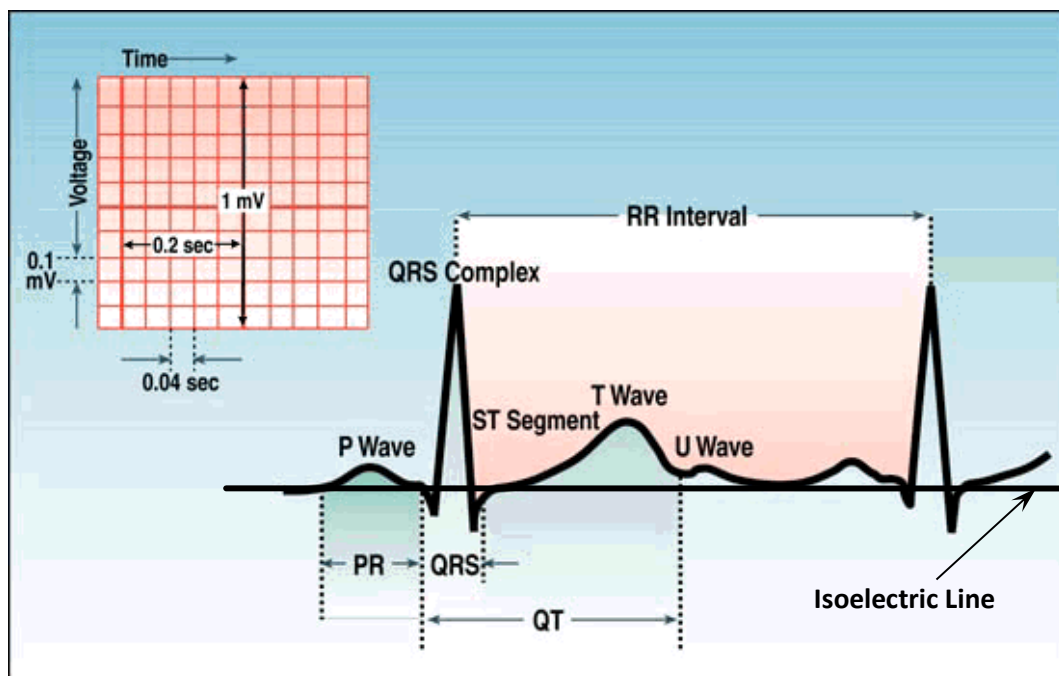


M3_on-line. Electrical activity of the heart. Electrocardiography. Determination of the heart's electrical vector.

Problems to be prepared:

- Fundamentals of the electrostatics, electric charge [1] – Chap. 21-2, conductors and insulators – Chap. 21-3, Coulomb's law – Chap. 21-4, the electric field – Chap. 22-2 and the electric potential – Chap. 24-3
- Fundamentals of the electric current [1] – Chaps. 26-2 and 26-3 and Ohm's law – Chap. 26-5
- Fundamentals of the electric circuit [1] – Chaps. 27-2 through 27-6
- Heart Electrical Activity. The Einthoven triangle. The cardiac vector.
- Electrocardiography: the methods of registration, the electrocardiogram.

The ECG is the most commonly performed cardiac test. An electrocardiogram is a test that measures the electrical activity of the heartbeat. As the heart undergoes depolarization and repolarization, the electrical currents that are generated spread not only within the heart, but also throughout the body. This electrical activity generated by the heart can be measured by an array of electrodes placed on the body surface. An ECG gives two major kinds of information. First, by measuring time intervals on the ECG, a doctor can determine how long the electrical wave takes to pass through the heart. Second, by measuring the amount of electrical activity passing through the heart muscle, a cardiologist may be able to find out if parts of the heart are too large or are overworked.



