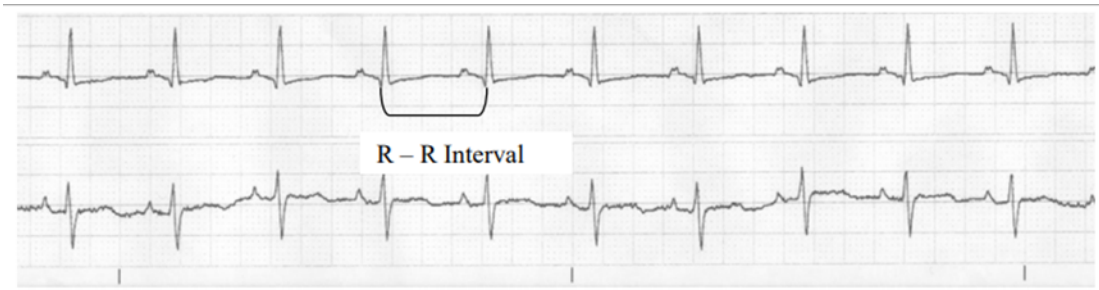
Now, let's take a look at the ECG paper. The ECG paper provides a measurement of the heart's electrical impulses measured against time. ECG paper is divided into 1 millimetre small squares and 5 millimetre large squares. The paper moves through the ECG at 25 mm per second. This means that, on the horizontal axis, one small square equals 0.04 seconds. One large square, made up of 5 small ones, equals 0.20 seconds. On the vertical axis, the paper shows the amplitude of the electrical impulse, which is measured in millivolts (mV)

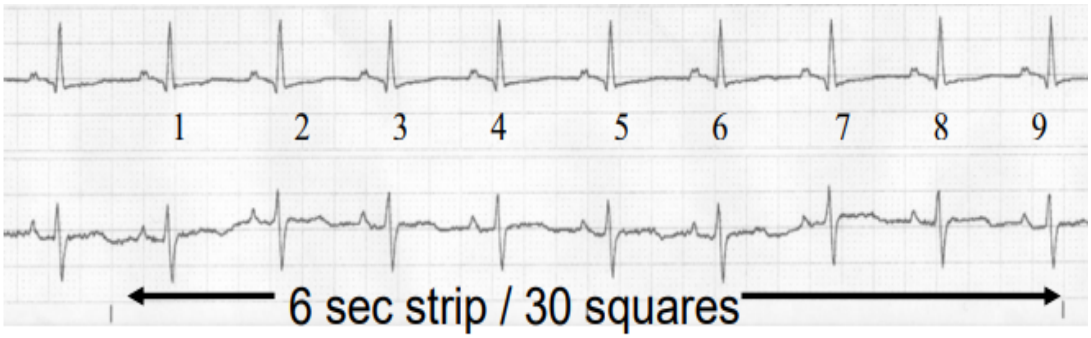


Determining Heart Rate • The PQRST Complex • The P Wave • The PR Interval • The QRS Complex • The T Wave • Normal Electrical Impulse Conduction • The Pacemakers of the Heart • Step-by-step Rhythm Interpretation

Let's look at how to measure heart rate on an ECG. First, count thirty large boxes on the ECG paper. As we've learned, each large box equals 0.20 seconds. So 30 large boxes gives you a six second strip. Next, count the number of beats, or complexes, within the six second strip.

