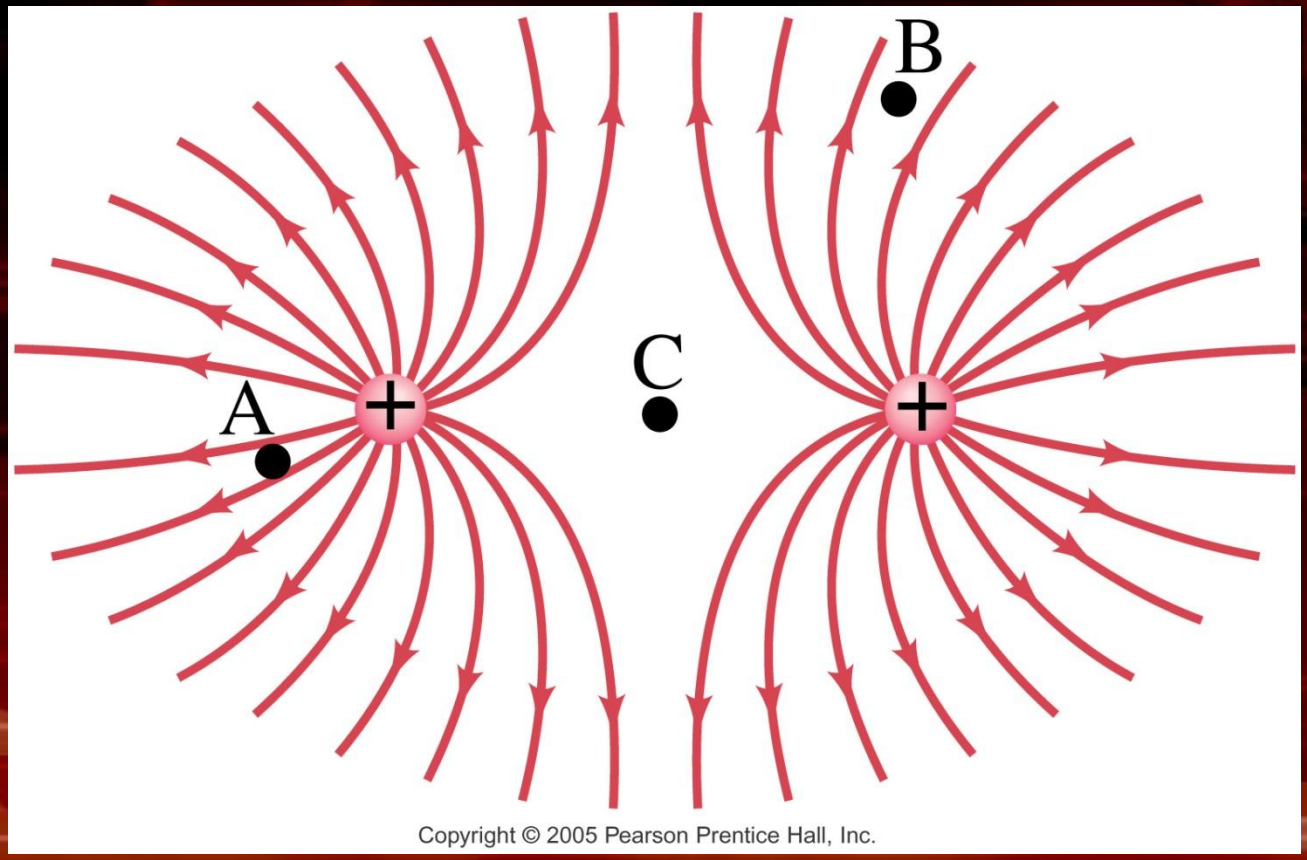
Chapter 32

Electrostatics



Electrostatics

Electricity – comes from the Greek word "elektron" meaning "amber"

Static Electricity - "the amber effect" where a rubber rod, glass, or plastic rod rubbed with a cloth attracts small pieces of paper or dust.

32.1 Electrical Forces and Charges

Electrical forces- a force that one charge exerts on another. When the charges are the same sign, they repel; when the charges are opposite, they attract.

