Lecture 1

1 Charges

Properties of charges

- Take on a positive or negative value
- Has a unit of the coulomb
- It is always conserved

Coulombs law relates the quantity of charge for a point charge with a force. Written out,

$$|F_E| = \frac{k_e|q_1||q_2|}{r^2} = [N].$$

Where $k_e = \frac{1}{4\pi\epsilon_0}$ with ϵ_0 being the permittivity of the vacuum of space. With a system of particles, the force on a particle is given by the total sum of the electric forces induced by all the other present charges.

$$\vec{F}_{\text{total}} = \sum_{\text{charges}} \vec{F}.$$

1.1 Electric Fields

Quite importantly, charges produced electric fields (which are also induced by magnetic fields but that is to be covered later). A point charge produces a radial electrical field, with positive charges producing radially outward fields and negative charges producing radially inward fields as seen in Figure.

The magnitude of the electric field at a given point in space with a singular point charge is equal to

$$\left|\vec{E}\right| = \frac{k_e|q|}{r^2} = \left[\frac{N}{C}\right].$$

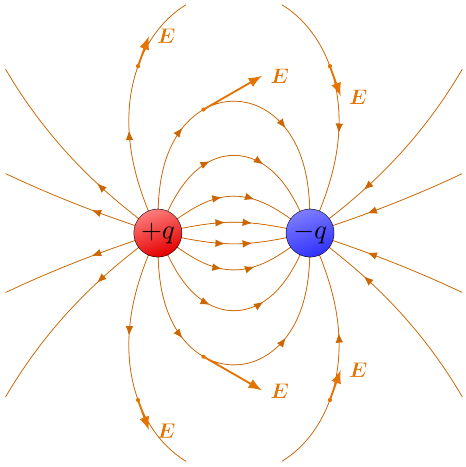

Figure 1: Electric field lines between a positive and negative point charge

Note that for a point charge in a given electric field, the force on it can be written as

$$\vec{F}_E = q\vec{E}.$$

Electric fields obey the superposition principle, meaning simply that the electric field at a point in space is equivalent to the vector sum of all the individual electric fields present at that point. Stated symbolically

$$\vec{E}_{\text{total}} = \sum_i \vec{E}_i.$$

Lecture 2

Lecture 3