They might not appear in the exam, but they are not unimportant.

I, II, III

British physiologist Augustus D. Waller of St Mary's Medical School, London publishes the first human electrocardiogram. It is recorded with a capilliary electrometer from Thomas Goswell, a technician in the laboratory. *Waller AD. A demonstration on man of electromotive changes accompanying the heart's beat. J Physiol (London) 1887;8:229-234*

Willem Einthoven
(1860-1927)

1924 Willem Einthoven wins the Nobel prize for inventing the electrocardiograph

Dutch physiologist Willem Einthoven sees Waller demonstrate his technique at the First International Congress of Physiologists in Bale. Waller often demonstrated by using his dog "Jimmy" who would patiently stand with paws in glass jars of saline.

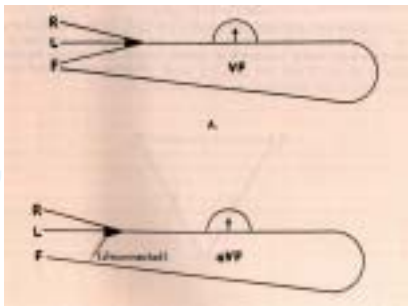
Willem Einthoven introduces the term 'electrocardiogram' at a meeting of the Dutch Medical Association. (Later he claims that Waller was first to use the term). *Einthoven W: Nieuwe methoden voor clinisch onderzoek [New methods for clinical investigation]. Ned T Geneesk 29 II: 263-286, 1893*

Einthoven, using an improved electrometer and a correction formula developed independently of Burch, distinguishes five deflections which he names P, Q, R, S and T. *Einthoven W. Ueber die Form des menschlichen Electrocardiogramms. Arch f d Ges Physiol 1895;60:101-123*

> **Why PQRST and not ABCDE?** The four deflections prior to the correction formula were labelled ABCD and the 5 derived deflections were labelled PQRST. The choice of P is a mathematical convention by using letters from the second half of the alphabet. N has other meanings in mathematics and O is used for the origin of the Cartesian coordinates. In fact Einthoven used O ..... X to mark the timeline on his diagrams. P is simply the next letter. A lot of work had been undertaken to reveal the true electrical waveform of the ECG by eliminating the damping effect of the moving parts in the amplifiers and using correction formulae. If you look at the diagram in Einthoven's 1895 paper you will see how close it is to the string galvanometer recordings and the electrocardiograms we see today. The image of the PQRST diagram may have been striking enough to have been adopted by the researchers as a true representation of the underlying form. It would have then been logical to continue the same naming convention when the more advanced string galvanometer started creating electrocardiograms a few years later.