32.1 Electrical Forces and Charges

Electrons are negatively charged

Protons are positively charged

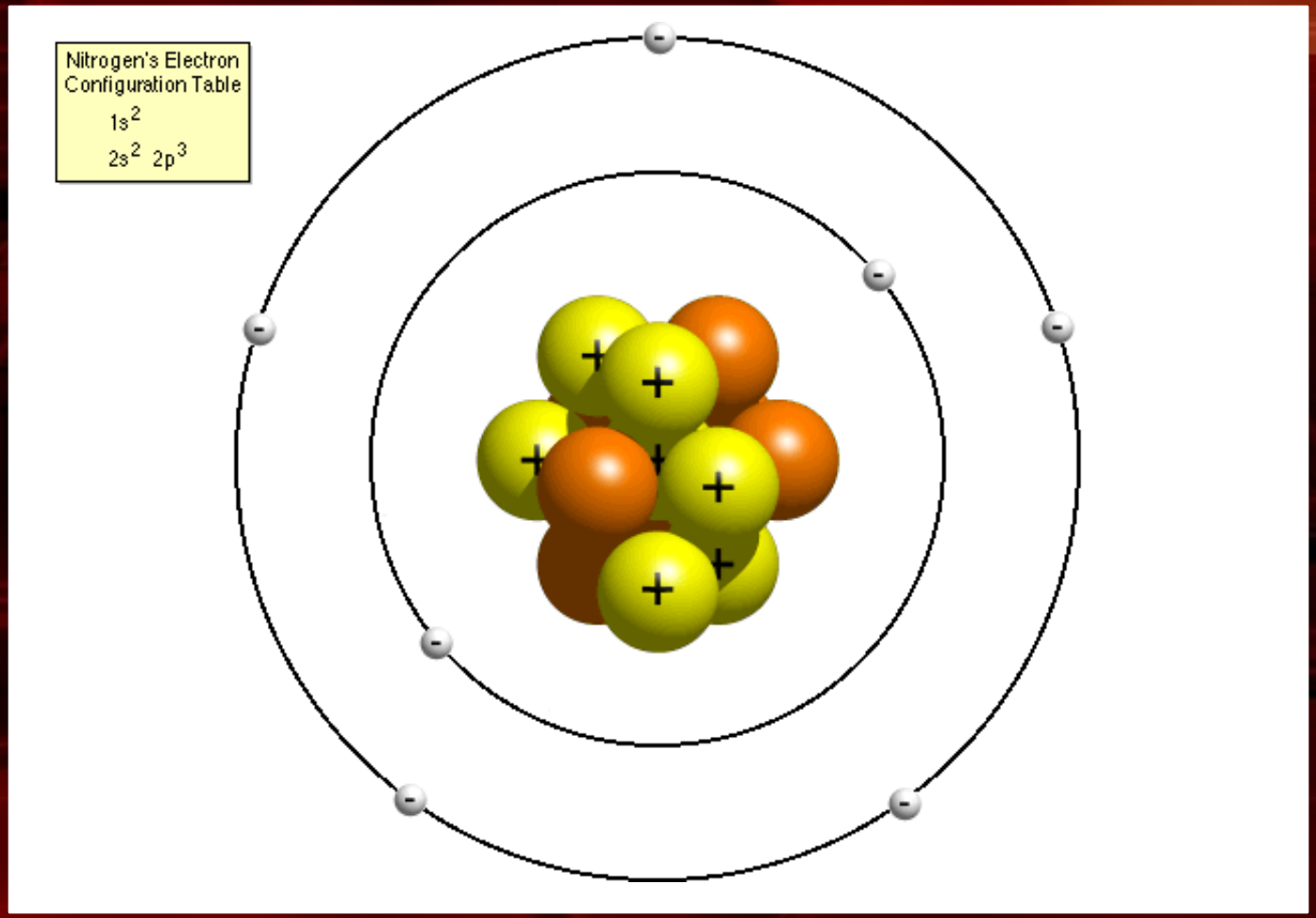
Neutrons have no charge.

32.1 Electrical Forces and Charges

Charge on the electron:

$$e = 1.602 \times 10^{-19}\ \mathrm{C}$$

32.1 Electrical Forces and Charges



Bohr model of the atom

32.1 Electrical Forces and Charges

Four Facts about the Atom

1. Every atom has a positively charged nucleus surrounded by negatively charged electrons.

32.1 Electrical Forces and Charges

Four Facts about the Atom

2. All electrons are identical; that is, each has the same mass and the same quantity of negative charge as every other electron.

32.1 Electrical Forces and Charges

Four Facts about the Atom

3. The nucleus is composed of protons and neutrons. All protons are identical. Protons have a mass that is 2000 times the mass of an electron, but its positive charge is equal in magnitude to the charge of an electron.

32.1 Electrical Forces and Charges

Four Facts about the Atom

4. Atoms usually have the same number of protons and electrons, no the atom has a zero net charge.

32.1 Electrical Forces and Charges

Like charge repel; opposite charges attract.

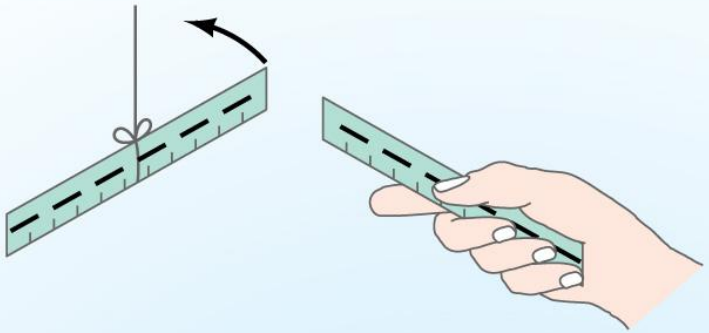
32.1 Electrical Forces and Charges

Time for a Gizmo!

