Lecture 2

Friday: HW due by 5pm

Supp Ex 1, 2, 4, 5ab, 6

Ch 20 Questions: 6

Ch 20 Probs: 11, 49

↳ grav force $F = G \frac{M_1 M_2}{r^2}$

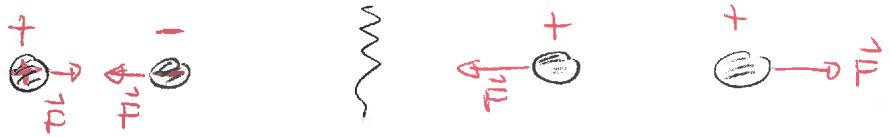
Monday Warm Up 2

Electric charge

We saw that objects which have been rubbed can exert forces that are not gravitational. These are electric forces and, to describe their basic properties, we use the fact that there are two types of electric charges: positive and negative.

The basic rule that governs these is:

> Like charges repel; opposite charges attract



We can describe basic phenomena associated with such charged objects by using a few basic facts.

Origin of charge / charge conservation

Charge originates with the presence of certain subatomic particles which are inherently charged. Specifically

Electrons are negatively charged	~ charge = $-e = -1.6\times10^{-19}C$
Protons are positively "	~ charge = $+e = +1.6\times10^{-19}C$

Note that neutrons are neutral. Here the units of charge are Coulombs (C).

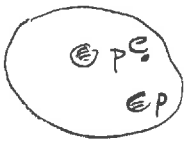
Ordinarily most objects contain the same number of electrons as protons. Such objects can be regarded as neutral too. More precisely

> The total charge of an object is the sum of the charges of all the constituent subatomic particles.

For example

Total charge = 0C

Total charge = $2\times(-1.6\times10^{-19}C)$
$= -3.2\times10^{-19}C$



Total charge = +e
$= +1.6\times10^{-19}C$.

A general observation and law of physics is the conservation of charge

> If a system is isolated then the total charge of the system remains constant even though charge may be redistributed amongst the constituents of the system

Charge transport

Note that charge can move to varying degrees within an object. Two extremes are:

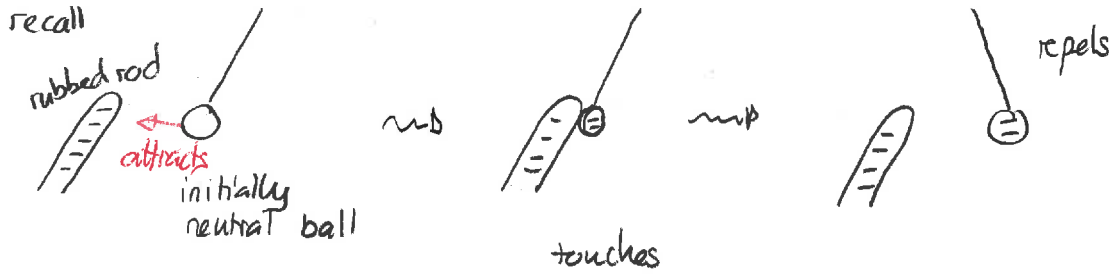
1) conductors – charge flows freely e.g. metals
2) insulators – charge cannot flow at all e.g. plastic

Electrostatic phenomena

We can describe various phenomena that one can readily observe

1) rod / ball repulsion

Redo Demo →



Quiz 1 - 80%

After they touch, negative charge from the rod is transfered to the ball, which is subsequently also negative. So these both repel.

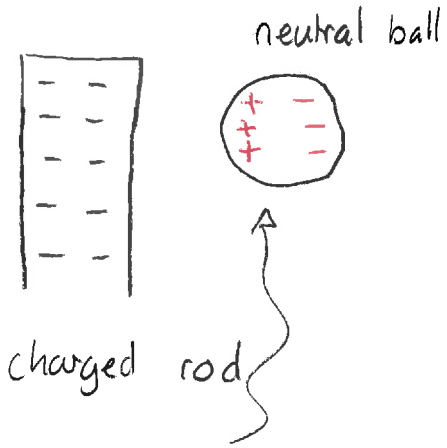
Quiz 2 - 80%

Demo: Electroscope

Polarization

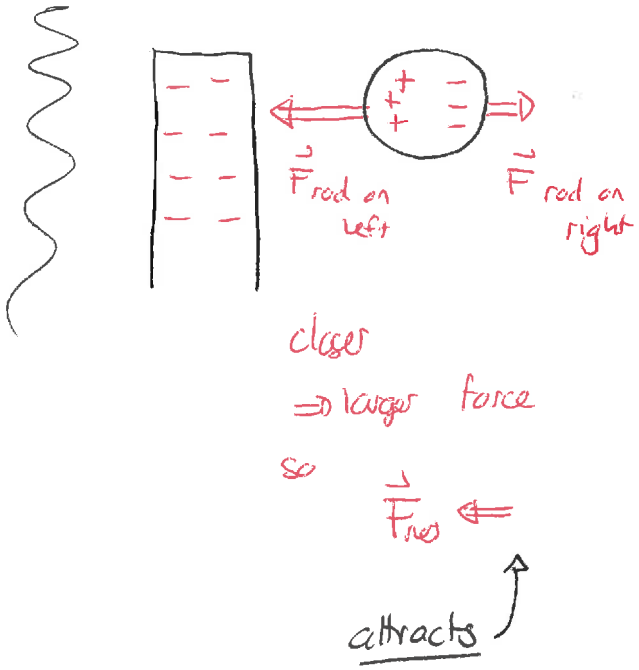
How was the neutral ball initially attracted to the charged rod? Although the ball is neutral overall, the distribution of charge may not be uniform. We will see that such non-uniformly charged objects can exert and feel electric forces even though they are neutral.

This process is called polarization



rod attracts +ve
repels -ve

charge is separated ⇒ polarized



Warm Up 1

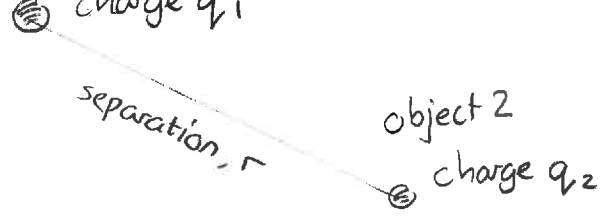
Coulomb's Law

We need a precise mathematical rule for describing forces We consider two point charges. Coulomb's law gives the basic force law in this situation

The electrostatic force exerted by one charge on another has:

1) magnitude

$$F_{1on2} = K \frac{|q_1||q_2|}{r^2}$$



2) direction along line between charges

Here $k = 8.99 \times 10^9\ Nm^2/C^2$ is a constant for any pair of charges

Note that this can subsequently be used to determine acceleration by determining the net force on the object and applying $\vec{F}_{net} = m\vec{a}$.

Warm Up 2