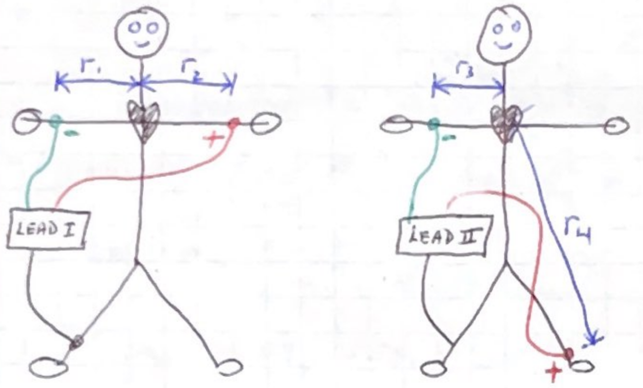
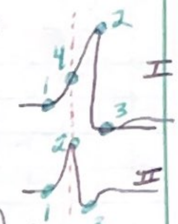


Assume $\langle r \rangle = 0.75\,m$

- Using sample data sets, collected in 2015. When the + and − leads on Lead I are reversed, the peaks are inverted into troughs



- Finding the voltage and time duration of one QRS peak.

Point	QRS	Lead I Time (s)	Lead I Potential (mV)	Lead II Time (s)	Lead II Potential (mV)
1	Q	0.848	0.867	0.844	0.842
2	R	0.874	~~0~~ 1.648	$\boxed{0.872}$	2.750
3	S	0.894	0.891	0.908	0.697
4		$\boxed{0.872}$	1.612	~~///~~	~~///~~

- Time duration of each peak (use points 1 and 3):

Lead I: $\Delta t_I = t_{3I} - t_{1I} = 0.894 - 0.848 = 0.046\,s = 46\,ms$

Lead II: $\Delta t_{II} = t_{3II} - t_{1II} = 0.908 - 0.844 = 0.064\,s = 64\,ms$

- Max. potential difference of each peak (use points 2 and 3):

Lead I: $\Delta V_I = V_{2_I} - V_{3_I} = 1.648 - 0.891 = 0.757\,mV$

Lead II: $\Delta V_{II} = V_{2_{II}} - V_{3_{II}} = 2.750 - 0.697 = 2.053\,mV$

- Calculating maximum dipole moment:

Use the time when Lead II gives a max. voltage
→ ~~Useing~~ Using Lead I, point 4 and Lead II, point 2

- x-component of dipole moment, p_x:

$\Delta V_{4,I} = 1.612 \, mV$
$\Delta V_{2,II} = 2.750 \, mV$

$$\Delta V_x = \Delta V_{Lead\ I} = \frac{p_x}{2\pi \epsilon_0 K_{water} r^2}$$

$$\text{So, } p_x = \Delta V_I \cdot 2\pi \epsilon_0 K_{water} r^2$$
$$= (1.612 \times 10^{-3} V)\, 2\pi (8.85 \times 10^{-12})(80)(0.75)^2$$
$$p_x = 4.03 \times 10^{-12} \ C \cdot m$$

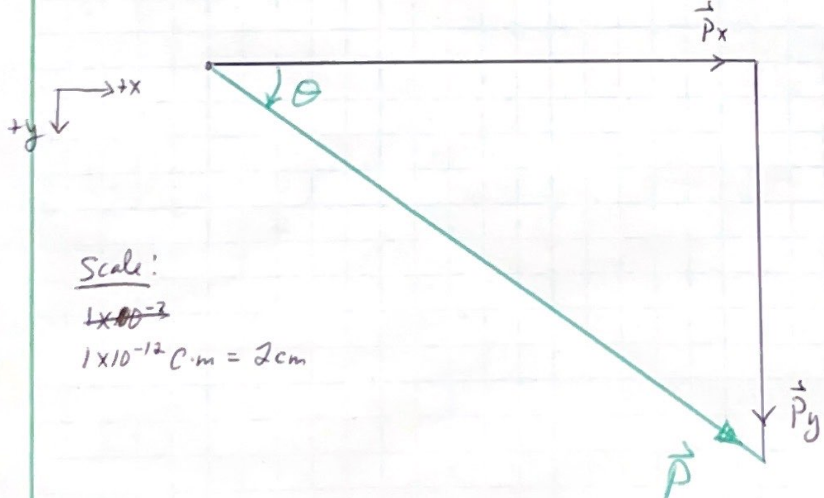
Units:
$$V \left(\frac{C^2}{N \cdot \cancel{m^2}}\right) \cancel{m^2} = \frac{VC}{N}$$
$$= \frac{V \cdot C^2}{\left(\frac{C \cdot V}{m}\right)} = \underline{\underline{C \cdot m}}$$

- y-component of dipole moment, p_y:

$$\Delta V_y = \Delta V_{II} - \frac{1}{2}\Delta V_I = \frac{p_y}{2\pi \epsilon_0 K_{water} r^2}$$

$$\text{So, } p_y = \left(\Delta V_{II} - \tfrac{1}{2}\Delta V_I\right) 2\pi \epsilon_0 K_{water} r^2$$
$$= (2.750 \times 10^{-3} - 1.612 \times 10^{-3})\, 2\pi (8.85 \times 10^{-12})(80)(0.75)^2$$
$$p_y = 2.83 \times 10^{-12} \ C \cdot m$$

- So, $p = \sqrt{p_x^2 + p_y^2} = 4.93 \times 10^{-12} \ C \cdot m$



$$\theta = \tan^{-1}\left(\frac{p_y}{p_x}\right)$$
$$\theta = 35.1^\circ$$