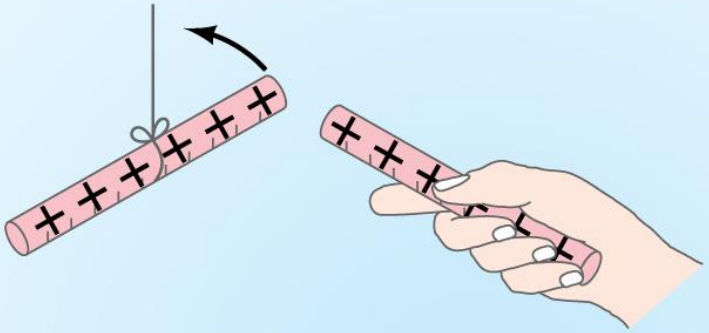
32.2 Conservation of Charge

Objects can be charged by rubbing

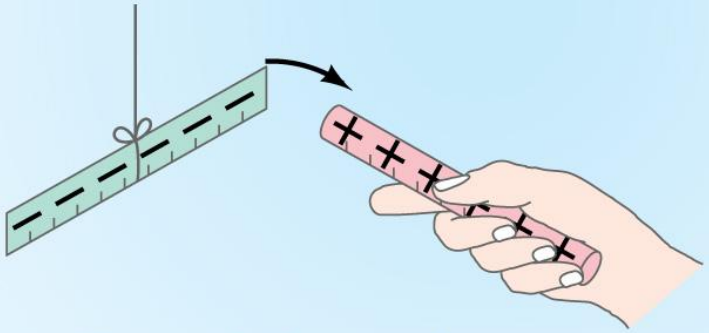
32.2 Conservation of Charge



(a) Two charged plastic rulers repel



(b) Two charged glass rods repel



(c) Charged glass rod attracts charged plastic ruler

Charge comes in two types, positive and negative; like charges repel and opposite charges attract

32.2 Conservation of Charge

Law of conservation of electric charge – the principle that the net electric charge is neither created nor destroyed but is transferable from one material to another.

32.2 Conservation of Charge

Atom is electrically neutral.

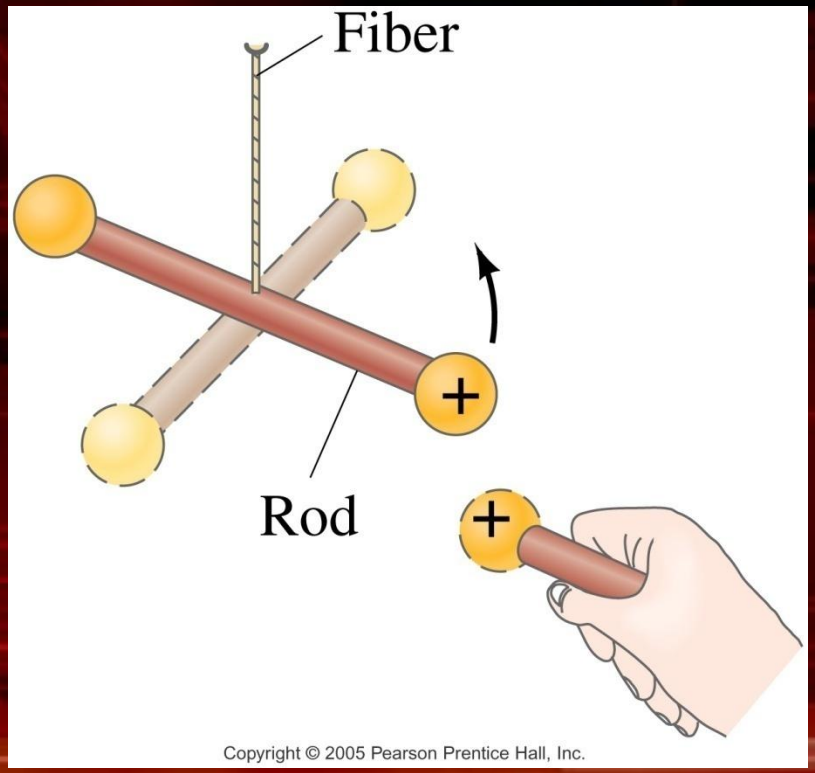
Rubbing charges objects by moving electrons from one to the other.

32.2 Conservation of Charge

An object that has unequal numbers of electrons and protons is electrically charged. If it has more electrons than protons, the object is negatively charged. If it has fewer electrons than protons, then it is positively charged.

32.3 Coulomb's Law

Experiment shows that the electric force between two charges is proportional to the product of the charges and inversely proportional to the distance between them.



