Announcements

- Homework
  - Online HW3 due tonight
  - Video Homework 2 due Monday
- Physics Tea today at 3pm!
- Board games will be being played during/afterwards if that sounds fun!
- Polling: `rembold-class.ddns.net`

Review Question

An electric dipole with a dipole moment of $\vec{\mathbf{p}}_1 = \langle 0, 1, 0 \rangle$ is fixed to the origin. A second dipole with a moment of $\vec{\mathbf{p}}_2 = \langle 0, -1, 0 \rangle$ is placed at the point $\langle -10, 0, 0 \rangle$. Describe the motion of the second dipole immediately after it is released.

A. It spins but stays the same distance from the origin dipole

B. It spins and moves away from the origin dipole

C. It spins and moves towards the origin dipole

D. It neither spins nor moves towards or away from the origin dipole

Solution: Neither spins nor moves

Getting Real

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  - Aid to separate the interaction of the surroundings from a specific system
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- Well, kinda...
  - Information only travels at the speed of light
  - Fields will "retain" previous info until updated

Upcoming:

Electric Fields *MATTER*

Tracing it back to the source. . .

Net Charge

The net charge of an object is the sum of the charges of all its constituent particles.

- Zero net charge = "neutral"
- Any net charge = "charged"

- Our smallest building blocks will be electrons and protons
- An proton or electron has a charge of $\pm 1.6 \times 10^{-19}$ C

Conservation of Charge

The net charge of a system and its surroundings can *not* change!

- Conservation of charge is technically a fundamental principle, as it is true in all situations

Charging boldly forth

- Materials can be broken up into type types:
  - Conductors
    - Material in which charges can move easily through the material
  - Insulators
    - Material in which charges are bound and incapable of easily moving through the material
- The different behaviors of the charges means we can get very different effects when talking about charged conductors or insulators, so always keep in mind which you are talking about!

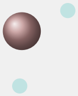
Sticky Demos

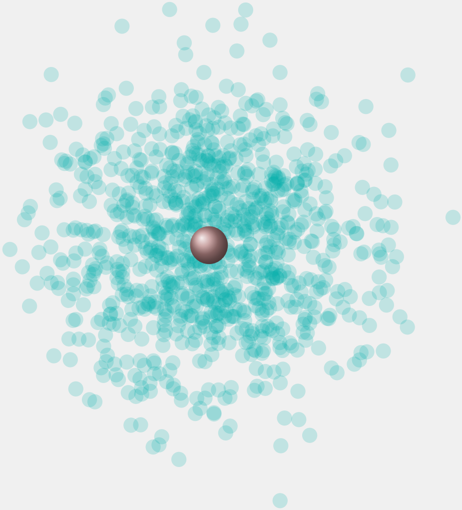
Questions to consider:

- How can we tell if something is neutral?
- Can we determine between positive and negatively charged objects?
- What is happening on a microscopic level?
- What charges are being moved around?
- Why are both tapes attracted to my neutral hand?!

Atomic Structure and Electric Fields

Atomic Structure and Electric Fields





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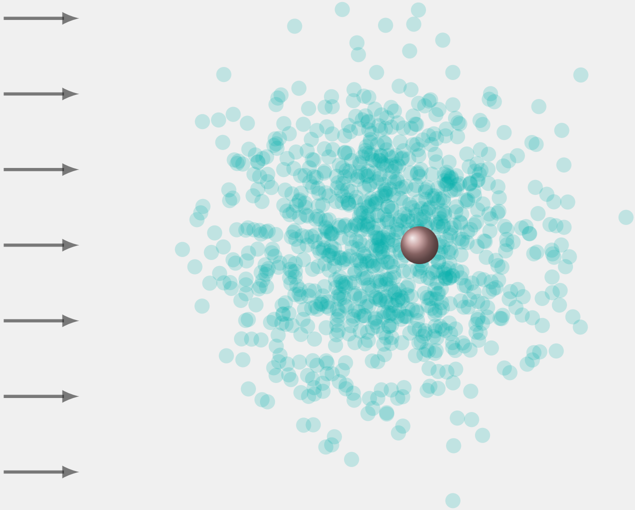

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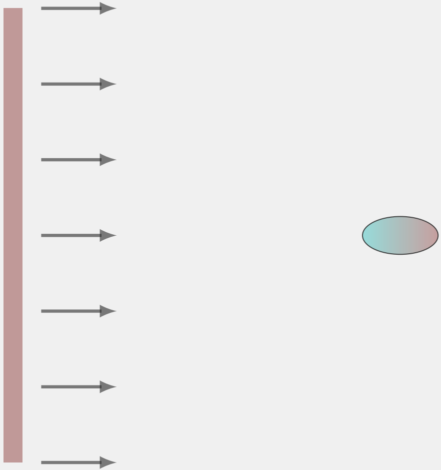


Induced Electric Dipoles

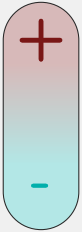
- An electric field will induce a dipole in a neutral atom or molecule
- Result:
  - Positive charge induces a dipole pointing away from it
    - Means negative side is closer that positive side
    - $\Rightarrow$ Net attractive force
  - Negative charge induces a dipole pointing towards it
    - Means positive side is closer than negative side
    - $\Rightarrow$ Net attractive force

Polarization Facts

- Will usually represent the dipole with an oblong shape with positive and negative ends
- Induced dipoles only exist while there is an electric field inducing them!
- For most materials, the "degree of polarizability" is proportional to the electric field doing the polarizing:

$$\vec{\mathbf{p}} = \alpha \vec{\mathbf{E}}$$

  and α is called the polarizability of the material



Polarizability Example

Hydrogen has a polarizability of about $7.4 \times 10^{-41}\,\mathrm{C^2m/N}$ and is comprised of protons and electrons ($1.6 \times 10^{-19}\,\mathrm{C}$). We apply an electric field of $3 \times 10^{6}\,\mathrm{N/C}$ to the material. How far do the charges separate and polarize?

Solution: $\approx 1.39\,\mathrm{fm}$