DIPOLE MODEL OF A HEART

Equipment

Generator of signals, voltmeter, plastic cuvette for measurements with an electric dipole and two electrodes for measurements.

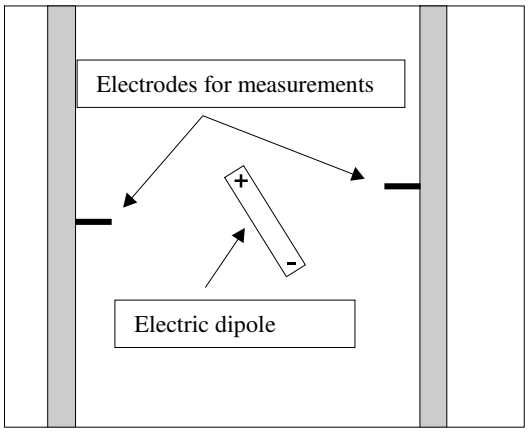


Fig 1. Scheme of the cuvette for measurements

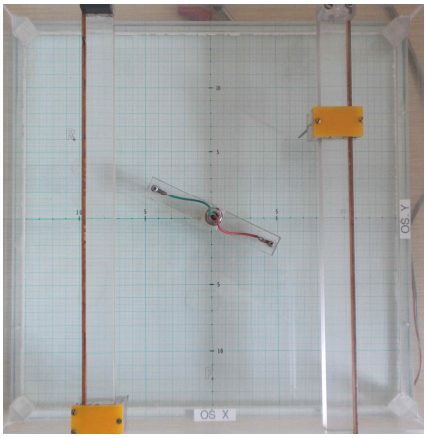


Fig. 2 Cuvette for measurements – view from the top

Course of measurements

Following studies will be performed during the practical:

1. Experimental part
   A. Drawing of isopotential lines of an electric field created by the dipole
   B. Estimation of the position of an electric dipole based on measurements of electric voltages between apexes of the Einthoven triangle
2. Computer part

1. Experimental part

Preliminary action

Pour 150 ml of distilled water and 150 ml of tap water to the cuvette for measurements (this will provide proper experimental conditions).

Set the proper work parameters of the signal generator:

- frequency: 5 kHz (press the button 1k and set the value of 5 on the knob of generator).
- working mode: press the button of the rectangular pulse
- constant component: knob's arrow in the vertical position
- amplitude: knob's arrow set in the extreme right position.

Make sure that the cables connecting the dipole to the generator are plugged in the correct way: ***red cable*** must be plugged to the ***upper output*** on the front plate of the generator, whereas ***green cable*** must be connected to the ***lower output*****! If not, ask the tutor to make correction!**

Pay attention to the „equilibrium" of the Experimental setup. If the electrodes are set symmetrically (e.g. left electrode in the point (-5,0), right electrode in the point (5,0)) and the axis of the dipole is set perpendicular

to the axis between the electrodes, the voltmeter should display zero ! **If not, ask the tutor to make correction!**

A. Drawing of isopotential lines of an electric field created by the dipole.

a) Set one of the electrodes (reference electrode) and the dipole in the student-chosen position.
b) Keeping the reference electrode and the dipole in the same position change position of the other electrode to find an isoelectric point (the point where the electric potential of both electrodes is the same – the voltmeter shows the **zero** voltage in such a point). Mark the coordinates of such a point on a plotting paper with the coordinate lines drawn. After having marked at least 10 such points draw a proper isoelectric line.

B. Estimation of the position of an electric dipole based on measurements of electric voltages between apexes of the Einthoven triangle

In this part of the practical the points L, R and F [with coordinates of (10,4;6), (-10,4;6) and (0;-12), respectively] \ represent the apexes of the equilateral triangle (Einthoven triangle), the dipole is located in the central point of the triangle.

Attention!!!! The „*positive electrode*" in this part of the practical means the electrode connected to the *upper input* on the back plate of the generator, whereas the „*negative electrode*" is the electrode connected to the *lower input* on the back plate of the generator! (Mixing of electrode connections will result in a „reversal" of the estimated dipole moment!!!!).

Course of measurements and presentation of the results:
a) Set the dipole in the student-chosen position and measure voltages for three bipolar leads:
   a) $V_I = V_L - V_R$ (positive electrode in the L point, negative electrode in the R point)
   b) $V_{II} = V_F - V_R$ (positive electrode in the F point, negative electrode in the R point)
   c) $V_{III} = V_F - V_L$ (positive electrode in the F point, negative electrode in the L point)
   and write down measured values to the table in the final report.
b) Present the values of each measured voltage in a form of a vector on the proper axis of the Einthoven's triangle shown on the report's sheet and summarise the vectors to obtain the total "electric vector". To obtain such a vector it is sufficient to summarise TWO out of three vectors. Measure the angle formed between the "electric vector" and the OX axis of the triangle as well as the angle between this axis and the vector of the electric dipole moment of the electric dipole in the cuvette (attention: red pole of the dipole is its positive pole, whereas the dipole moment vector is defined as a vector from negative to positive pole!). Write down values of both angles to the report's sheet.
c) Repeat measurements performed in points a) and b) for two other, significantly different, student-chosen positions of the electric dipole in the cuvette.

Attention! After having finished the measurements pour the water out of the cuvette and wipe it dry using sheets of lignin!

