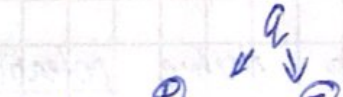
lab 7. Investigation of electrostatic Fields

Theory.

An electric field surrounds charged particles and represents the force per unit charged felt by other charged particles in that field. If the electric field does not change in time, then the force felt by charged particles in the electric field is given by:

$$\vec{F} = \vec{E}(\vec{r}) \cdot q$$

$\vec{E}$ - electric field vector at position $\vec{r}$
q - charge being affected by the electric field.



positive charge — negative charge.

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2} \Rightarrow \text{Columbs law}$$

$$\varepsilon_0 = 8,854\,187\,82 \cdot 10^{-12} \frac{A^2 s^4}{m^3 kg} \quad \text{(permittivity of free sp)}$$

q_1, q_2 - charges of the 2 particles
r - distance

$$K = \frac{1}{4\pi\varepsilon_0} = 8,987\,551\,787 \cdot 10^9 \frac{N \cdot m}{C^2}$$

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2} \cdot \hat{r} \qquad \vec{E}(\vec{r}) = \sum_{i=0}^{N} \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_i}{r_i^2} \cdot \hat{r}_i$$

$\hat{r}$ - unit vector of the displacement vector.

Electric potential is the negative of the work done in moving an object.

$$V = -W = -\int_{\infty}^{r} \frac{\vec{F}}{q} \cdot dr$$

$$\vec{F} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Qq}{r^2} \cdot \hat{r}$$

$$V = \int_{\infty}^{r} \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r^2} \, dr$$

$$V = -\frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r}$$

IF the charge is negative, then the electric potential is positive

Rules:

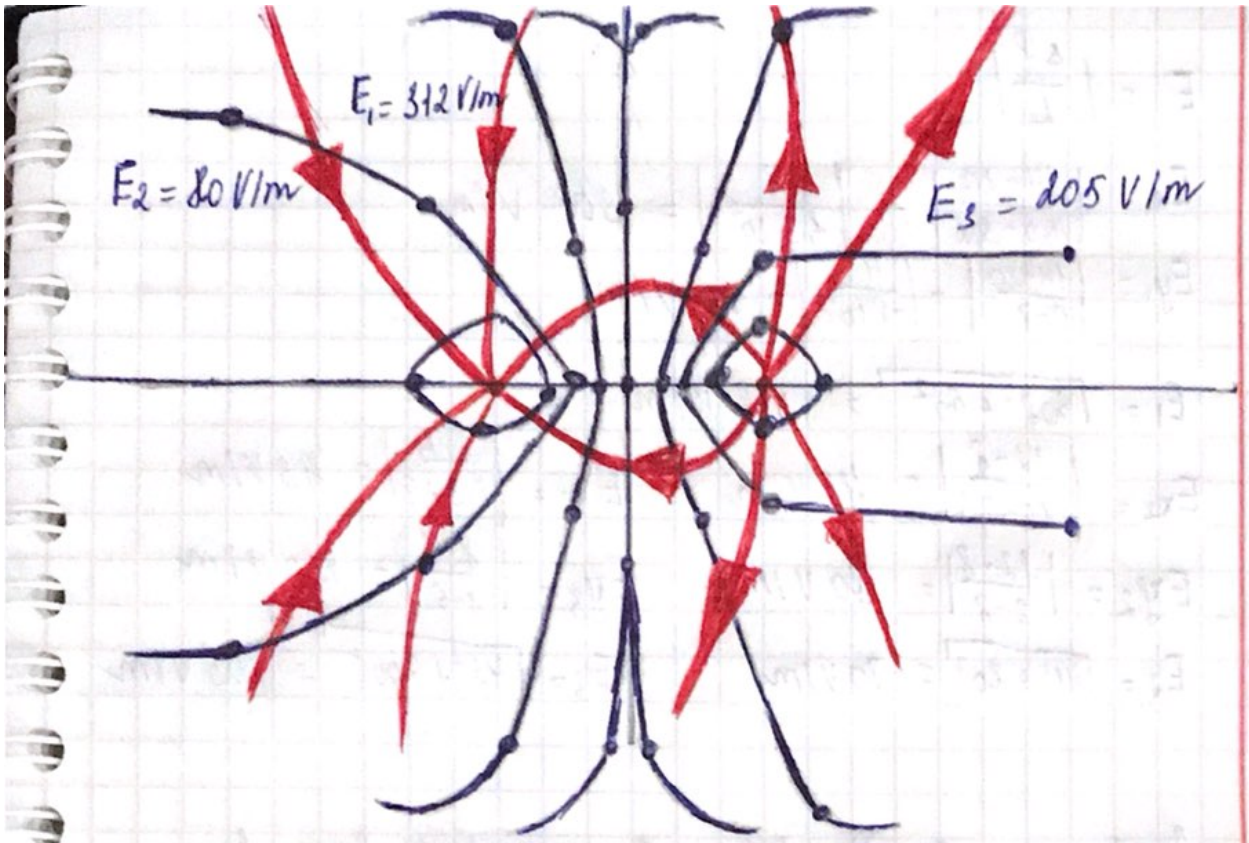
1. Field lines start at positive charges and terminate on negative charges and for a single charge continue to infinity

2. Vector E is directed along the tangent to a field line at any its point

3. Density is equal or proportional to the magnitude of E

$$\vec{E} = -\text{grad } \varphi$$

$$E_n = \frac{d\varphi}{dn}$$



14V	[4,5; 0)	[3; 1,2)	[1,9; 0)
12V	[10; 5)	[3; 2,8)	[1,3; 0)
10V	(3,2; 8)	[1,5; 3)	[0,8; 0)
8V	[0,3; 8)	[0; 4)	[0; 0)
6V	[-2,7; 8)	[-1,1; 8)	[-0,6; 0)
4V	[-9; 6)	[-4,7; 4)	[-1,3; 0)
2V	[-1,9; -0,1)	[-3; 1,5)	[-5; 0)

$$E = \left| \frac{\Delta \varphi}{\Delta} \right|$$

$$E_{x_1} = \left| \frac{14-10}{4,5-3,2} \right| = \left| \frac{4}{1,3 \cdot 10^{-2}} \right| = 308 \text{ V/m}$$

$$E_{y_1} = \left| \frac{14-10}{0-8} \right| = \left| \frac{4}{-8 \cdot 10^{-2}} \right| = 50 \text{ V/m}$$

$$E_1 = \sqrt{308^2 + 50^2} = 312 \text{ V/m}$$

$$E_{x_2} = \left| \frac{12-8}{10-0,5} \right| = 41 \text{ V/m} \qquad E_{x_3} = \left| \frac{1-4}{0,3+9} \right| = 43 \text{ V/m}$$

$$E_{y_2} = \left| \frac{12-8}{3-8} \right| = 80 \text{ V/m} \qquad E_{y_3} = \left| \frac{8-4}{2-6} \right| = 200 \text{ V/m}$$

$$E_2 = \sqrt{41^2 + 80^2} = 90 \text{ V/m} \qquad E_3 = \sqrt{43^2 + 200^2} = 205 \text{ V/m}$$

Conclusion: In this lab I understood how to work with electrostatic fields. Also I knew about how electric fields are produced and their effect on charged objects. I learned how to sketch field and potential patterns. So, this lab for me was very useful.