Chapter E2: Electric Fields

E2.2 The Field Concept

Without the idea of fields, electromagnetism would violate special relativity.

E2.3 An Operational Definition of $\vec{E}$

Imagine placing a charge q_{test} somewhere. If there are other charges in the vicinity Coulomb's law says that q_{test} will experience a force for F_e. The electric field is then defined by:

$$\vec{E} \equiv \frac{\vec{F}_e}{q_{\text{test}}} \, . \tag{1}$$

E2.4 The Field of a Point Charge

The unit vector $\hat{r}_{12}$ is a vector with a magnitude of 1 that points from position 1 to position 2. One way to think of this is that a unit vector is "just a direction".

The electric field at point P due to a a point charge q_1 is given by:

$$\vec{E} = \frac{kq_1}{r_{P1}}\hat{r}_{P1} \tag{2}$$

This is the equation to begin with when calculating an electric field. Using Eq. (E2.10) from our text will unnecessarily complicate your life.

Example: What is the electric field 10 cm to the left of a charge of 5 nC?

E2.5: The Superposition Principle

To calculate the field due to two point charges, calculate the fields due to each, and add the fields, remembering that the field is a vector and not a scalar.

Example: A charge of -5 nC is placed 10 cm directly below the charge from the previous example. What is the field 10 cm to the left of the upper charge?

E2.6 & E2.7: Field of a Charged Wire and Field of a Thin Ring

The main physics idea here is that we can break the big object into small pieces, use Eq. (2) to calculate the field arising from each small piece, and then adding up all the fields to get the field of the entire object. Conceptually, this is straightforward. However, actually carrying out this process can be a little bit of a mess sometimes, but some find it fun and strangely satisfying.

The main results from these sections are Eqs. (E2.19a) and (E2.19b), for the field due to the wire, and Eq. (E2.25) for the field above the thin ring.

Another important tidbit in these section is the idea of checking the formulas by examining their behavior in limiting cases.