Go to: Course homepage, Lectures

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

1. Exercises on the dipole field.
2. Net charge and conservation of charge.
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:
   a. Ionized solutions. Mobile +/- ions. Mobile electrons.
   b. Apply external E to a conducting medium
      1. Initial stage: Drude model, drift velocity \propto Eext.
      2. Intermediate stage: drift velocity \propto (Eext – Epol) - - > 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)

Lec 5

1. Review dipole field — clicker question

Dipole system — $\pm q$ separated by distance s.

clicker

Lec 4-1: $q_1, -q_2$ where $q_1 > q_2$

A. Approximate magnitude —

$$\frac{kq}{d^2} = \frac{ke}{d^2}$$

→ B. $\frac{ke}{d^2}$

Lec 4-2 Which location has $E \propto \frac{kp}{d^3}$?

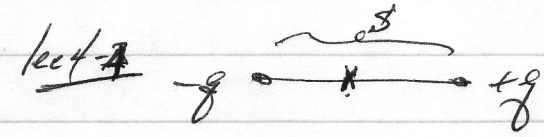
A: $\frac{2kp}{d^3}$

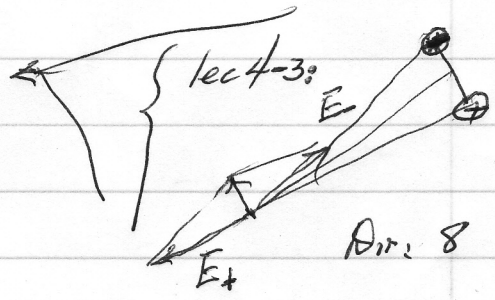
B: --- in between

C $\frac{kp}{d^3}$

→

Lec 4-4





At clicker: $E^- :$ ←

$E^+ :$ ←

∴ Magnitude at S - $|E| = |E^-| + |E^+| = 2|E^-|$

→

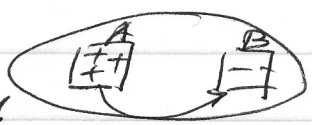
$$= \frac{2kq}{(\frac{s}{2})^2}$$

Chapter 15 Electric fields + Matter

2. Net charge + conservation of charge

- Matter - Basic building blocks of matter are made out of + & - + 0 charge. Matter itself made out of + & - charge bits of matter. Net charge of matter can be +, − charged objects.
- Conservation of charge

Net charge of a system



e.g.: say +1

Can have bits of charge from A to B. But net charge will still be +1.

Can also have annihilation pairs $e^- \rightarrow \gamma\gamma$

net charge = 0 net charge = 0

In nature net charge of an isolated system is conserved. Total charge of the universe is conserved.

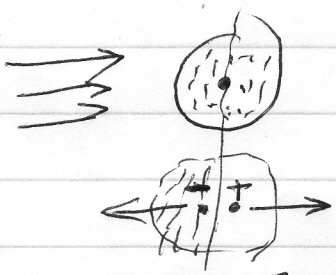
3. Insulators:

- Matter medium { insulators, conductors

Induced dipole:

a. Insulators: Electrons are bound to the atom. No "free electrons"

Insulator atom:



Induced dipole.

Weak dipole moment

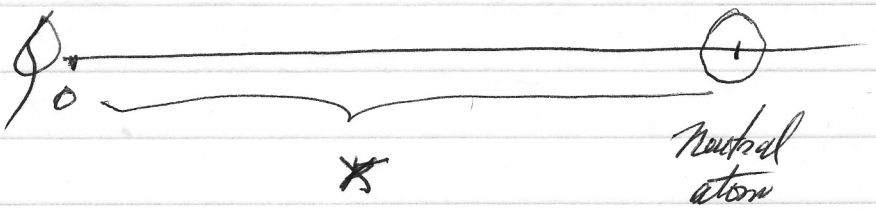
$p = qs$

atom is polarized.

