Unit 3 - Types of Fields
Types of Charges
Types of Circuits

Electrostatics

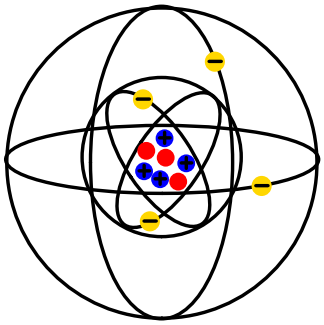
Electrostatics is the study of stationary electric charges.

The Electrical Nature of Matter

An atom consists of a small, relatively massive _____ that contains particles called _____ and _____. Surrounding the nucleus is a diffuse cloud of orbiting particles called _____.

Only two types of electric charge have been discovered, positive and negative.

- proton $(1.673 \times 10^{-27}$ kg)
- electron $(9.11 \times 10^{-31}$ kg)
- neutron $(1.657 \times 10^{-27}$ kg)



The SI unit for measuring the magnitude of electric charge is the coulomb (C).

Because any electric charge, q, occurs in integer multiples of elementary charges of magnitude, e, electric charge is said to be quantized.

$q = Ne$

q -> electric charge (C)
N -> number of charges
$e = 1.60 \times 10^{-19}$ C

↑ represents only the magnitude of the charge on a proton or electron

Example:
How many electrons are there in 1.00 C of negative charge? (6.25×10^{18})

$q = Ne$

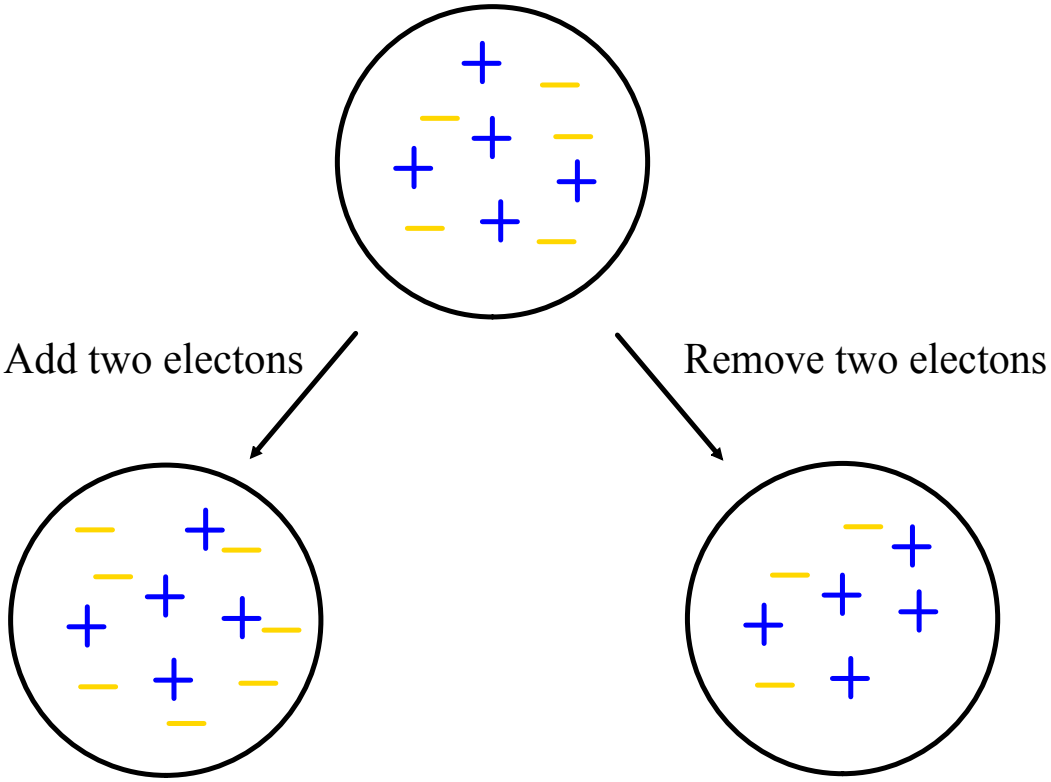
$1 = N(1.60 \times 10^{-19} C)$

$6.25 \times 10^{18} = N$

NOTE: 1 electron = 1.60×10^{-19} C
1.00 C = 6.25×10^{18} electrons

Transfer of Charge

Electric charge can be transferred from one object to another. Usually electrons are transferred.