32.3 Coulomb's Law

Coulomb's law:

$$F = \frac{kQ_1Q_2}{d^2}$$

F = electrical force (Newtons)

k = constant = 9×10^9 Nm^2/C^2

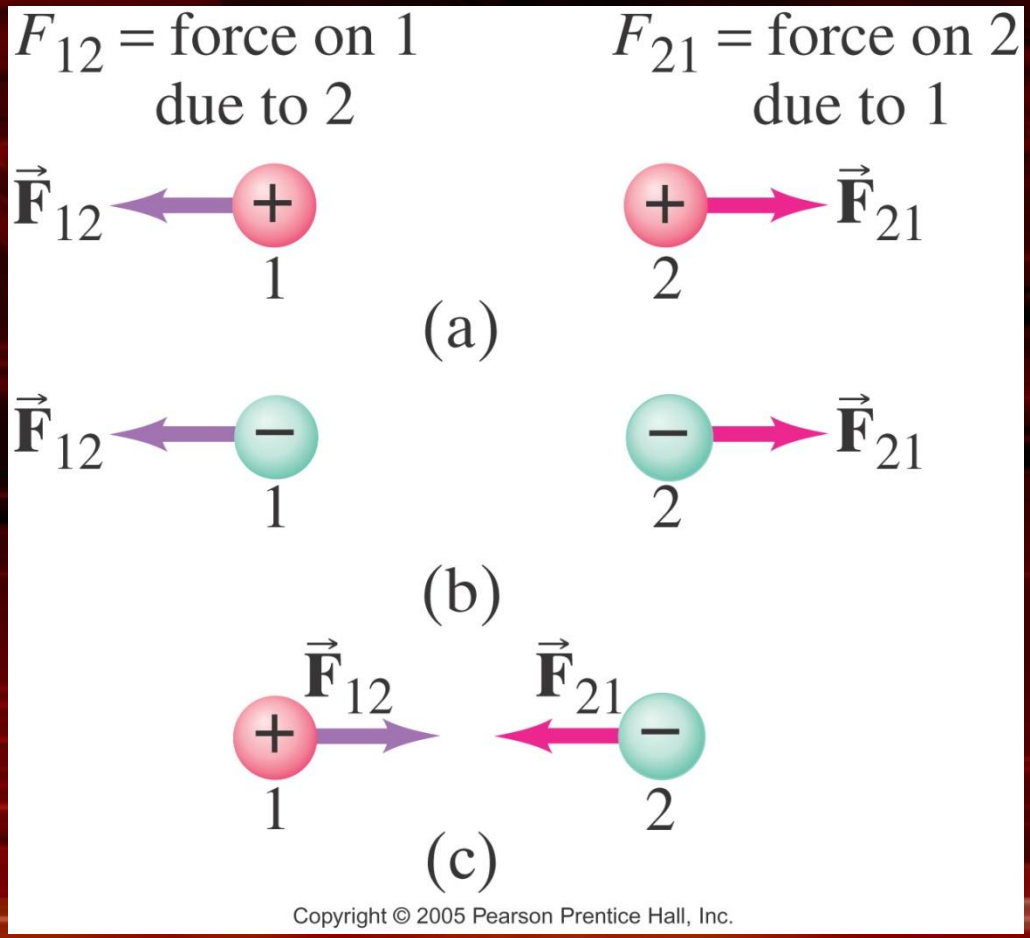
Q_1 = charge of one particle (Coulombs)

Q_2 = charge of other particle (Coulombs)

d = distance between charges (meters)

32.3 Coulomb's Law

The force is along the line connecting the charges, and is attractive if the charges are opposite, and repulsive if they are the same.



32.4 Insulators and Conductors

Conductor:

Charge flows freely

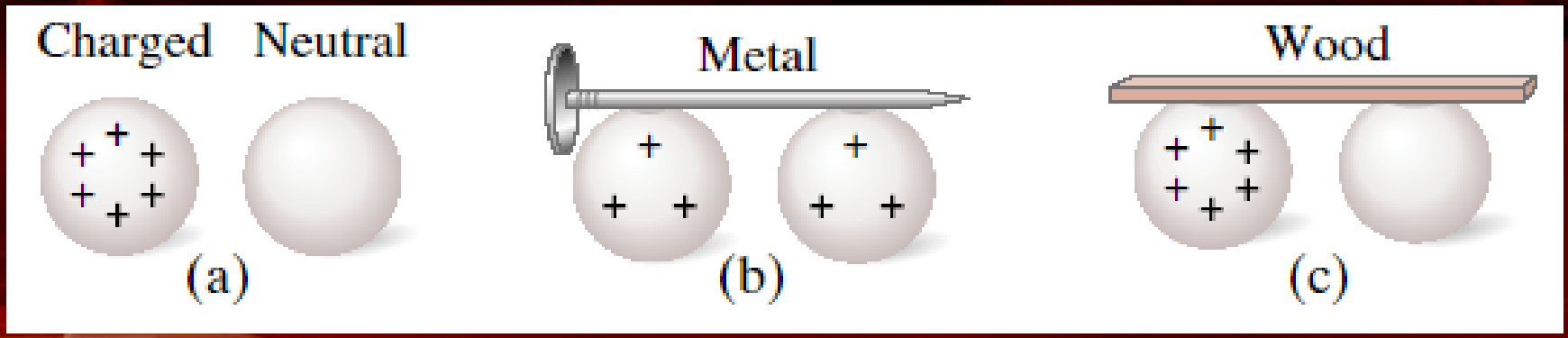
Metals

Insulator:

Almost no charge flows

Most other materials

Some materials are semiconductors.



32.4 Insulators and Conductors

In conductors the electrons are free to move around and are not anchored to any particular nuclei.

This reason is also why electrical conductors are good conductors of heat- the electrons are loose.

32.4 Insulators and Conductors

In insulators the electrons are tightly bound and remain with particular atoms.

This reason is also why electrical insulators are poor conductors of heat- the electrons are confined.

32.4 Insulators and Conductors

Time for a Gizmo!

