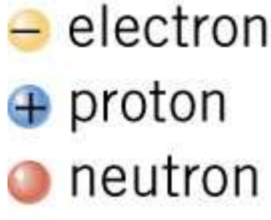
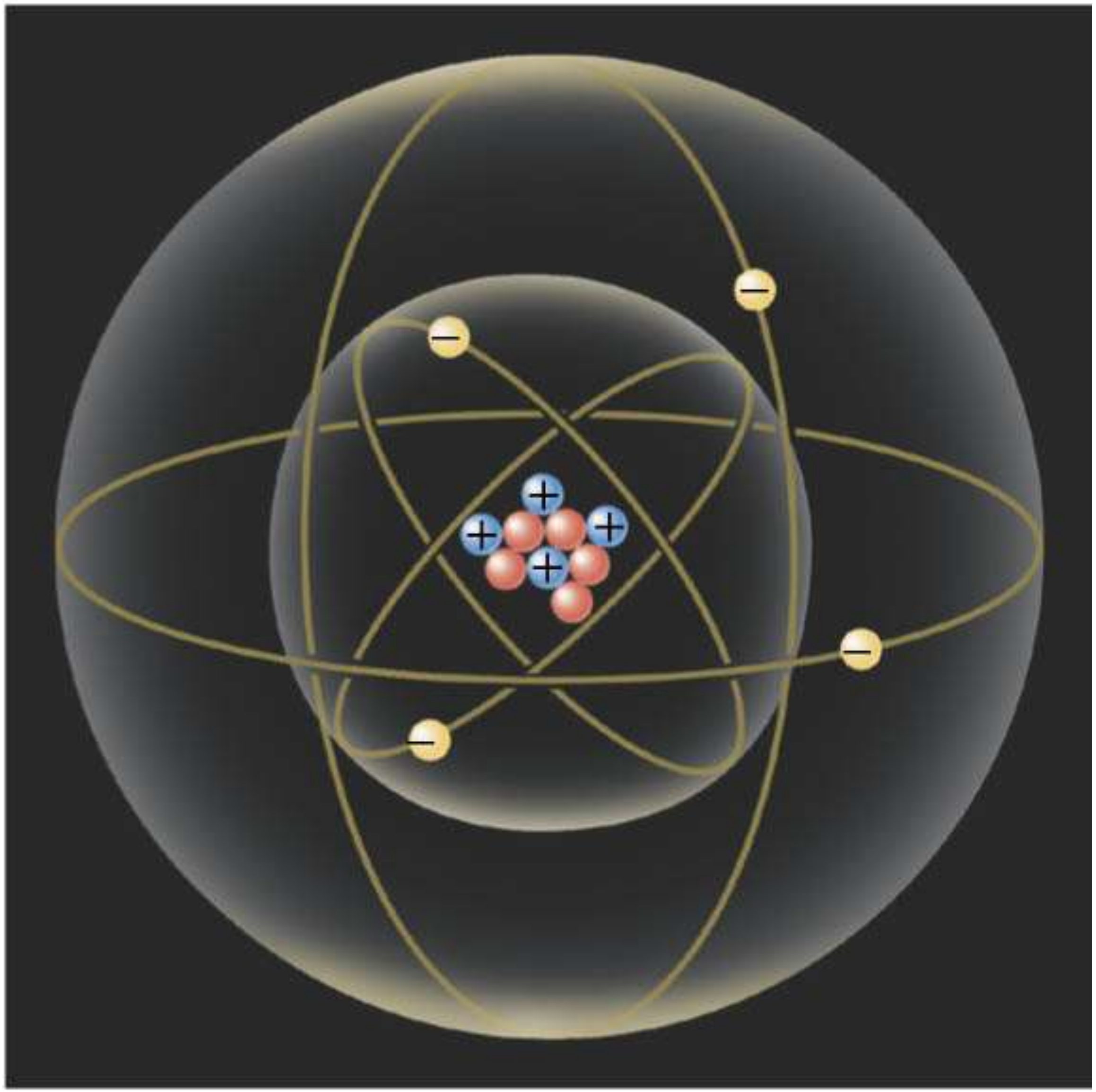
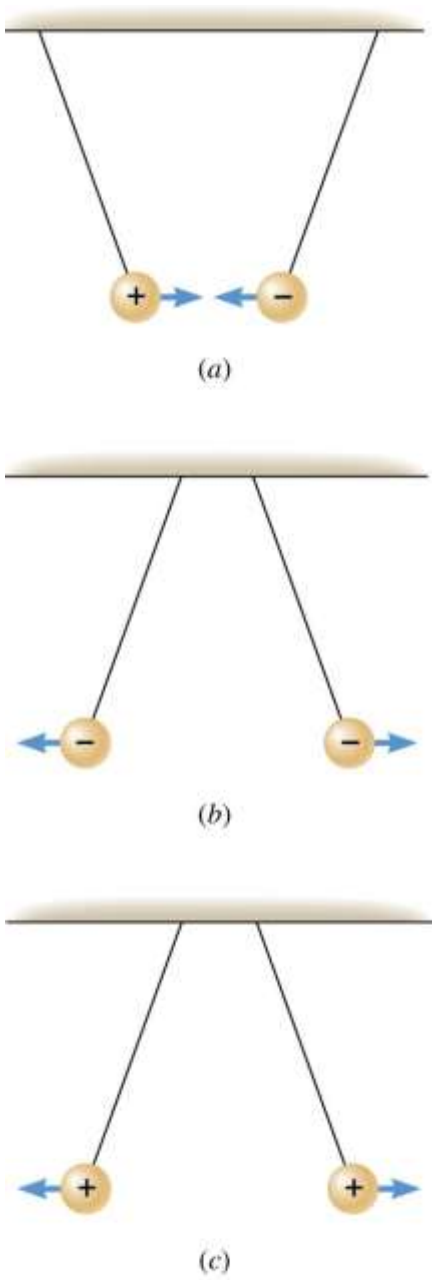