Separation of charge often occurs when two unlike materials are rubbed together - electrification by friction.

Electric charges are involved in chemical reactions, electric circuits and radioactive decay. In any situation, the Law of Conservation of Electric Charge is obeyed. Charge can't be created or destroyed. The net electric charge of an isolated system is constant.

Static Electricity Series

\+

fur
acetate
glass
wool
silk
cotton
vinyl
rubber
amber (tree resin)

−

A material will lose electrons when rubbed with a material lower in the list.

Examples:

(i) rubber and silk

(ii) silk and glass

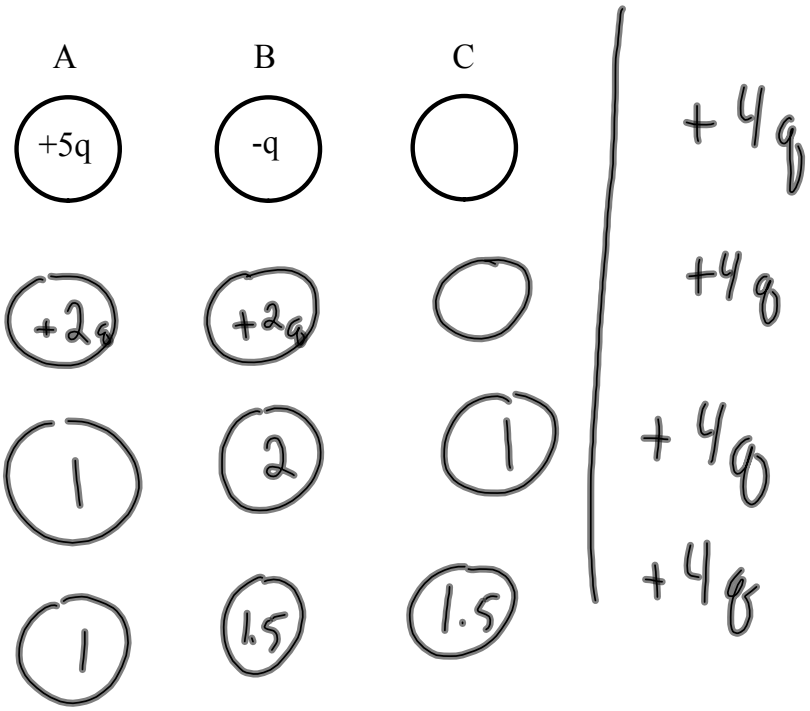
(iii) glass and cotton

(iv) wool and vinyl

Try This

Consider three identical metal spheres, A, B and C. Sphere A carries a charge of +5q. Sphere B carries a charge of -q. Sphere C carries no net charge. Spheres A and B are touched together and then separated. Sphere C is then touched to sphere A and separated from it. Last, sphere C is touched to sphere B and separated from it.