Ethioven 1903

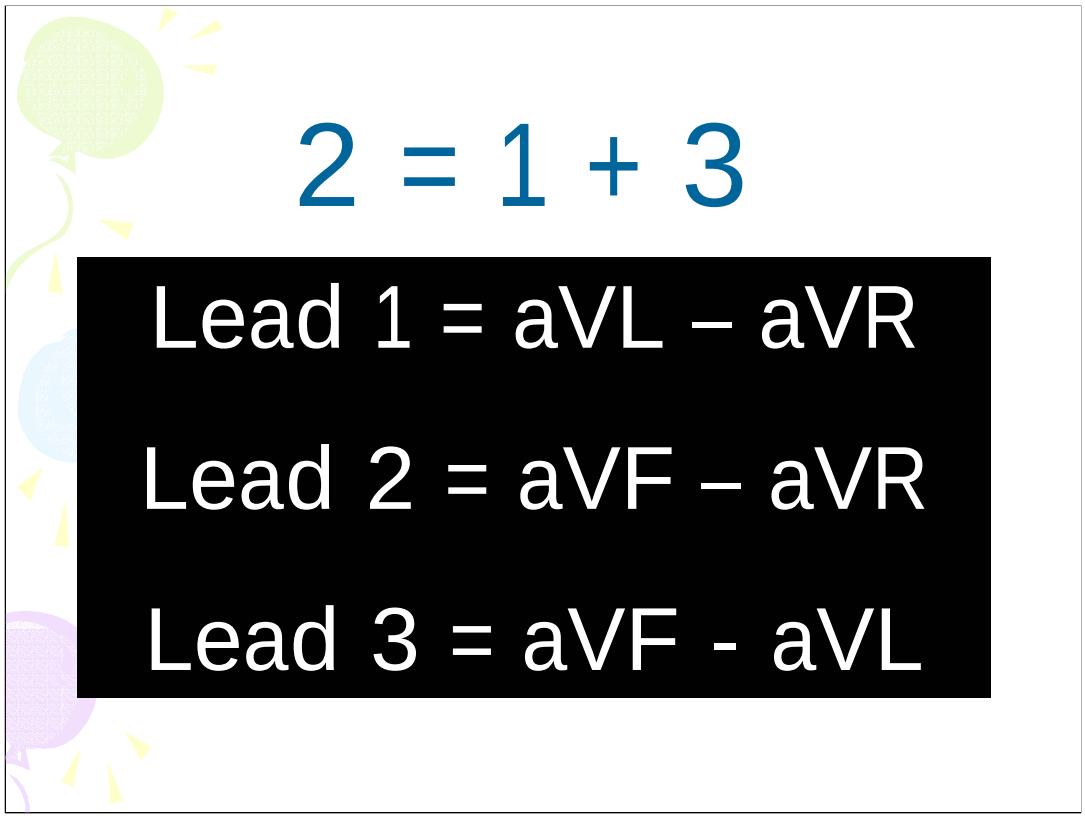
Wilson, F.N. 1934



Goldberger, E. 1942

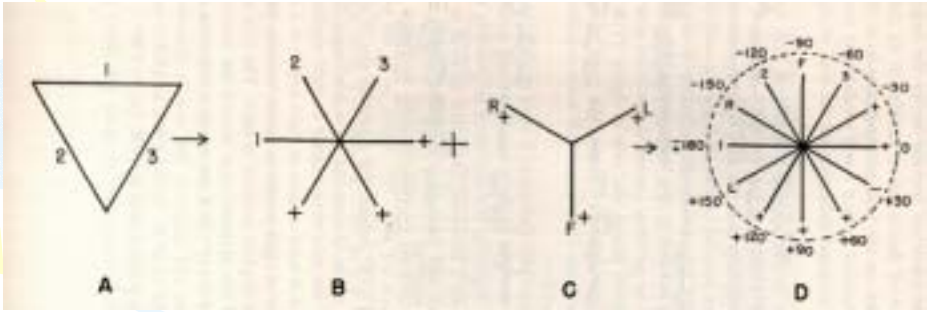
By joining the wires from the right arm, left arm and left foot with 5000 Ohm resistors Frank Wilson defines an 'indifferent electrode' later called the 'Wilson Central Terminal'. The combined lead acts as an earth and is attached to the negative terminal of the ECG. An electrode attached to the positive terminal then becomes 'unipolar' and can be placed anywhere on the body. Wilson defines the unipolar limb leads VR, VL and VF where 'V' stands for voltage (the voltage seen at the site of the unipolar electrode). *Wilson NF, Johnston FE, Macleod AG, Barker PS. Electrocardiograms that represent the potential variations of a single electrode. Am Heart J. 1934;9:447-458.*

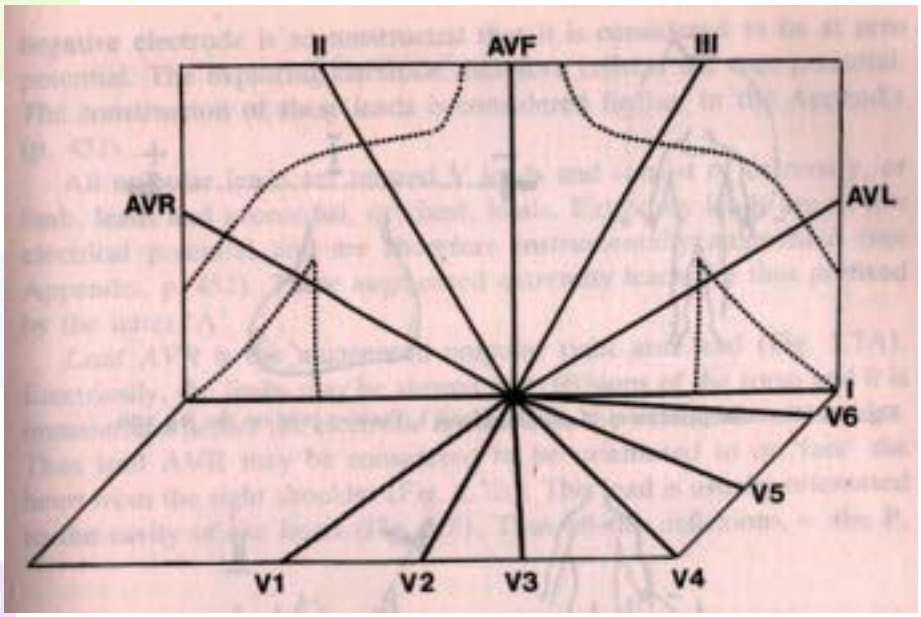
Emanuel Goldberger increases the voltage of Wilson's unipolar leads by 50% and creates the augmented limb leads aVR, aVL and aVF. When added to Einthoven's three limb leads and the six chest leads we arrive at the 12-lead electrocardiogram that is used today.



In essence, you only need 2 leads.

Monkey → Man





In summary,

The limb leads are bipolar lead, they are in the coronal plane,

The chest leads are unipolar lead, they are in the horizontal plane.