$Q = -e = -1.609 \times 10^{-19}$ Coulombs

$Q = +e = 1.609 \times 10^{-19}$ Coulombs

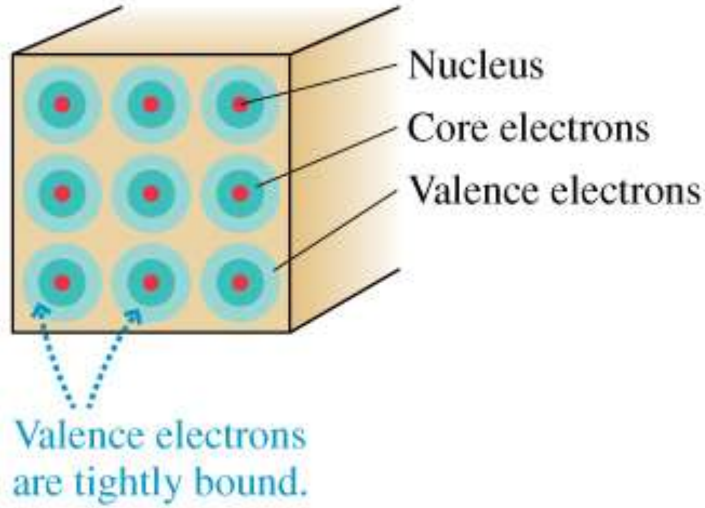
$Q = 0$



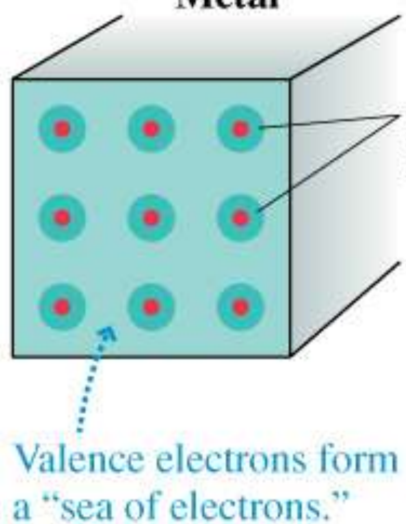


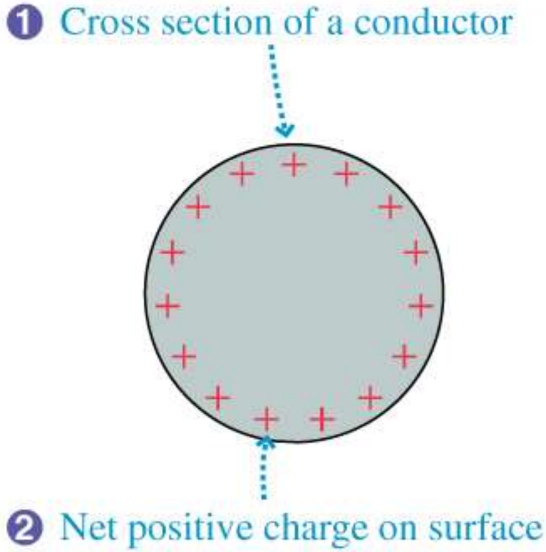
Opposites
attract,
like repel.

