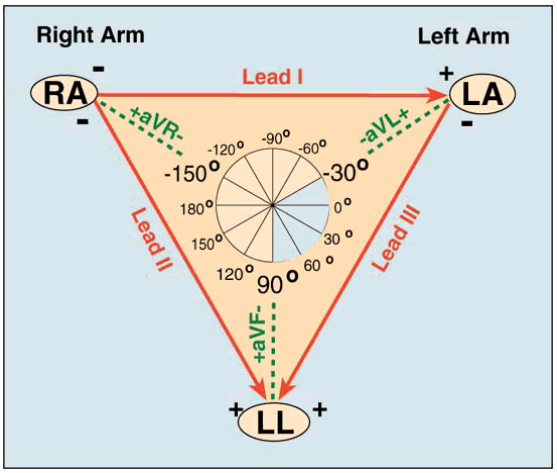
Objectives:

1) Calculate mean electrical axis using QRS
2) Know the placement of chest leads

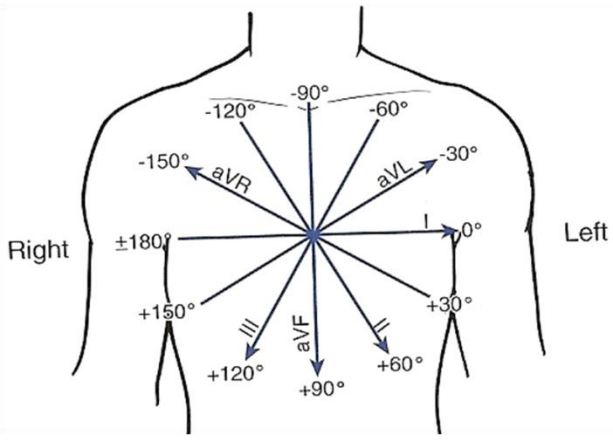
For your reference, I will attach three links. One of which is a must watch for you to understand how to calculate QRS in the easiest possible manner; the other two are for ECG in general.

Mean electrical axis

The most important thing to remember is the Einthoven triangle (ECG triangle):



- The center of this triangle is the heart.
- Lead I, II, and III are called bipolar limb leads, because they extend between two limbs.
- The other leads are unipolar leads; they extend from the heart (high resistance, negative electrode) to one of the limbs:
    - Heart to right arm: aVR
    - Heart to left arm: aVL
    - Heart to left foot: aVF
- Based on the triangle, we constitute the hexagonal radial axis. This axis is what we use as a reference line:



- How do we measure the mean electrical axis:
    - Take ANY two leads (the easiest are aVF with lead I)
    - Measure the height of the QRS complex:
        - Count the number of small squares from the bottom of the S until the isoelectric line
        - Count the number of squares from the isoelectric line until the top of Q.
        - Subtract the number of squares above the isoelectric line from the number of squares below
            - If you have 5 squares above and 2 below, the result would be +3
    - Repeat the steps for the second lead
    - Now, that you have the result, refer to the hexagonal radial axis:
        - Locate your lead
        - Count the number of units (+3 is equal to 3 units for example)
        - Mark the place
        - Extend a perpendicular line
        - Repeat with the second lead
    - Extend a line from the center towards the point of intersection
    - Measure the angle using a protractor
- Result analysis:
    - 0 to 90: Normal
    - 90 to 180: Right axis deviation
    - 0 to -90: Left axis deviation
- If you take lead I and aVF:
    - If lead I is positive, and aVF positive: Normal
    - If lead I is negative and aVF is positive: Right axis deviation
    - If lead 1 is positive and aVF negative: Left axis deviation
    - If both are negative: extreme deviation
    - If you want to measure the exact angle, measure the number of the squares and take its inverse tangent ($\tan^{-1}$(result))
- Every lead has a lead perpendicular to it:
    - Lead I and aVF
    - Lead II and aVL
    - Lead III aVR
- If there is a certain lead, that has a QRS of 0 (or close to that value), look at the perpendicular lead. The mean electrical axis will be in the direction of that lead.
    - Let us say that lead III is almost 0; we look at aVR and see if it is positive or negative to know the angle directly
- If aVF is too high and lead I is low: angle closer to 90

- If aVF is equal to lead I: angle is 45
- If lead I is high and aVF is low: angle less than 45
- Tall and thin people have their axis near 90
- Short and obese closer to 0
- This is why we extended our spectrum from -30 to 110

Chest leads

- They are unipolar leads.
- Negative electrode (negative pole) is connected to high resistances (zero terminal)
- Positive electrode is on the chest (exploring electrode)
- It just measures the electrical activity of the transverse plane of the heart.
- It does not have a mean electrical axis as we don't have any known angles
- How do we place the electrodes?
    - What we need to know is that every electrode has two coordinates:
        - Horizontal
        - Vertical
    - V1: Right side, at the 4^{th} intercostal space, parasternally (at the sternal border)
    - V2: Left side, at 4^{th} intercostal space, parasternally (at the sternal border)
    - V4: Midclavicular line at the 5^{th} intercostal space
    - V3: Midway between V4 and V2
    - V5: Anterior Axillary Line at the 5^{th} intercostal space
    - V6: Mid Axillary Line at the 5^{th} intercostal space
- Charges:
    - V1 and V2: Negative
        - Opposite to their positive electrode (in reference to the mean electrical axis)
    - V3 and V4 possibly negative or positive
    - V5 and V6: Positive
- Why do we take many leads?
    - If someone, for example, has an infarction, we can determine its location using the leads. More leads lead to more accuracy in determining the location.
    - Lead I, V3, and V4 aberrant: anterior infarction (LAD)
    - V6 and aVF: inferior infacrction (Right coronary artery)
- If the person is fat or if we suspect a problem in the posterior aspect of the heart, we use esophageal leads.

Links! :D

1) https://www.youtube.com/watch?v=KIFqzN5LwH4 Professor Fink, Cardiac physiology, ECG! He covers the whole subject (4 videos, 3.5 hours total)
2) https://www.youtube.com/watch?v=jg5X3V5IPS4 Mean electrical axis, video 1 (5 minutes review of everything you need to know about how to calculate the MEA)
3) https://www.youtube.com/watch?v=f0n3bhAgZ6E (Mean electrical axis, video 2 (10 minutes review!)