

22.01

Electric Fields

“Action At a Distance”

- Particles that don’t physically “touch” can stil have electrostatic forces exchanged
 - How does that work if the particles aren’t “touching”?
 - * **Answer:** *electric fields*

About This Chapter

- *Three* goals of this chapter
 1. Define **electric field**
 2. Learn about analytic methods of describing electric fields
 3. Learn about how electric fields can affect charged particles

What is an “Electric Field”?

- **Field** = an object where each element in some specified **domain** is *uniquely* mapped to another **value**
 - Very similar to the concept behind a *function*
 - **Domain** = the space over which the field is described
 - The **value** can be **scalar** or **vector**
 - * **Scalar** = a mathematical object that specifies *magnitude*
 - **Fields** where the *associated values* are scalars are called a **scalar field**
 - * **Vector** = a mathematical object that specifies *magnitude* and *direction*
 - **Fields** where the *associated values* are vectors are called a **vector field**
 - More abstractly, a **vector** is just a mathematical object that contains many **scalar** values
 - * **Scalars** and **vectors** each have systems of operators that define how arithmetic works within their world and between
 - Examples
 - * Temperature field in an oven
 - * Pressure field in a pool

- **Electric Field** = a **vector field** that maps individual points in space to electrostatic force per unit charge
 - Mathematically, it looks like this

$$\vec{E} = \frac{\vec{F}}{q_0}$$

- where q_0 is an extremely small, positive charge, and \vec{F} is the electrostatic force exerted on the particle of charge q_0
- *Notice* that, since q_0 is a *positive* charge, \vec{E} and \vec{F} *must* point in the same direction
- The SI unit for electric field is $\frac{N}{C}$, which is a **vector** object

Procedure For Figuring Out \vec{E}

1. Take a particle of a very small, positive charge q_0
2. Place that particle at a point \vec{P} near some charged object O
3. Determine the electrostatic force between O and the particle of charge q_0 through empirical means
 - Perhaps measure acceleration and use newtonian mechanics to find \vec{F}
4. Calculate \vec{E} at \vec{P} by the following equation

$$\vec{E}_{\vec{P}} = \frac{\vec{F}_{\vec{P}}}{q_0}$$