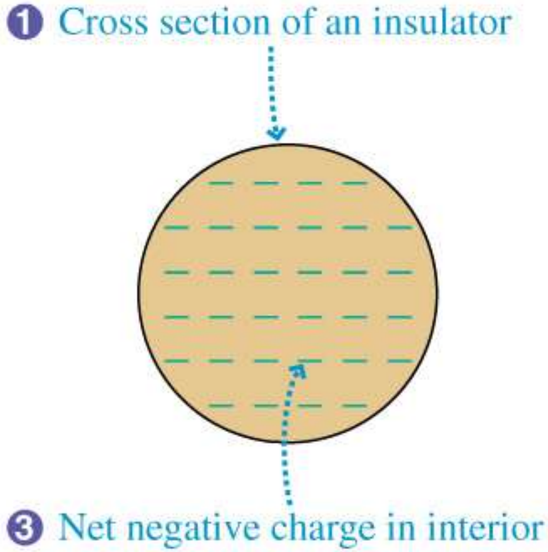
Insulator



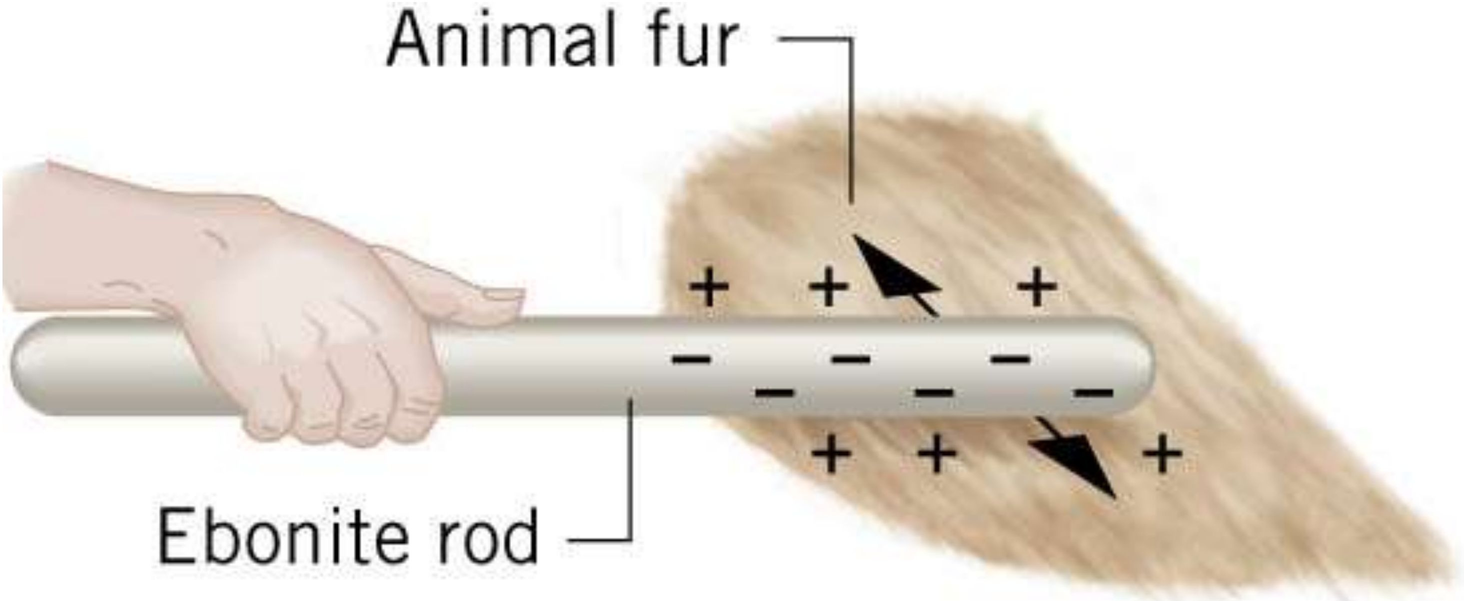
Metal




❶ Cross section of a conductor
❷ Net positive charge on surface


❶ Cross section of an insulator
❸ Net negative charge in interior

