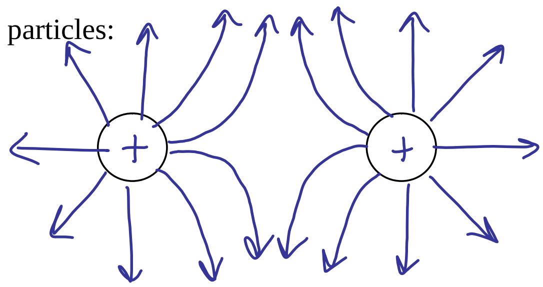
Electrostatics Notes

3 – Electric Field from Multiple Charges

We have already seen how charged particles emit electric fields, but how do these fields interact when two or more charges act on each other?

Consider two positively charged particles:

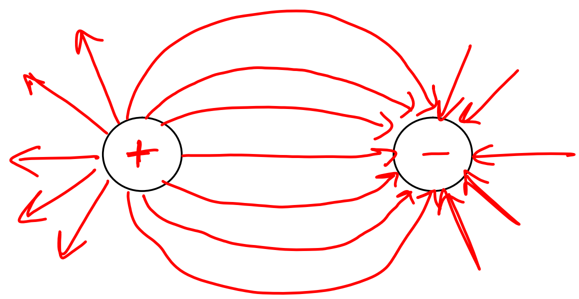


Note that the electric lines of force work… in opposition to each other.

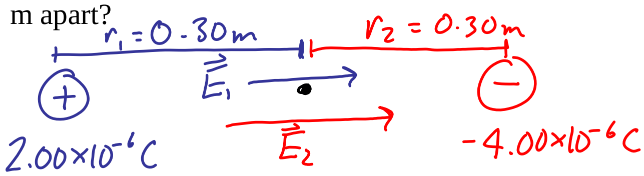
Because this electric field is a force field, it is a vector. So when multiple fields overlap we simply… add them up as vectors.

OK, now try two opposite charges:

Again the two fields interact, only this time they… reinforce each other



Example:
What is the strength of an electric field midway between a 2.00 uC charge and a -4.00 uC that are 0.60 m apart?



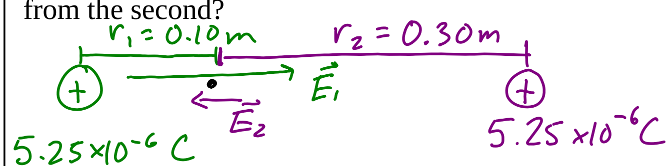
$$\vec{E}_1 = \frac{kq_1}{r_1^2} = 200\,000\ N/C$$

$$\vec{E}_2 = \frac{kq_2}{r_2^2} = 400\,000\ N/C$$

* Note that we don't use the "-" sign for the charge

$$\vec{E}_T = \vec{E}_1 + \vec{E}_2 = 600\,000\ N/C$$

Example:
Two 5.25 uC charges are 0.40 m apart. What is the strength of the electric field between them at a point 0.10 m away from the first charge and 0.30 m away from the second?



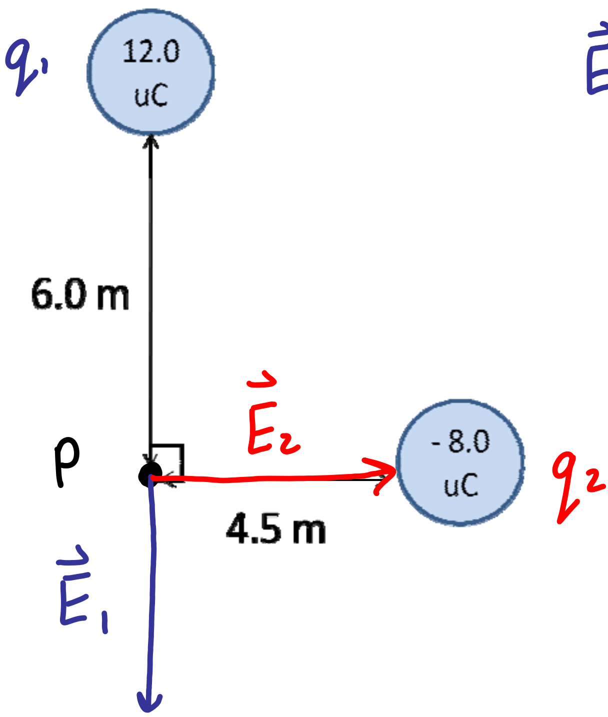
$$\vec{E}_1 = \frac{kq_1}{r_1^2} = 4\,725\,000\ N/C$$

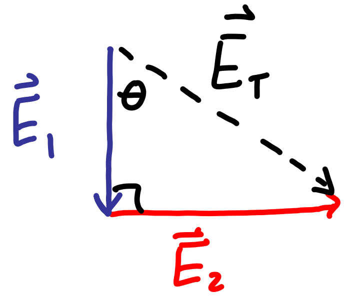
$$\vec{E}_2 = \frac{kq_2}{r_2^2} = 525\,000\ N/C$$

$$\vec{E}_T = \vec{E}_1 - \vec{E}_2 = 4.20\times10^{6}\ N/C$$

Example:

Find the magnitude and direction of the electric field at the point P due to the charges as shown.





$$\vec{E}_1 = \frac{kq_1}{r_1^2} = 3000 \text{ N/C}$$

$$\vec{E}_2 = \frac{kq_2}{r_2^2} = 3556 \text{ N/C}$$

$$\vec{E}_T = \sqrt{\vec{E}_1^2 + \vec{E}_2^2} = \boxed{4650 \text{ N/C}}$$

$$\tan\theta = \frac{\vec{E}_2}{\vec{E}_1}$$

$$\theta = \tan^{-1}\left(\frac{\vec{E}_2}{\vec{E}_1}\right) = \tan^{-1}\left(\frac{3556}{3000}\right) = \boxed{50^\circ}$$