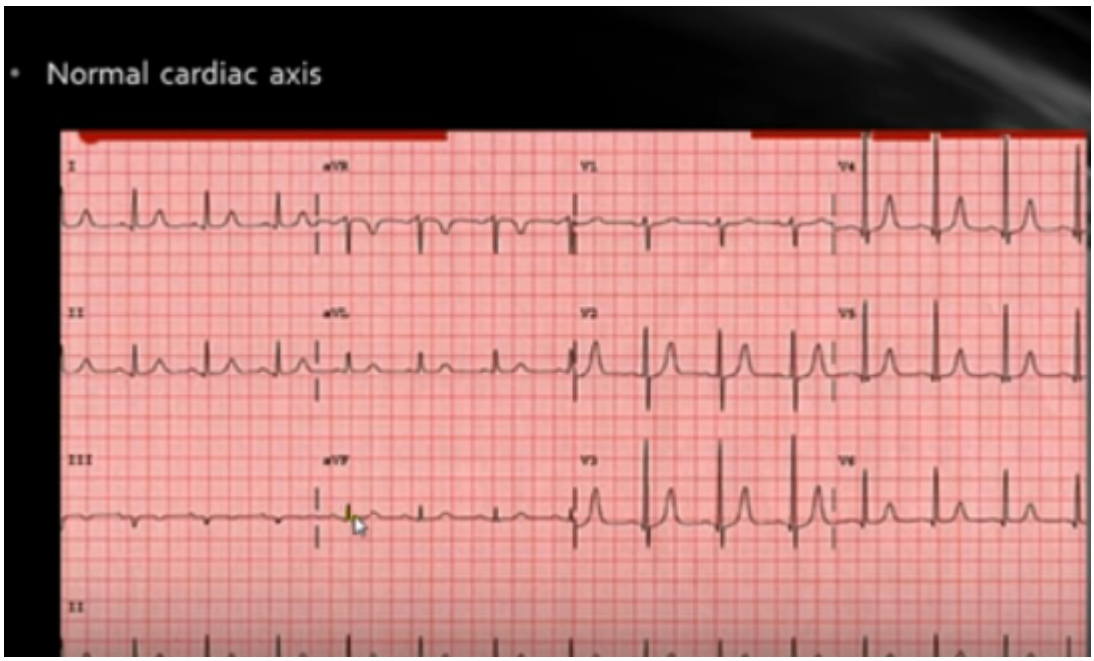
Multiply this number by ten. This will give you the number of heart beats per minute. It's important to note that this method is accurate only to within ten beats per minute.