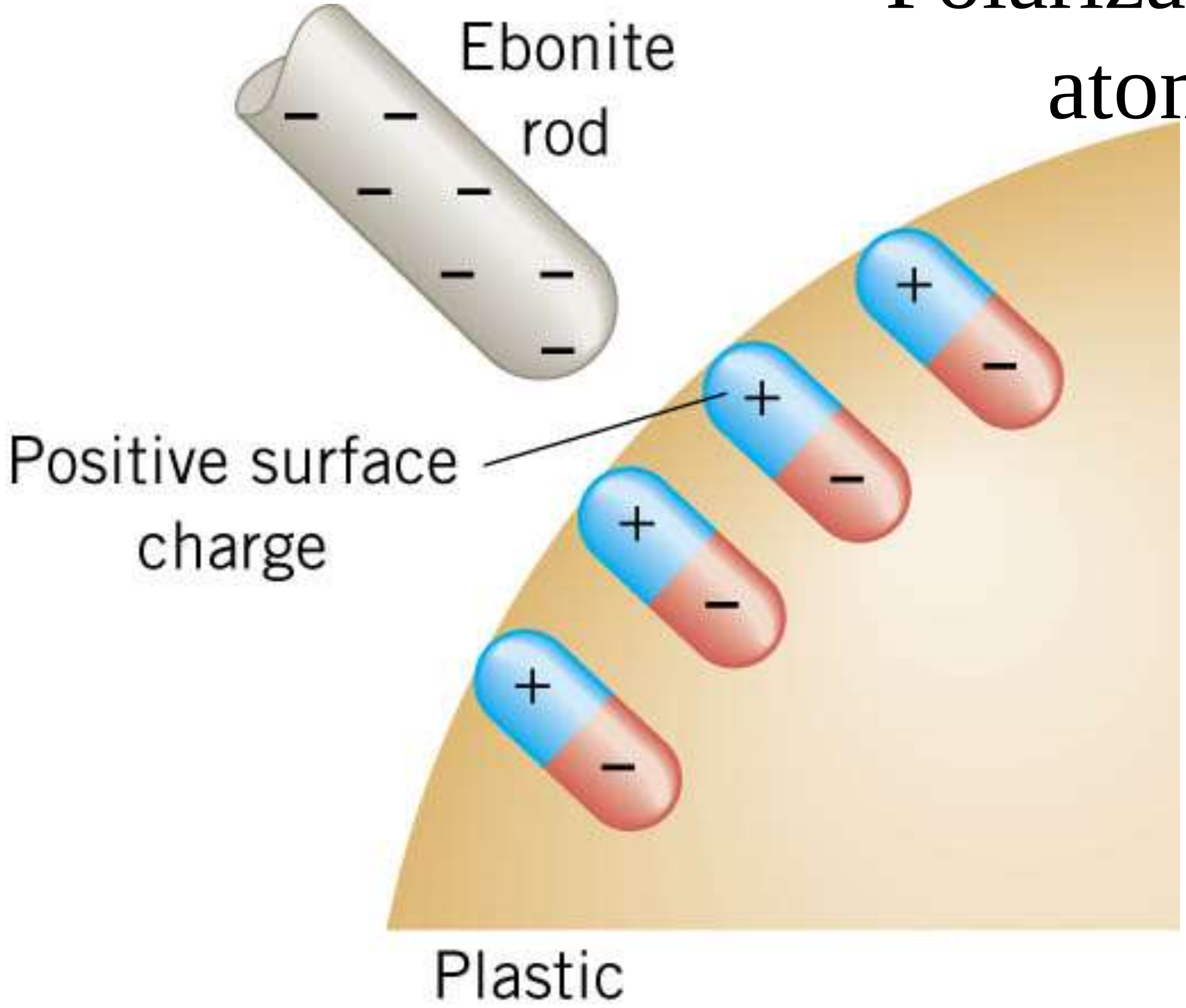
Charging by Rubbing



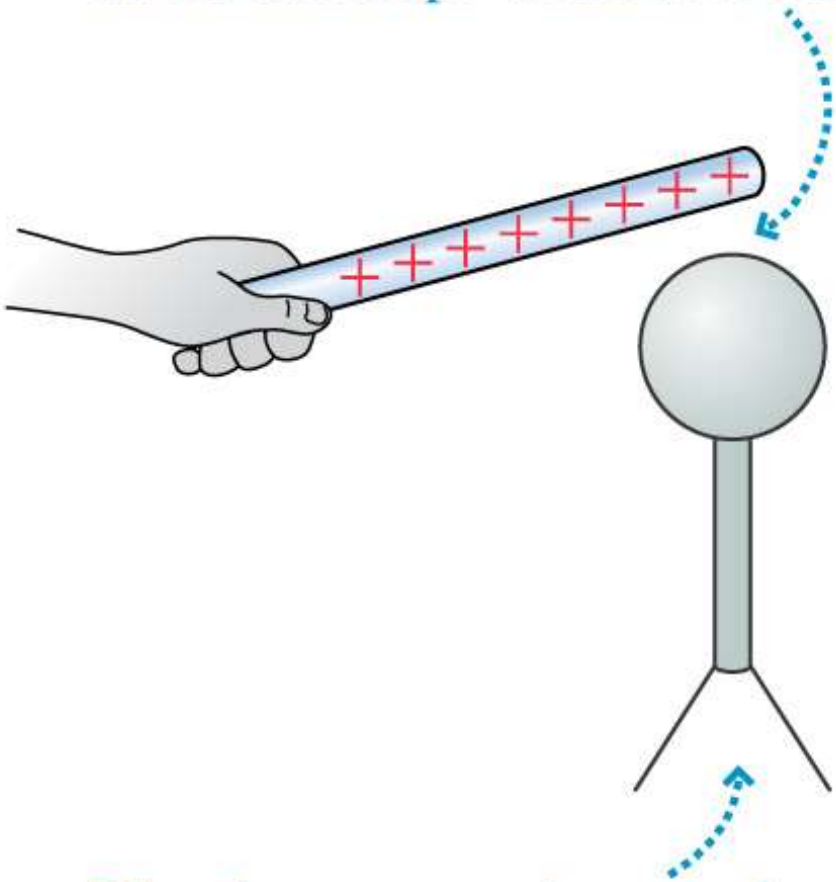
Simulation 1

Simulation 2

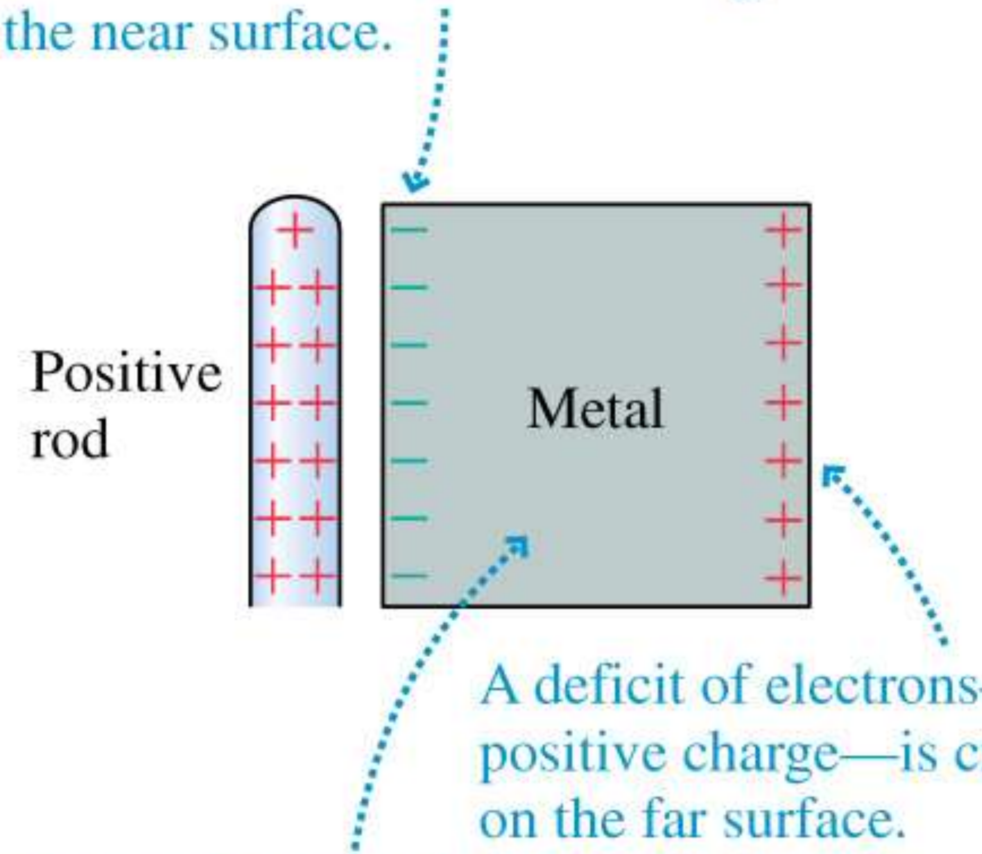
Polarization of atoms



