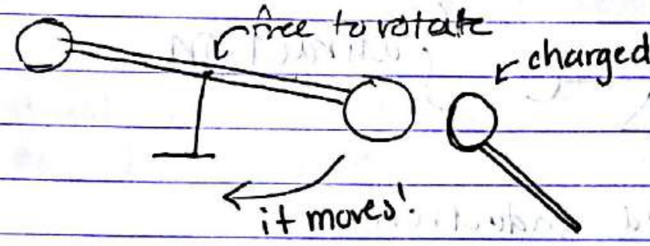
Chapter 21 Lecture

-Take past midterms! - this midterm has no electrostatics.

Electrostatics

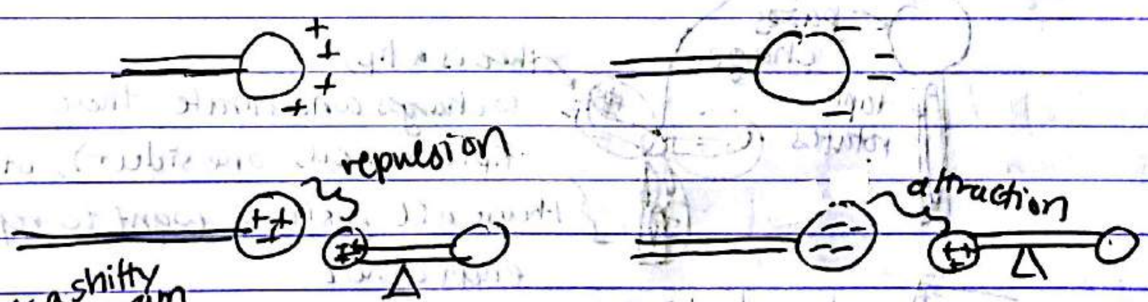


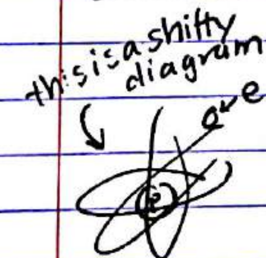
invisible force! wow!

Observations

- Force - attractive
- rubbing two balls w/fur causes a repeling force
- rubbing one ball w/wax paper & other w/fur causes an attractive force

> We are charging the objects. (transferring charge)



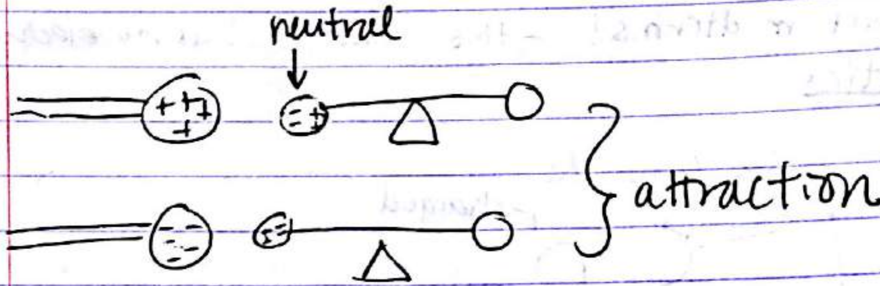


← $q_e < 0$

$q_p > 0$

Two basic distinctions:

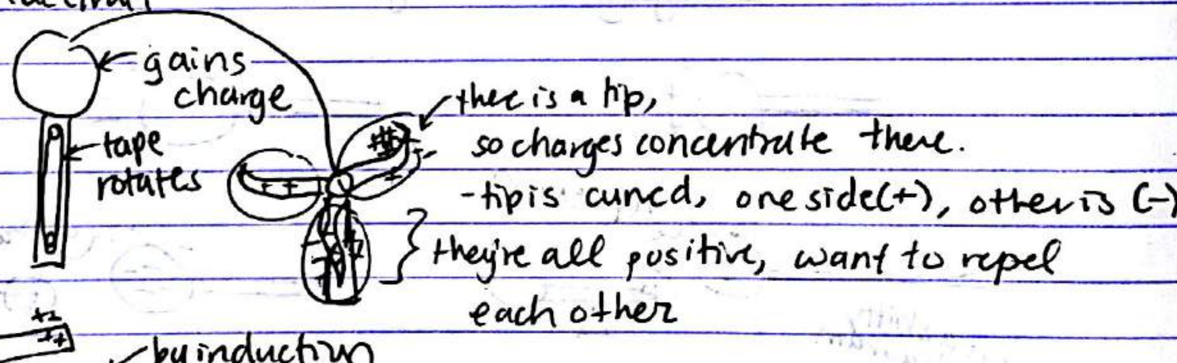
- conductors
  - easily take away charge
- insulators
  - harder to take away charge