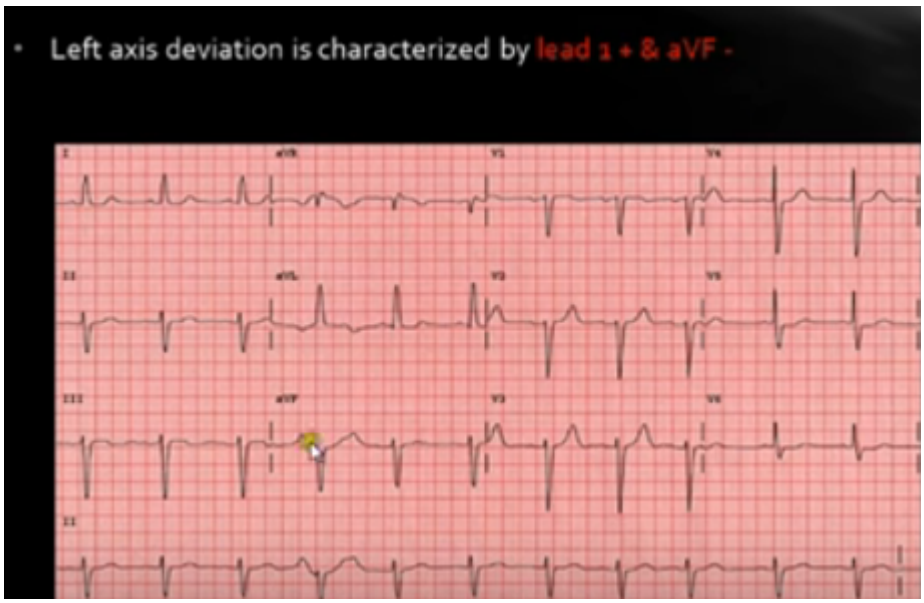


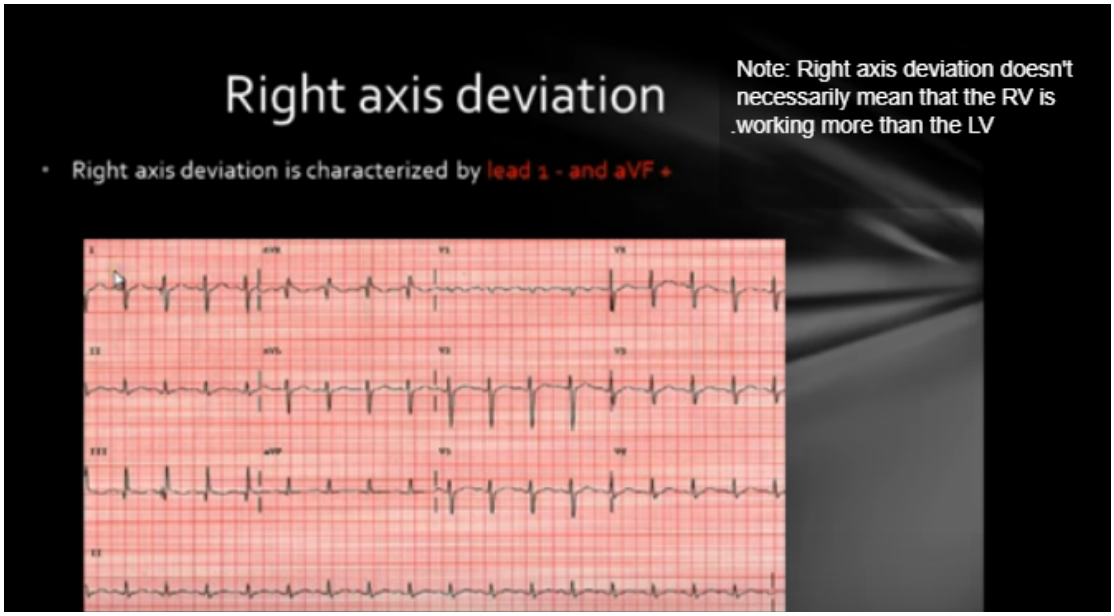


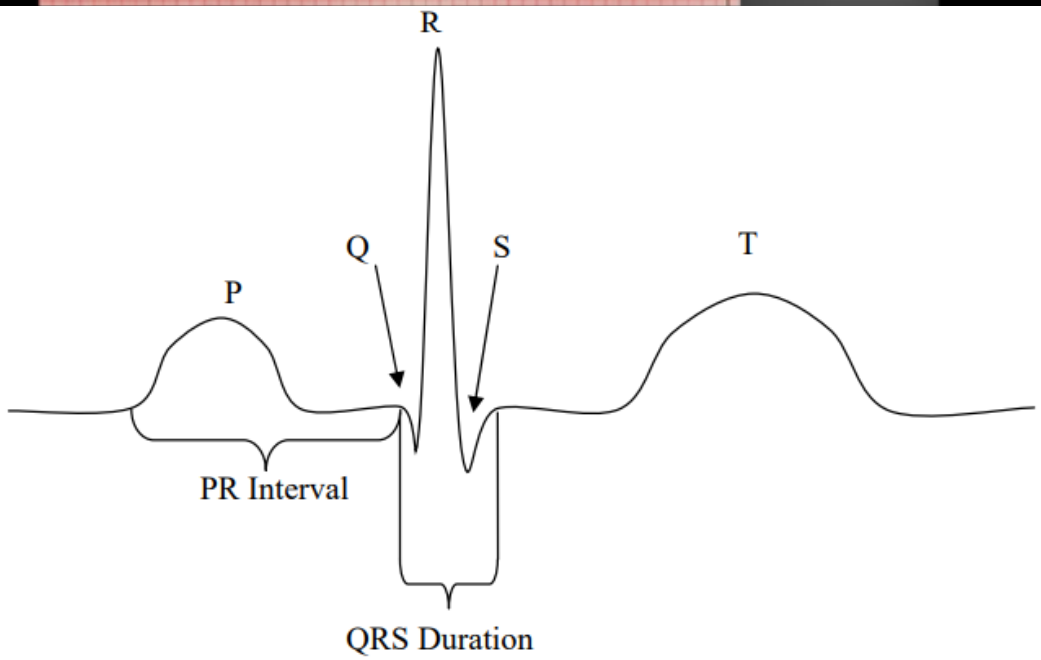
9 complexes in 6 seconds. 9 x 10 means the heart rate is roughly 90 bpm