Bring a positively charged glass rod close to an electroscope without touching the sphere.

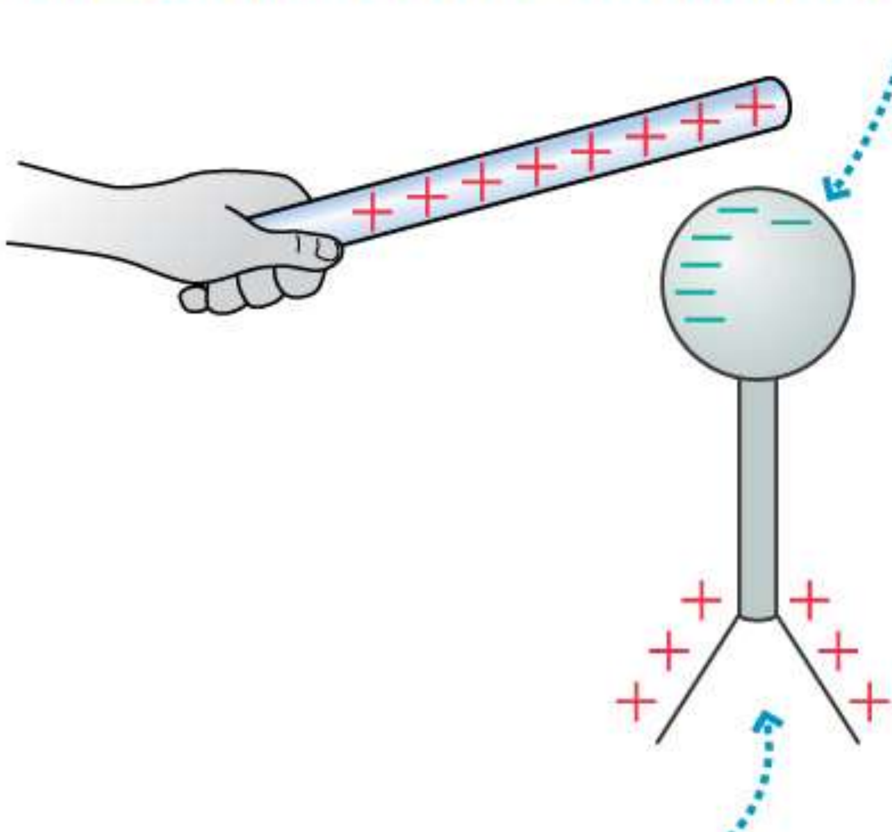


The electroscope is neutral, yet the leaves repel each other. Why?


(a)
The sea of electrons is attracted to the rod and shifts so that there is excess negative charge on the near surface.
Positive rod
Metal
A deficit of electrons—a net positive charge—is created on the far surface.
The metal's net charge is still zero, but it has been *polarized* by the charged rod.