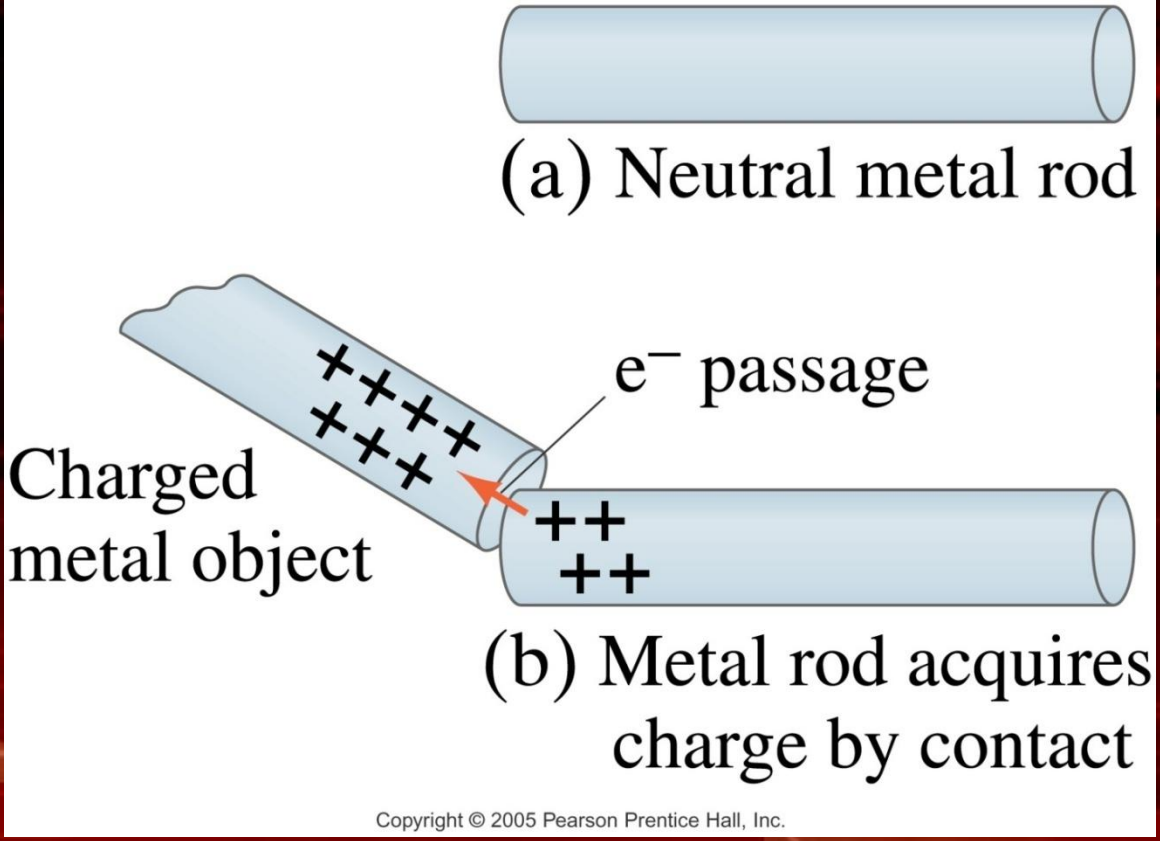
32.5 Charging by Friction and Contact

Objects can be charged by rubbing

32.5 Charging by Friction and Contact

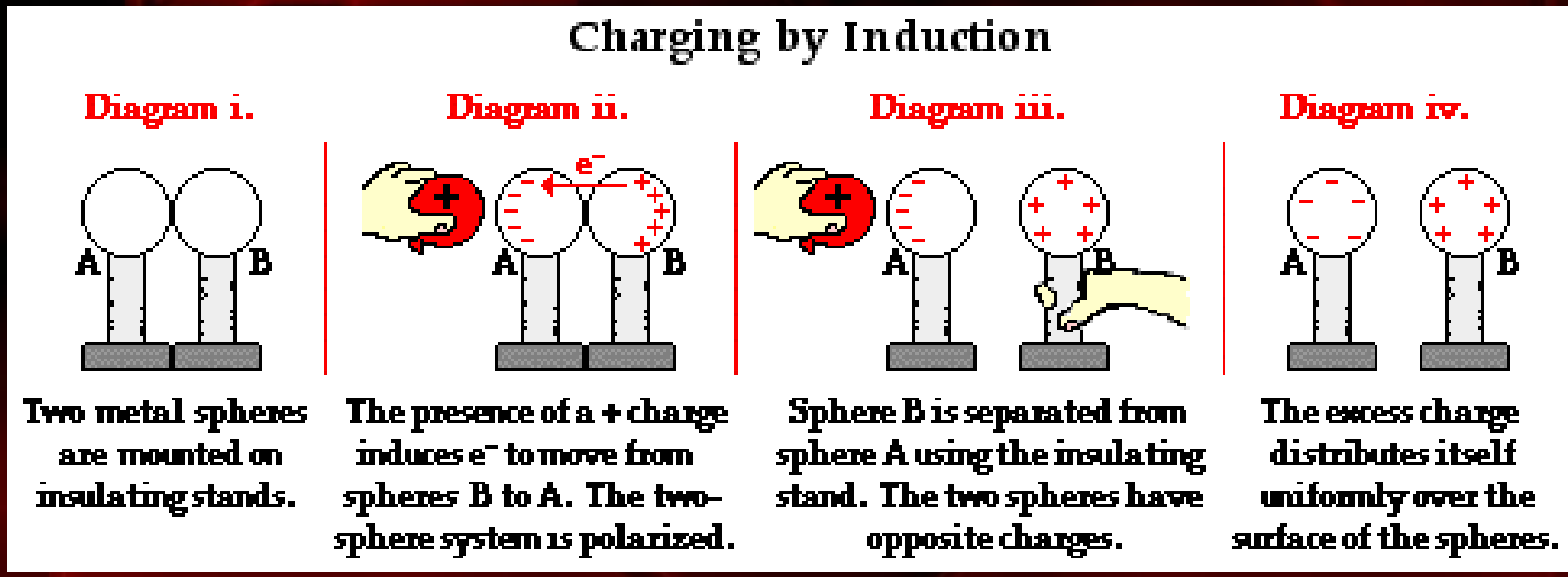
Metal objects can be charged by conduction:

Having direct contact with one another



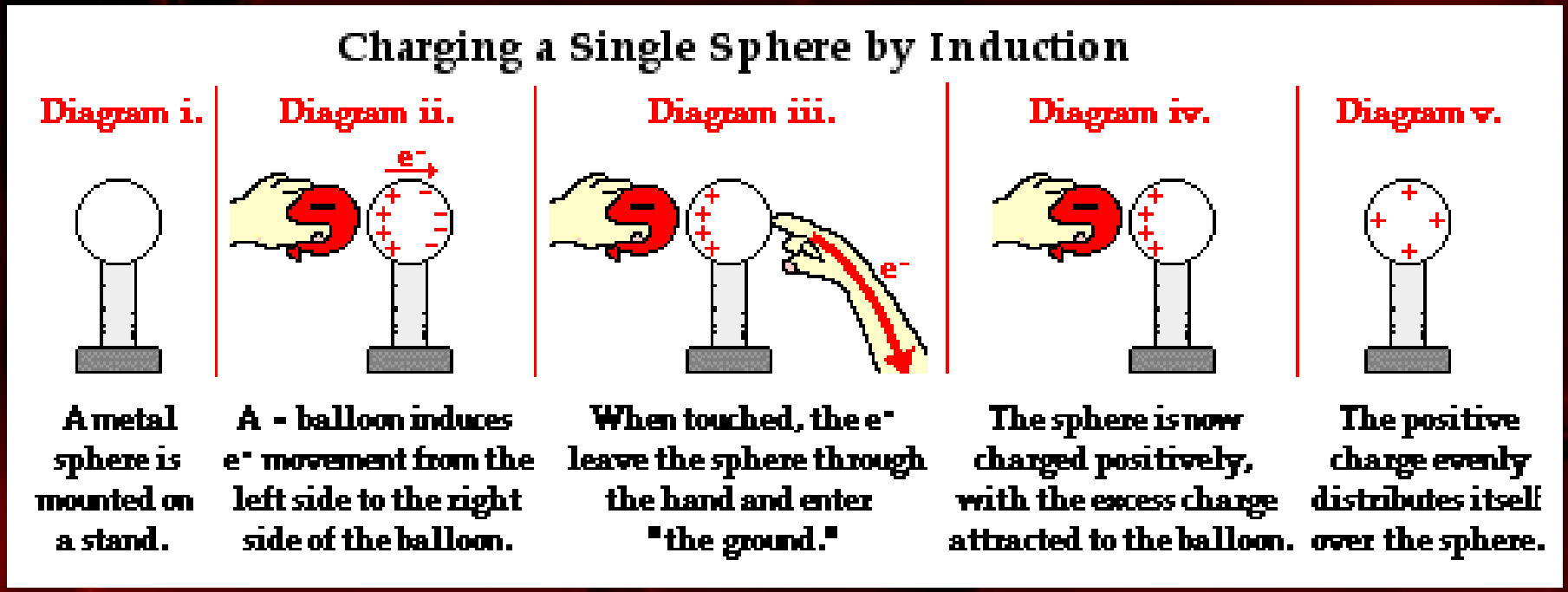
32.6 Charging by Induction

They can also be charged by induction: No direct contact with one another



32.6 Charging by Induction

Another way to charge by induction:



32.6 Charging by Induction

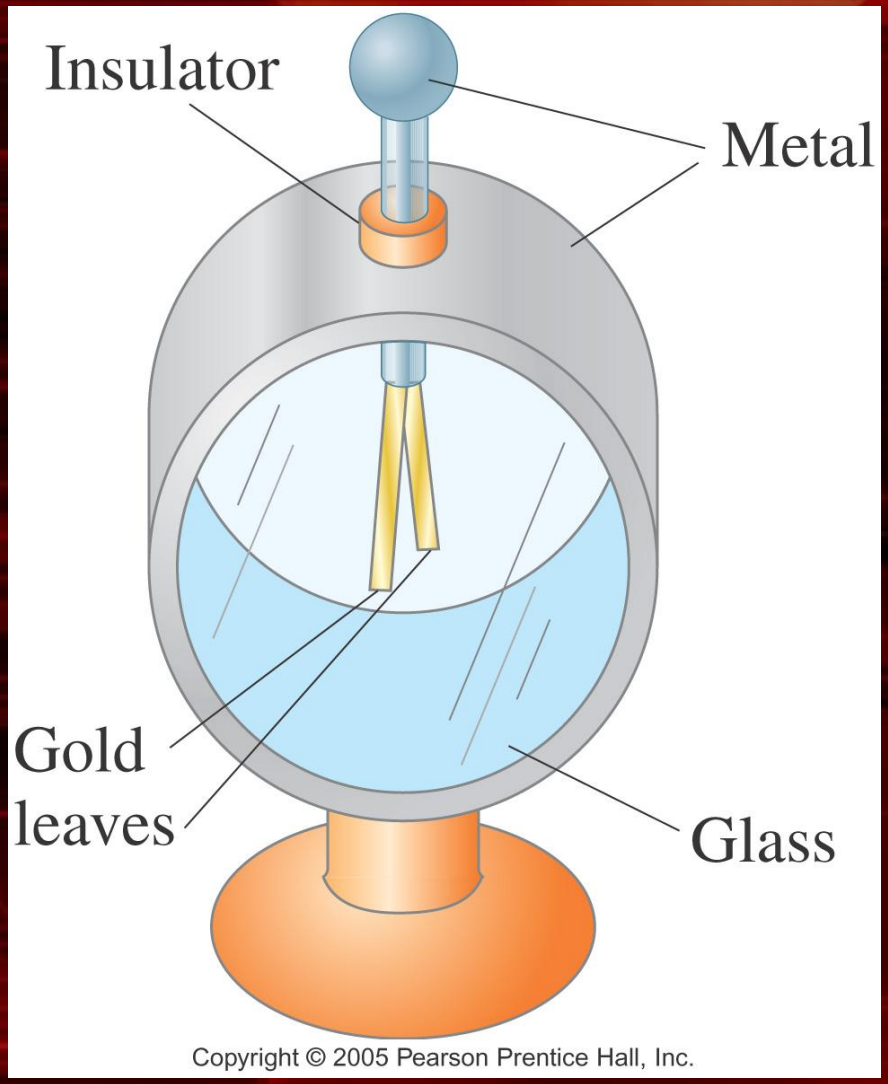
Charging by induction occurs during thunderstorms.

Lightning is an electrical discharge between oppositely charged parts of clouds.

Lightning rods allow the shortest path to the ground by collecting electrons from the air.

