Lecture 2

niceguy

January 11, 2023

1 Electric Field Intensity

Two objects are required for an electric force

- Source charge Q_1
- Test charge Q_2

Definition 1.1. The *electric field intensity* is defined as

$$\vec{E}_{12} = \lim_{Q_2 \to 0} \frac{\vec{F}_{12}}{Q_2}$$

Note that the force is experimentally determined to be

$$\vec{F}_{12} = k\frac{Q_1 Q_2}{R^2}\hat{a}_{12}$$

where

$$k = \frac{1}{4\pi\varepsilon_0}$$

The relations below are then easily derived

$$\vec{E}_{12} = \frac{Q_1(\vec{R} - \vec{R}')}{4\pi\varepsilon_0|\vec{R} - \vec{R}'|^3}$$

$$\vec{F}_{12} = Q_2\vec{E}_{12}$$

The electric field has 4 key properties as mentioned in the previous lecture

1. $\vec{E}$ points away from positive charges
2. $\vec{E}$ points towards negative charges
3. $\vec{E}$ points along the line connecting the source to the measurement point
4. $\vec{E}$ is linear, hence superposition applies

2 Cylindrical Coordinates

Note that

$$\vec{R} = r\hat{a}_r + z\hat{a}_z$$

3 Spherical Coordinates

Note that

$$\vec{R} = r\hat{a}_r$$

We use the notation in physics, i.e. $\hat{a}_\phi$ lies on the xy plane, and at $\theta = 0$, $\hat{a}_r = \hat{a}_z$.