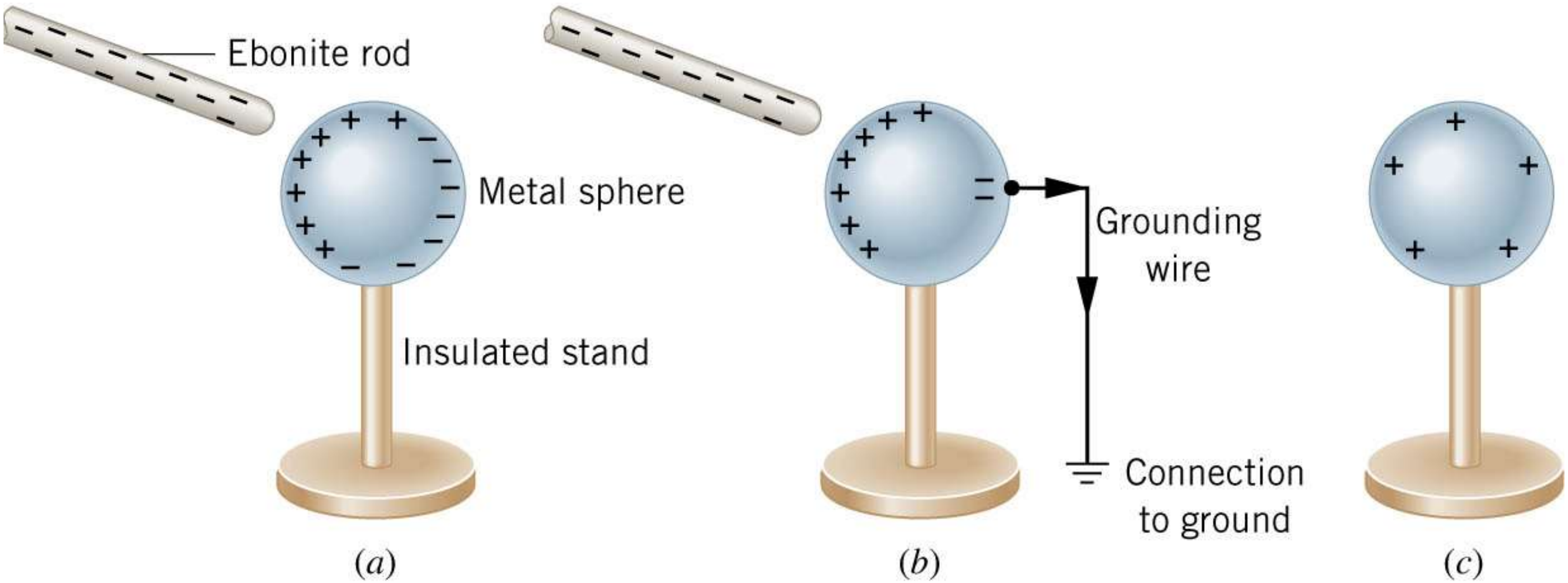
(b)

The electroscope is polarized by the charged rod. The sea of electrons shifts toward the rod.



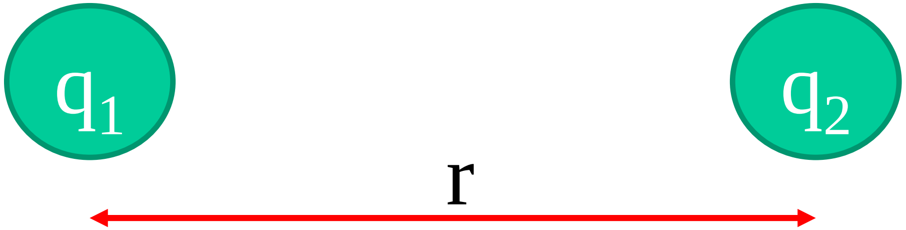
Although the net charge on the electroscope is still zero, the leaves have excess positive charge and repel each other.

Charging by Induction



Coulomb's Law

$$F = \left|\frac{kq_1q_2}{r^2}\right|$$



Direction of force, goes in by hand.

k = 8.99 × 10^9 N-m^2/C^2

Simulation