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Lec 6. Selected problems in 15.2-15.8 iq04

1. Conductor:
   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). Eventually Enet=0.

2. A metal block + two point charges (clicker 7-4, see also clicker 7-3)
   Typo: 7-4D: Direction of the field at A (not at B)
3. Definitions: permanent dipole (e.g. water) vs induced dipole (e.g. Carbon tetrachloride) See h1-015.
   Digression: Write F \propto (1/r^n), where r is large. What is the n-dependence for cases below?
   a. Forces between q + permanent dipole
   b. Forces between q+ atom (induced dipole): clicker 6.2
   c. Forces between two permanent dipoles (see p618, Fig. 15.70, clicker 5-3)
   d. Force between a permanent dipole + atom (induced dipole). What is n for this case?

4. Clicker 8-1 (Discussion related to h3-11): Effect on the measured field when the magnitude of the test charge is non-negligible.
5. Discussion on h3-16. (see p605, E=0 and q=(Q/8)(L/r)^2)
   Model estimate on the polarizability of a neutral atom: clicker 8-2.

Class Announcements:
My regular office hour is MWF: 9:15-10:15. Other time by appointment.
Lec 6-1

E interaction matrix

\{ Insulator
Conductor \}

\{ Ionsed \}

\{ Metallic \}

Mobile electron

\[ F = qE \]
\[ a = \frac{qE}{m} \]

Initial step

\[ v = \frac{qE}{m} \]

Drift velocity

\[ v = at \]

Collision: \( \Delta t \)

\[ v = \frac{qE}{m} \]

\[ v = \left( \frac{qE}{m} \right) \]

\[ \bar{v}(\text{final}) = \frac{qE}{m} \]

Neutrally charged electron

\[ v = \text{at} \]

\[ \bar{v}(\text{final}) = \frac{qE}{m} \]

Eventually: \( \bar{v} = 0 \)

\[ E = 0 \]

\[ \text{Static equilibrium.} \]

\[ \text{Choker 7-3: What is net field at B?} \]

\[ E_{B} = \text{due to surface charge} \]

\[ E_{g} = \text{due to internal} \]
A. \( E \times B \) due to \( + \) side surface charge

- \( + + \)

B. \( E \times B \) due to all charges —
Resultant field at B 0

C. \( E \times B \) due to all surface charge:
\[ E^+ + E^- + E^B = 0 \]

\[ \frac{E^+ + E^-}{E^B} = -E^B \]

With hint: Where \( E^B \) 

D. \( E \times A \) due to all charges,
due to surface charge
Dyson on 11-015

Permanent dipole: Water, Indene dipole

Water: Permanent dipole

Carbon tetrachloride: No permanent dipole

There is induced dipole.

\[ \frac{g_1}{g_2} \quad \frac{\kappa E_0}{r^2} \]

\[ \frac{q}{p} \quad \left( \frac{\kappa E_0}{r^3} \right) \]

\[ \frac{g}{\text{atom}} \quad \frac{\kappa E_0}{r^3} \quad p = \alpha E_0^8 = \left( \frac{k_0}{r^2} \right) \]

\[ \frac{\partial k}{r^3} \quad \frac{\partial E}{r^2} \quad \alpha \frac{4}{15} \]

\[ p - p: \text{ Lekman curve} \]

\[ 4E = 4 \left( \frac{2}{3} \right) = \frac{8}{3} \]

p = q\text{ } q\text{-atom} \text{ Attraction} \quad F \sim \frac{1}{r^2} \quad F = 8 \frac{2\kappa E_0}{r^3} \left[ \frac{1}{(1-c)^3} - \frac{1}{(1+c)^3} \right] \]

\[ \frac{1}{4} \quad \frac{1}{16} \quad \frac{1}{256} \]
Deffine: \[ E = \frac{F}{q_0 B} \]

Example: Let \( q < 0 \)

\[ \begin{array}{c}
\text{Draw a conducting sphere with charge } q \text{ on it.}

\text{Make pg g at P and F1}

\text{and } \overrightarrow{F_2}

\text{At } q_2 > q_1 \text{ show } \frac{E_2}{E_1} > \frac{q_2}{q_1} = E_1

E_2 > E_1

Reason: \( q_1 \) leads to \( E_0 > B \Rightarrow F_1 \)

\[ E_p' = E_p + E_p' \]

\[ E_p'' > E_p' \]
Calculate magnitude:

\[ p = 2 \cdot E_0 \]

Equal condition:

\[ -8 \quad +8 \]

\[ E_0 = E_0^{-8} + E_0^{+8} = \frac{2k_0\phi}{(\frac{\lambda}{2})^2} \]