Lecture 5  Sec 15.3-15.5, 15.6a (a partial coverage of 15.6)

1. Exercises on the dipole field.
3. Insulator:
   a. Induced dipole moment, polarized medium.
   b. Force between a positive Q and a neutral atom.
   c. Force between a negative Q and a neutral atom.
   d. Polarized medium
   e. Two exercises (15X6, 15x7). --- Clicker 6-3.
4. Conductor:
   b. Apply external E to a conducting medium
      1. Initial stage: Drude model, drift velocity $\propto$ Eext.
      2. Intermediate stage: drift velocity $\propto (E_{ext} - E_{pol}) - >0$.

5. Clicker 7-5.

Class Announcements:
MWF: After lecture, brief questions outside of the lecture hall.
   Office hour: 9:15-10:15.
   Other time by appointment (especially in the afternoons of MWF)
1. Rev's dipole field - electric potential

Dipole system - $E$ repelled by distance $s$.

\[ \text{c) } E_1, -E_2 \text{ where } E_1 > E_2 \]

A. Approximate magnitudes:

\[ \frac{KE}{d^2} = \frac{KE}{d^2} \]

\[ \rightarrow B_0 \frac{KE}{d^2} \]

1. at $E$ which location has $E$ a $\frac{KE}{d^3}$?

A: \[ \frac{2KE}{d^3} \]

B: \[ \frac{KE}{d^3} \text{ between} \]

C: \[ \frac{KE}{d^3} \]

At this point:

\[ E^- \leftarrow \]

\[ E^+ \leftarrow \]

\[ \textit{Magnetic at } S - |E| = |E^-| + |E^+| = 2|E| \]

\[ = \frac{9KE}{(\frac{d}{3})^2} \]
Chapter 15  Electric fields & Matter

2. Net charge & conservation of charge
   - Matter: Basic building blocks of matter are made out of +e & -e charge. Matter is made out of +e & -e charge.
   - Bulk of matter: Net charge of matter can be +, - charged dipole.
   - Conservation of charge
     Net charge of a system: 

     ![Diagram of charge conservation]

Check both sides of charge for A to B. But net charge will remain 0.

Can also have circulation of charge: $\vec{E} \rightarrow \vec{D}$

![Diagram of electric field and dipole]

In nature, charge is conserved. Total charge of the universe:

3. Insulator: Insulated
   - Matter medium of insulators

Induced dipoles:
- Insulator: Electrons are bound to the atom. No free electron.

Insulator atom:

\[ \vec{F}_e = qE \]
\[ \vec{F}_p = -qE \]

Induced dipole:

With dipole roll:

\[ p = qS \]

Atom is polarized.
From electron $\Phi$ (positive) + neutral atom

$F,_{\text{induced}} \Phi = \Phi E'$

\[ F_{\text{induced}} \Phi = \Phi \frac{2 \Phi}{x^3} = \frac{\Phi^2}{x^3} \cdot \frac{k \Phi}{x^2} \]

\[ F_{\text{induced}} \Phi = \frac{2 \Phi E^2}{x^3} - \frac{\Phi E^2}{x^3} \]

\[ F_{\text{induced}} \Phi = \frac{\Phi E^2}{(x^2 - \frac{\Phi^2}{2})^2} - \frac{\Phi E^2}{(x^2 - \frac{\Phi^2}{2})} = \frac{\Phi E^2}{x^2} \left[ \frac{1}{(1+\epsilon)^2} - \frac{1}{(1-\epsilon)^2} \right] \]

\[ 4 \epsilon = -4 \left( \frac{3}{x^2} \right) = -\frac{2x^2}{3} \]

\[ \Phi \rightarrow \Phi + \frac{\Phi}{x^2} \]

\[ F_{\text{induced}} = -F_{\text{induced}}^{\Phi} \]

Attraction between them

\[ \text{Attraction force} = -\text{Recoil force} \]
a. Microscopic view of insulating medium —
   - Polarize by external field, Fig. 15.19
   - Can have excess charge in interior, not at anywhere

b. Exercises: (15X6), (15X7) Which case has a stronger attraction in each of two questions in Sec 6.3?

4. Conduction medium — Charged solution of the metal medium, e.g. NaCl — ± mobile ions Na⁺, Cl⁻
   - Mobile electrons

   Turn on \( E_{\text{ext}} \) — e.g. metal

   \[ \begin{align*}
   E_{\text{ext}} & \rightarrow + \\
   & \rightarrow + \\
   & \leftarrow E_{\text{pol}}
   \end{align*} \]

   Initial stage —

   Delivery stage

   \[ \nu = \frac{eE_{\text{ext}}}{m} \Delta t \]

   Intermediate: \[ |\nu| \sim \frac{e}{m} (\Delta t) (E_{\text{ext}} - E_{\text{pol}}) \]

   NaCl

   \[ \begin{align*}
   & \leftarrow E_{\text{pol}} \\
   & \rightarrow E_{\text{ext}} \\
   & \leftarrow E_{\text{pol}}
   \end{align*} \]

   \[ \rightarrow 0 \]