3- Axis : look at lead I & avf







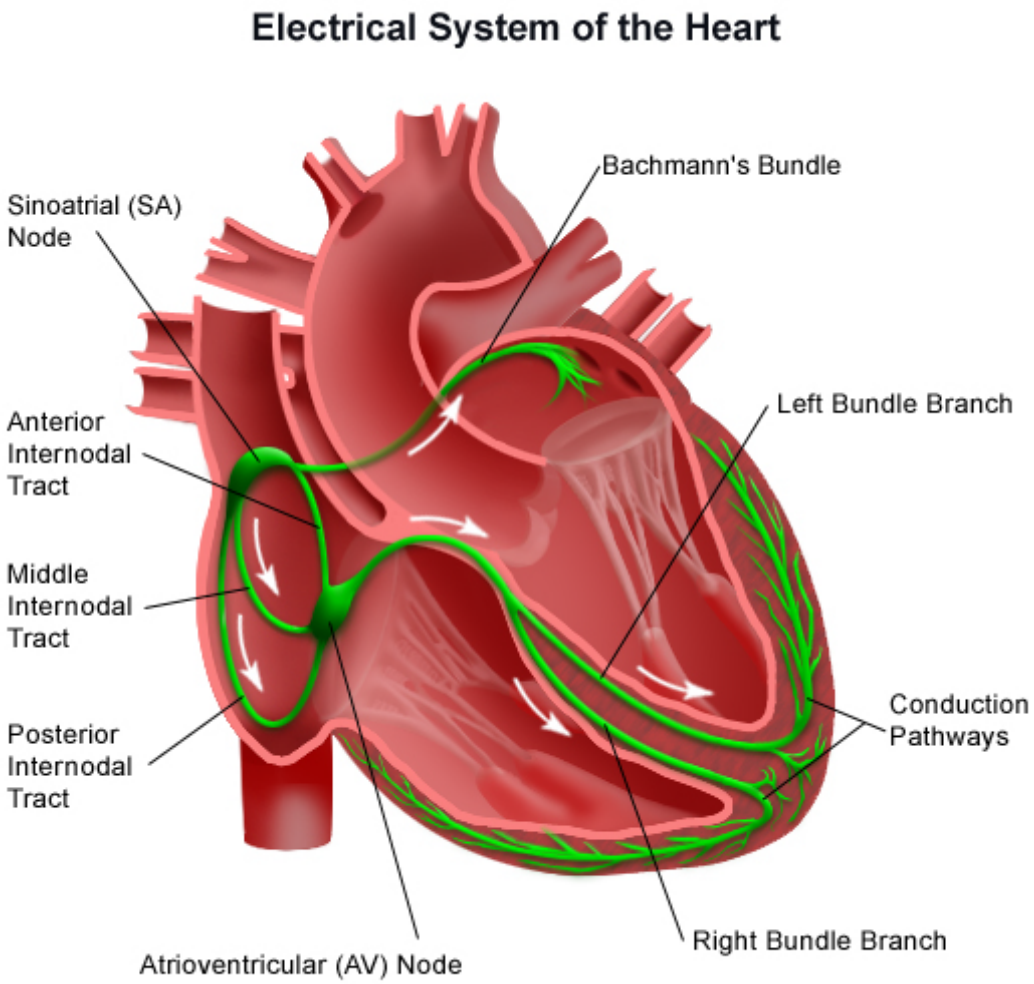


The duration of the P wave is normally, about 0.08 to 0.10 seconds, covering 2 to 2.5 small squares horizontally on the ECG paper.
The amplitude, or height, of the P wave is 2.55mm or less, covering approximately 2.5 squares vertically on the ECG paper.
The P wave is positive in most leads, which means it's above the baseline, or isoelectric line, on the ECG paper.
It should also be rounded, not peaked, pointy or notched.
The PR interval is measured from the beginning of the P wave to the beginning of the QRS complex.
It represents the time taken for the electrical impulse to spread through the atria and down through the astrioventricular node, or AV node, to the heart's ventricular muscles.
The AV node is a secondary pacemaker, acting as a back up to the SA node.

The PR interval on an ECG should measure 0.12 to 0.20 seconds, covering 3 to 5 small boxes on the ECG
If the PR interval is abnormally short or abnormally long, it may indicate a heart problem.
The QRS complex on an ECG represents the electrical activity associated with the activation of the heart's
ventricles. In other words, it shows the depolarisation of the ventricles.
It may have three components:
• The Q Wave
• The R Wave
• The S Wave
The Q Wave is the first negative deflection on the complex.
The R wave is the first positive deflection of the complex.
The S wave is the first negative deflection after the R wave.
We can use the duration, amplitude, and shape of the QRS complex to diagnose cardiac arrhythmias, and other heart diseases.
the QRS complex normally lasts *0.08 to 0.12* seconds. At most, this covers three small boxes horizontally on the ECG

The T wave should not be greater than 5mm in the standard leads, or less than 10mm in the chest leads

As we learned earlier, the sinoatrial node, or SA node, is the dominant pacemaker of the heart.
It has an intrinsic rate of 60-100 beats per minute.
The atrioventricular (AV) node is a secondary pacemaker, and acts as a back up pacemaker to the sinoatrial node.
It has an intrinsic rate of 40-60 beats per minute.
The ventricular cells can also act as pacemakers, backing up the AV node. They have an intrinsic rate of
only 20-45 beats per minute.



Remember:

a normal 12 lead ECG does not always rule out a acute myocardial infarct