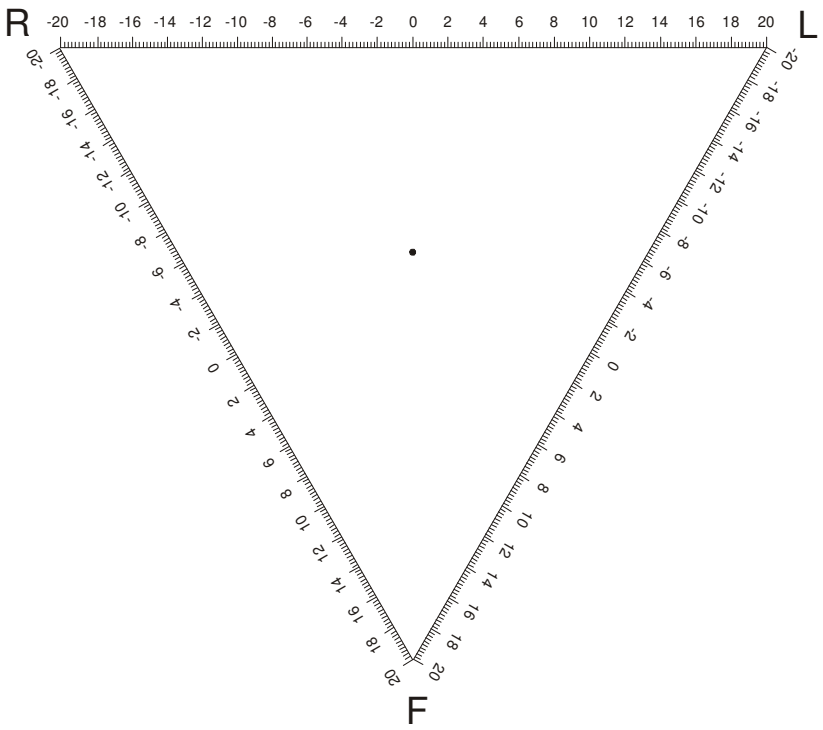
Required background in biophysics

1. Knowledge of basic definitions applied in electricity: electric potential, intensity of electric field, dipole moment, electromotive force.
2. Dipole model as physical model of an electric activity of the heart.
3. Ideas of electrocardiography, Einthoven's triangle, bipolar Einthoven's leads (V_I, V_{II} and V_{III}) and geometric estimation of a projection of the "electric vector of the heart" on the front vertical plane.

Wroclaw Medical University Department of Biophysics and Neuroscience	**Practical No 24** **Dipole model of the heart**
…… ……..…...…….. ……. Names of students	Faculty: …….. Group No: ……..……. Date: …….……..
Grade:	Tutorial signature

1. Experimental part

Dipole's position No 1

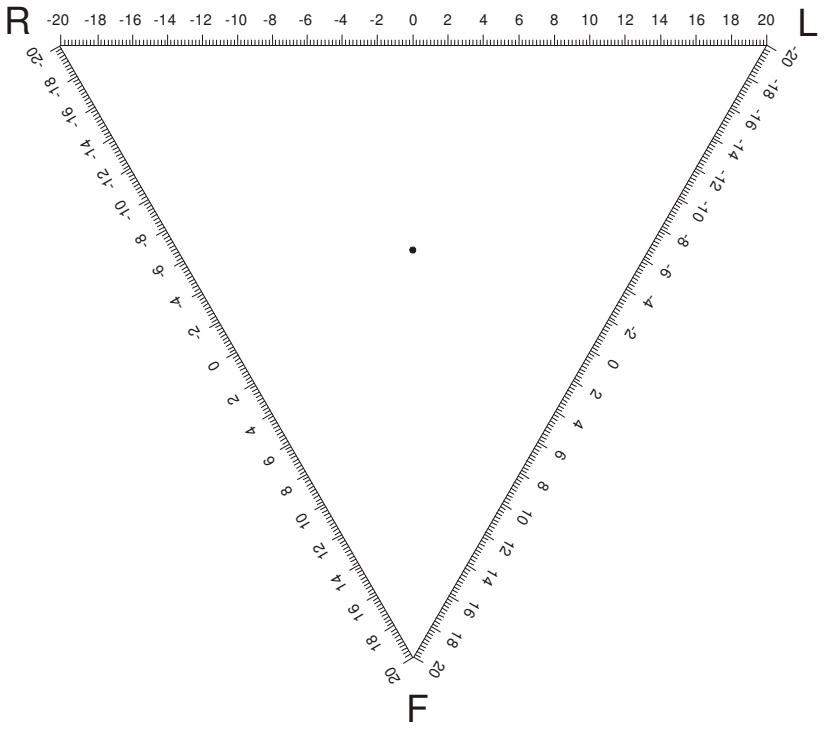


V_I [value]	V_{II} [value]	V_{III} [value]

No	Angle between the „electrical vector of the heart" and the OX axis (measured in the Einthoven's triangle)	Angle between the vector of the electric dipole moment of the electric dipole and the OX axis (measured in the experimental setup)
1.		
2.		
3.		

Dipole's position No 2

V_I [value]	V_{II} [value]	V_{III} [value]



Dipole's position No 3

V_I [value]	V_{II} [value]	V_{III} [value]