P Waves - atrial depolarization

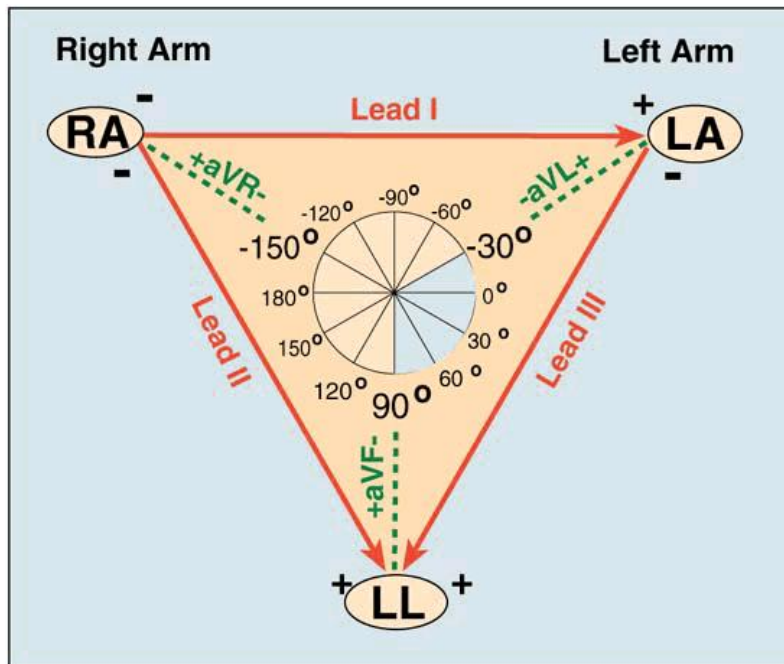
QRS Complex – ventricular depolarization

T Wave – repolarization of ventricles

U Wave – repolarization of Purkinje fibers

Isoelectric Line – baseline voltage of the electrocardiogram

The cardiac vector indicates the direction of the depolarization in time. The ECG measured from any one pair of the bipolar leads is a time variant, single dimensional projection of the cardiac vector and could be represented using the Einthoven triangle



Einthoven's triangle provides a way to understand the amplitude of the ECG waves. One way to verify that your data is correct is to plot the cardiac vector into the Einthoven triangle. For this:

- 1) construct an equilateral triangle with the base on top. Top will be lead I, right = lead III and left = lead II
- 2) from the middle point of each side, plot on the corresponding lead (triangle side) a segment of magnitude proportional to the amplitude of the QRS complex.
- 3) trace a line perpendicular to the segment at each end of the segment.

The perpendicular lines corresponding to the initial point of the vectors will intersect in the center of the triangle; the perpendiculars traced from the end of the vector should also intersect at one point. The line between the two intersections shows the orientation of the heart.

INSTRUCTION

Attention – In Section “Problems to be prepared” one can find our recommendation for study:

- Electrocardiography: the methods of registration, the electrocardiogram.

Before starting laboratory on-line, please find in the Internet short instructive movies with practical demonstration how electrodes ECG can be attached to the patient. For example: 3.51 min video on YouTube: “How to record an ECG – OSCE Guide, Geeky Medics”.

1.1. Electrocardiograms.

In order to register electrocardiograms in Biophysics Laboratory one can currently use the electrocardiograph AsCARD (Lab M3):



The electrocardiograph AsCARD is equipped with a 10-electrodepatient's cable. In order to receive 12 standard leads of Einthoven, Goldberger, Wilson, the electrodes should be attached in the following way (in parentheses electrode label in the USA):

Limb electrodes:

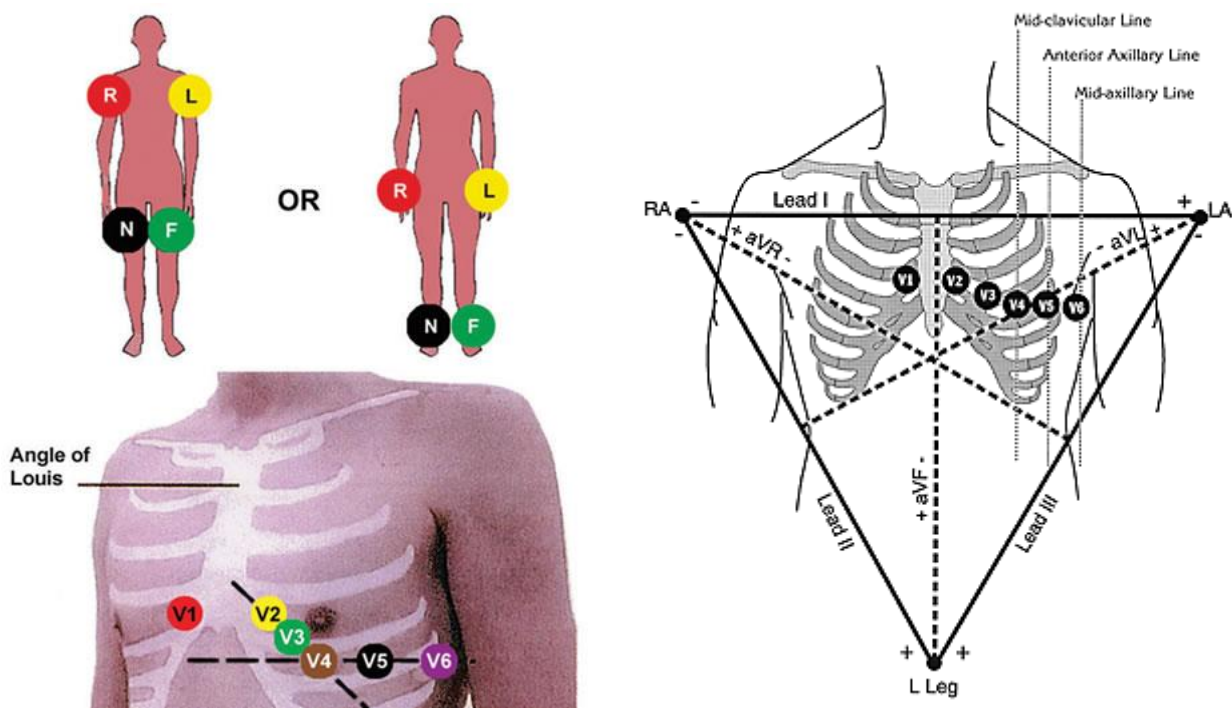
- R (RA) – red On the right arm, avoiding bony prominences.
- Y (LA) – yellow In the same location that R was placed, but on the left arm this time.
- F (LL) – green On the left leg, avoiding bony prominences
- N (RL) – black In the same location that F was placed, but on the right leg this time.

Precardiac electrodes:

- C1 (V1) white-red in the fourth intercostal space just to the right of the sternum
- C2 (V2) white-yellow in the fourth intercostal space just to the left of the sternum
- C3 (V3) white-green half way between C2 (V2) and C4 (V4)
- C4 (V4) white-brown the fifth intercostals space in the mid-clavicular line (the imaginary line that extends down from the midpoint of the clavicle).

- C5 (V5) white-black Horizontally even with V4, but in the anterior axillary line. (The anterior axillary line is the imaginary line that runs down from the point midway between the middle of the clavicle and the lateral end of the clavicle; the lateral end of the collarbone is the end closer to the arm.)

- C6 (V6) white-violet Horizontally even with V4 and V5 in the midaxillary line. (The midaxillary line is the imaginary line that extends down from the middle of the patient's armpit.)



Above presented instruction shows how electrocardiogram can be measured in the Lab.

1.2. Real electrocardiograms (registered in Biophysics Lab) will be provided for students during lab on-line.

2. In the report:

- determine the duration of particular phenomena in the heart (complete the Tables)
- calculate frequency of impulses in the heart on the basis of RR interval
- plot on graph paper the instantaneous cardiac vector using the R wave. Mark on the electrocardiogram position from which data were taken. Graph and recorded ECG attach to the report.
- make the conclusions.

	Resting ECG	
	Length (mm)	Duration (s)
RR Interval		
PR Interval		
QRS Duration		
QT Interval		

[1] Walker J., Halliday and Resnick, *Principles of physics : international student version*, 9 th ed., extended, Hoboken : John Wiley & Sons, Inc., 2011. , ISBN 978-0-470-56158-4