$F_+ = qE$

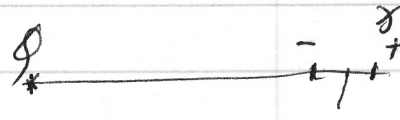
$F_- = -qE$

b. Force between q (positive) + neutral atom



$$F_q^{\text{induced } p} = q\,E_0^{p} = q\,\frac{2kp}{x^3} = \frac{q\,2k}{x^3}\cdot \underbrace{\alpha E_0^{q}}_{\frac{kq}{x^2}}$$

$$= \frac{2\alpha(kq)^2}{x^5}$$

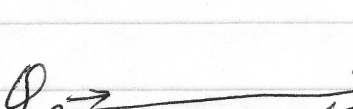


$$F^{q}_{\text{induced } p} = F^{-q}_{+q}\left(x+\tfrac{s}{2}\right) + F^{-q}_{-q}\left(x-\tfrac{s}{2}\right)$$

$$= \frac{kqq}{\left(x+\frac{s}{2}\right)^2} - \frac{kqq}{\left(x-\frac{s}{2}\right)^2} = \frac{kqq}{x^2}\left[\frac{1}{(1+\epsilon)^2} - \frac{1}{(1-\epsilon)^2}\right]$$

$$-4\epsilon = -4\left(\frac{s}{2}\right)\frac{1}{x}$$

$$= -\frac{2s}{x}.$$



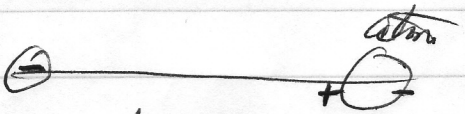
$$= \frac{kqq}{x^3}(-2).$$

$$= -F_q^{\text{induced } p}$$

Attraction between them.

Action force = − Reaction force

ex. of $q<0$



Again attraction.

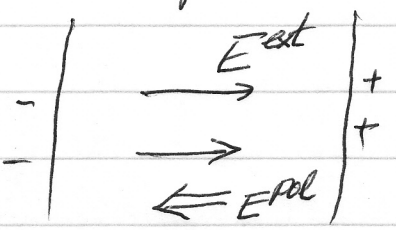
d. Microscopic view of insulating medium —
- Polarizes by external field Fig 15.19
- Can have excess charges in interior ~~+ at~~ at surface Fig 15.2

e. Exercises: (15X6), (15X7) which case has a stronger attraction in each of two questions in Lec 6-3,

4. Conducting medium — Ionized solution & the metal medium,
e.g. NaCl — ± mobile ions Na^+, Cl^-

mobile electrons

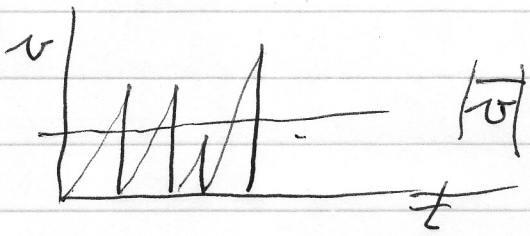
Turn on E^{ext} : e.g metal.



Initial stage — Drift velocity

$\bar{v} = a\,\Delta t$

Collision time

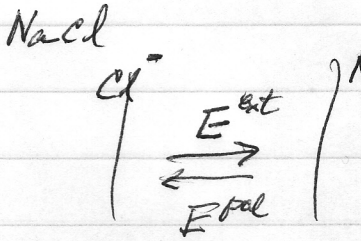


$$|\bar{v}| = \frac{F}{m}\Delta t = \frac{eE^{ext}}{m}\Delta t$$

$$= \left(\frac{e\,\Delta t}{m}\right) E^{ext}$$

Intermediate : $|\bar{v}| \sim \left(\frac{e\,\Delta t}{m}\right)\left(E^{ext} - E^{pol}\right)$

$\longrightarrow 0$



Clicker 7-5

1. e^- from skin to tape
2. Cl^- skin to tape
3. protons X
4. tape is not conducting medium
5. X