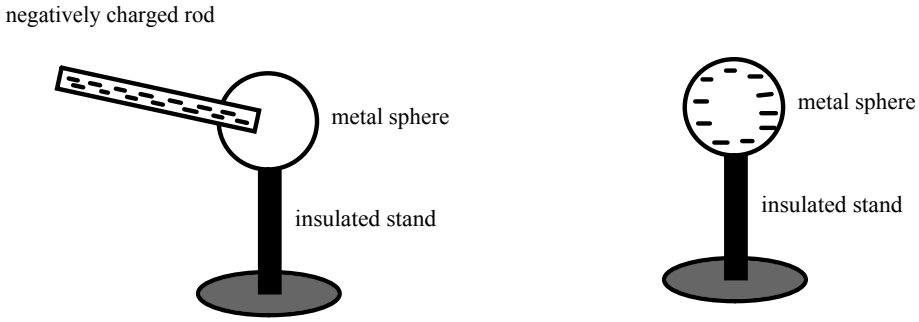
a) How much charge ends up on sphere C?
b) What is the total charge on the three spheres before they are allowed to touch each other?
c) What is the total charge on the three spheres after they are allowed to touch each other?



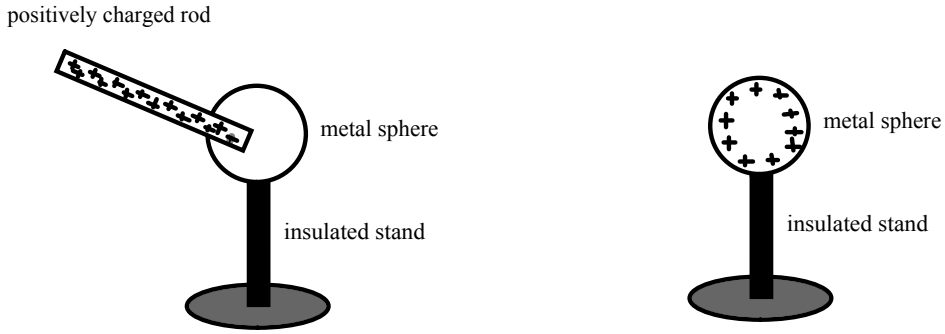
★

Charging by Conduction

When a negatively charged rod touches a metal sphere, some of the excess electrons from the rod are transferred to the sphere. Once the electrons on are the sphere, they repel one another and spread out over the sphere's surface. The insulated stand prevents the electrons from flowing to the earth, where they would spread out even more. When the rod is removed, the sphere is left with a negative charge distributed over its surface.



What if a positively charged rod was used instead?



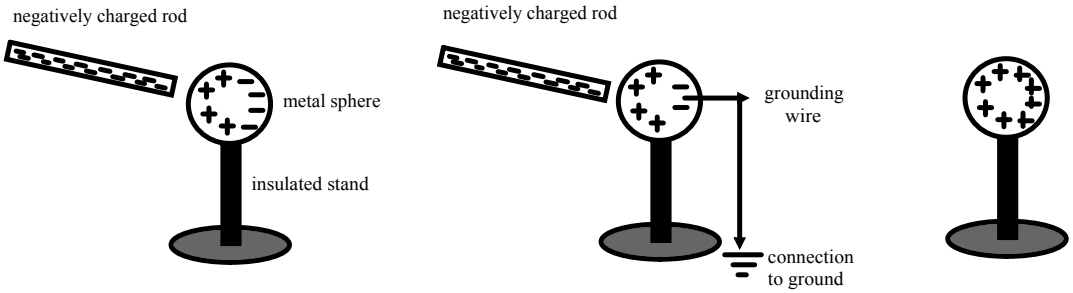
Electrons from the sphere would be transferred to the rod leaving the sphere with a positive charge.

The process of giving one object a net electric charge by placing it in contact with another object that is already charged is known as charging by conduction.

Δ

Charging by Induction

It is possible to charge an object without contact.

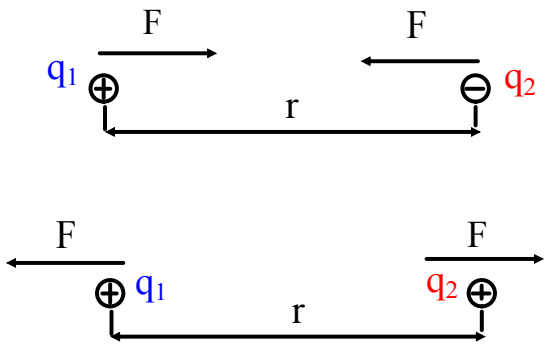


The process of giving one object a net electric charge without touching the object to a second charged object is called charging by induction.