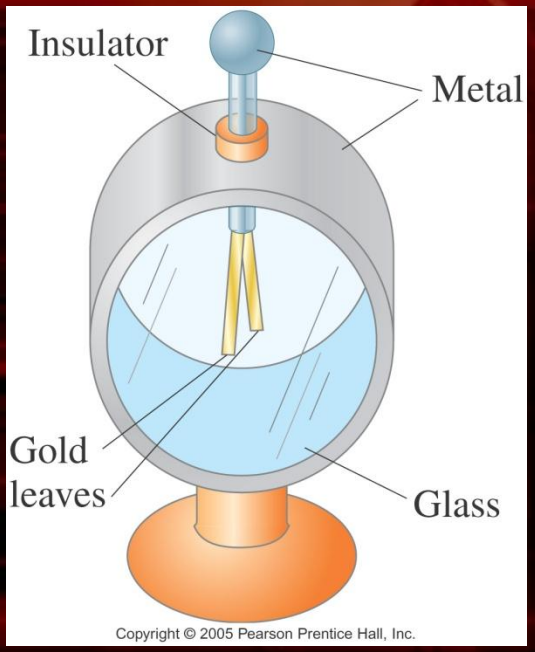
32.6 Charging by Induction

The electroscope can be used for detecting charge:



32.6 Charging by Induction

1. Charge by Conduction (touching)
2. Charge by Induction (no touching)

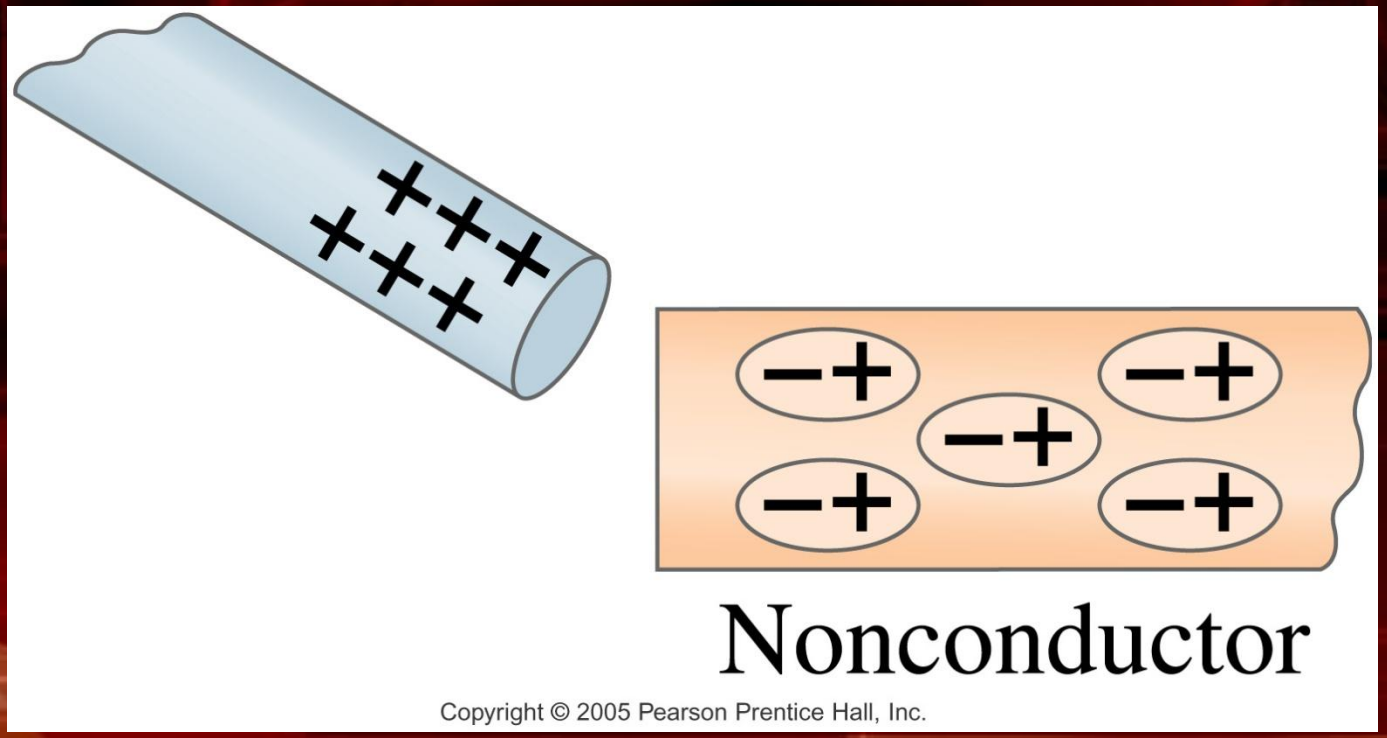


32.6 Charging by Induction

Time for a Gizmo!

32.7 Charge Polarization

Nonconductors won't become charged by conduction or induction, but will experience charge separation:



32.7 Charge Polarization

Polar molecule: neutral overall, but charge not evenly distributed