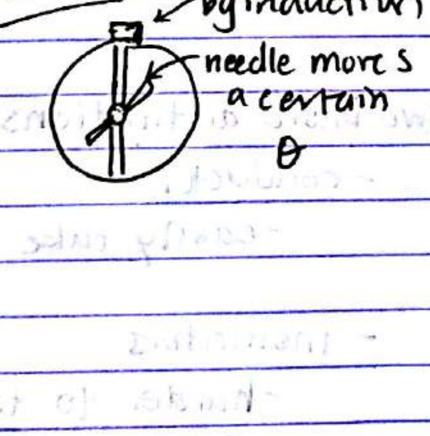


This is called induction
- a charged object comes <u>close</u> to a neutral object. The neutral object's charges redistribute itself.
- charge is conserved.

The absence of electrons creates a positive charge. (hole)

van de Graft

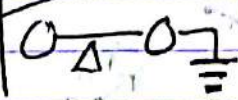




Coulomb Force

- this is a new force!
- closer you are, stronger the charge
  ($1/$distance) → $\frac{1}{r^2}$
- attractive, repulsive (signed)
- need 2 objects that are charged - Q, q

$\vec{F}_{grav} = \frac{GMm}{r^2}$



⚡ Ground, reservoir of charge (think of reservoir for isotherm)

$|F_c| \propto \frac{Qq}{r^2}$

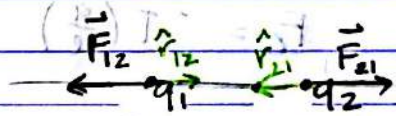
coulomb's constant

$|\vec{F}_c| = \frac{k_c Q q}{r^2}$ (Nm^2/C^2) = $8.9e9 \frac{Nm^2}{C^2}$

units of charge (C) are measured in Coulombs

$k_c = \frac{1}{4\pi\varepsilon_0}$ ← permittivity of free space (how easy it is to transfer charge)

$$|\vec{F}_c| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Qq}{r^2}$$



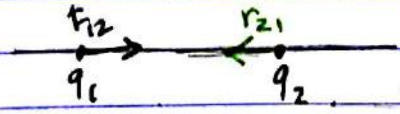
, q_1 & q_2 have same sign

$\vec{F}_{12} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}\hat{r}_{21}$

Force on q_1; q_2 exerting force; from q_2 to q_1 (unit vector) convention pls :-

★ same sign q_1, q_2
= repulsive $\vec{F}$ (>0)
opposite sign q_1, q_2
= attractive $\vec{F}$ (<0)

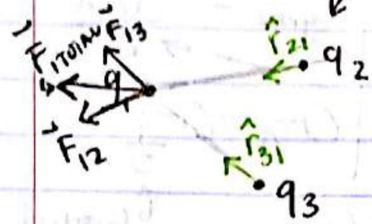
} the direction is given by the product $q_1 q_2$



still: $\vec{F}_{12} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}\hat{r}_{21}$, but $q_1 q_2 < 0$.

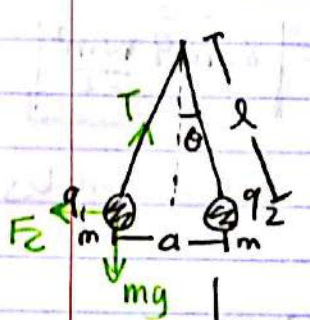
By Newton's Third Law,
$\vec{F}_{12} = -\vec{F}_{21}$:)

Three Charge *assume q_1, q_2, q_3 have same sign



$$\vec{F}_{1TOTAL} = \vec{F}_{13} + \vec{F}_{12}$$

Generalization: $\vec{F}_{TOT\,i} = \sum_{i+1}^{n} \vec{F}_{ij}$



q_1, q_2 same sign
same magnitude

$$F_c + T\sin\theta = 0$$

$$F_c = -T\left(\frac{a}{\ell}\right)$$

$$\frac{k q_1 q_2}{4\pi\varepsilon_0 r^2} = \frac{-Ta}{\ell}$$

$$\frac{kq^2}{4\pi\varepsilon_0 a^2} = \frac{-Ta}{\ell} \quad (T \to mg/\cos\theta)$$

$$q = \sqrt{\frac{Ta^3 4\pi\varepsilon_0}{\ell}}$$

$$= \sqrt{\frac{mg\tan\theta\, 4\pi\varepsilon_0 a^2}{\ell}}$$