Electric Force

A fundamental characteristic of charge is that like charges repel and unlike charges attract.

The force that charges exert on one another is called an electric force or electrostatic force.



French physicist Charles-Augustin Coulomb (1736-1806) carried out a number of experiments to determine how the electric force that one point charge applies to another depends on the amount of each charge and the separation between them.

$$F \propto q_1 q_2$$

$$F \propto \frac{1}{r^2}$$

Coulomb's Law

$$F = \frac{k\, q_1 q_2}{r^2}$$

F -> magnitude of the electrostatic force (N)
q_1 -> magnitude of point charge 1 (C)
q_2 -> magnitude of point charge 2 (C)
r -> distance between point charges (m)
k -> proportionality constant

$$k = 9.0 \times 10^9 \frac{Nm^2}{C^2}$$

NOTE: Charges are often given in units of μC ($1\mu C = 10^{-6}$ C).

The electrostatic force is attractive if the charges have unlike signs and repulsive if the charges have like signs.

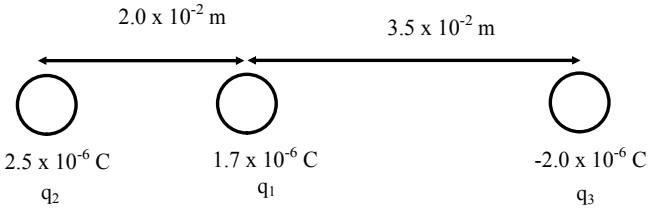
Page 638, #1-5

Coulomb's Law - Three Charges

Coulomb's can be applied when three charges are involved.

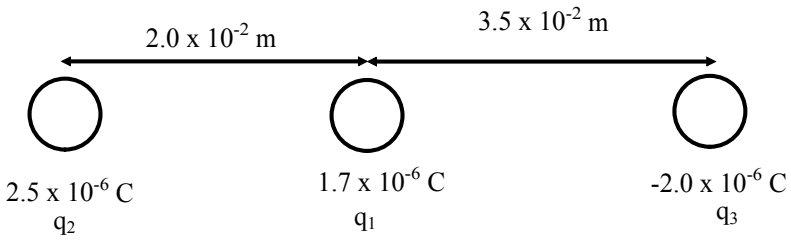
Example

A charge of 1.7×10^{-6} is placed 2.0×10^{-2} m from a charge of 2.5×10^{-6} C and 3.5×10^{-2} m from a charge of -2.0×10^{-6} C as shown in the diagram.



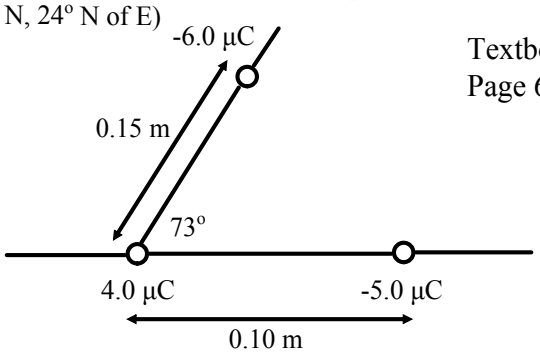
a) Calculate the net electric force on the 1.7×10^{-6} C charge. (1.2×10^{2} N, right)

b) Calculate the net electric force on the 2.5 x 10^{-6} C charge. (81N, left)



Example:

The diagram shows three point charges that lie in the x, y plane. Find the net force on the 4.0 μC point charge. (23 N, 24° N of E)



Textbook:
Page 640-641, #7-10

•

Attachments

Inverse Square Love.jpg

Physics 122 - Practice Coulomb's Law.doc

Ohm Pictures.jpg