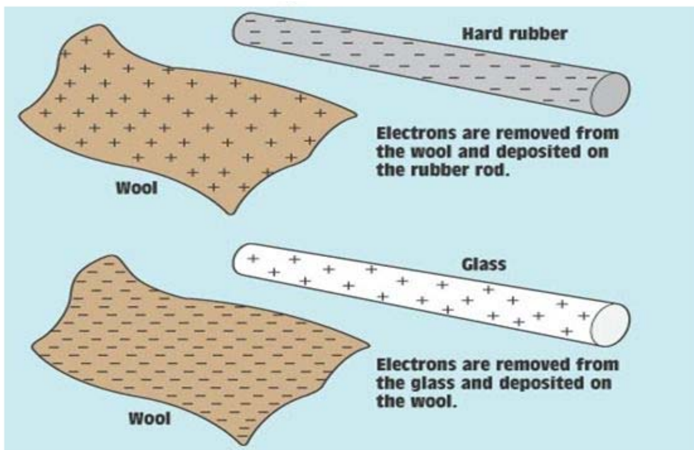
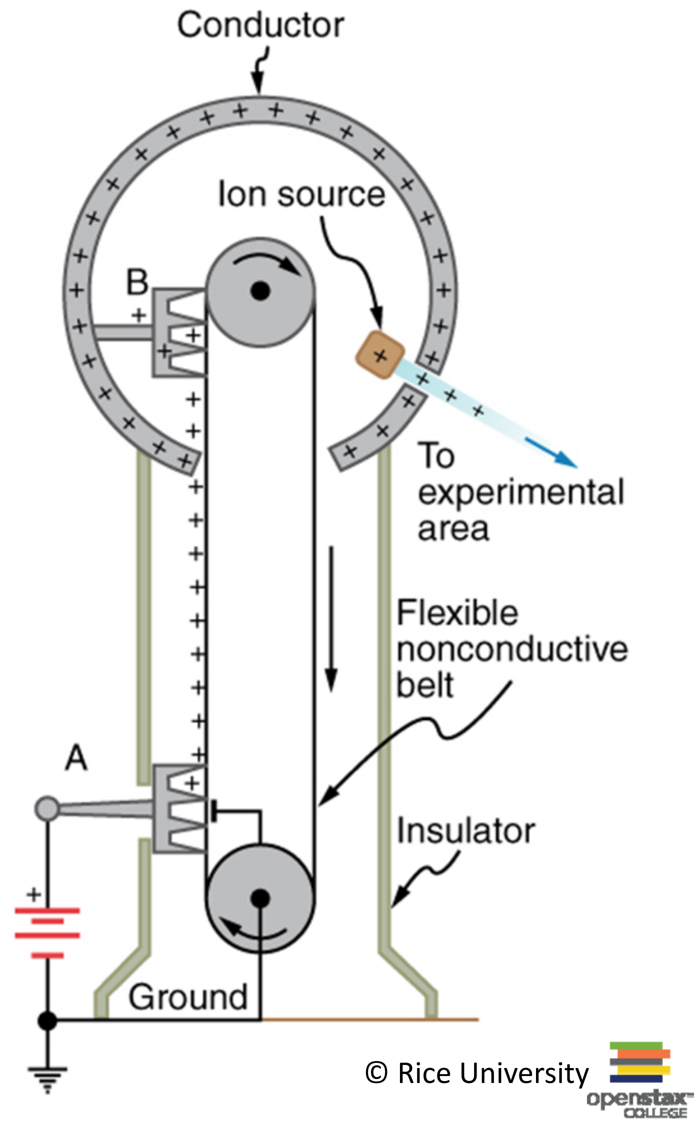
Charges and Coulomb's Law

Producing electrostatic charges





Van de Graaff generator

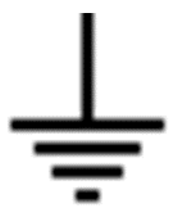
What is inside the tower of this building?

Conductors, Insulators, and Earth

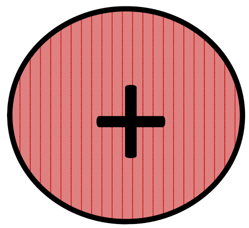
Charges can move freely in a *conductor*.
An *insulator* does not allow charges to move through them. A semiconductor is essentially an insulator, but we can make it a poor conductor by doping it with electron donating or accepting impurities.

For a net charge in a conductor:
(i) They can only stay on the surface of the conductor.
(ii) They will be more concentrated at sharper areas.

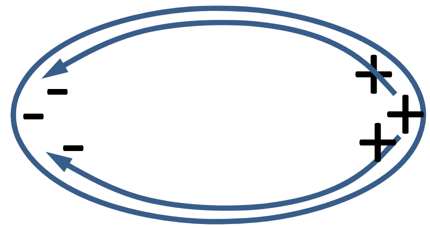
Earth is a gigantic charge reservoir. Receiving or giving a few charges will have no significant effect on it.
Symbol:



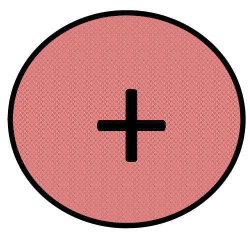
Polarization of a neutral object by another charged object



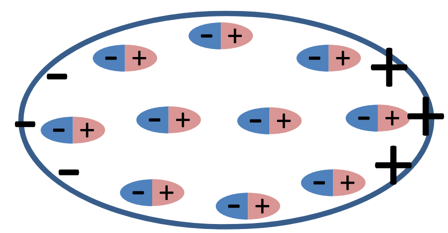
Charged object



Conductor. Total charge =0



Charged object



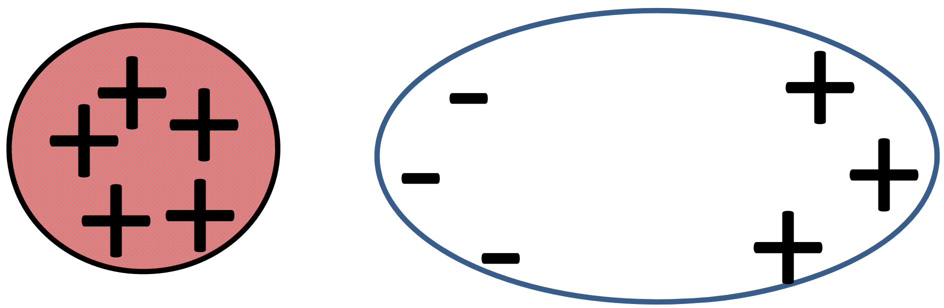
Insulator. Total charge =0

Different mechanisms, but same effect for both cases. The effect is more significant for conductor.

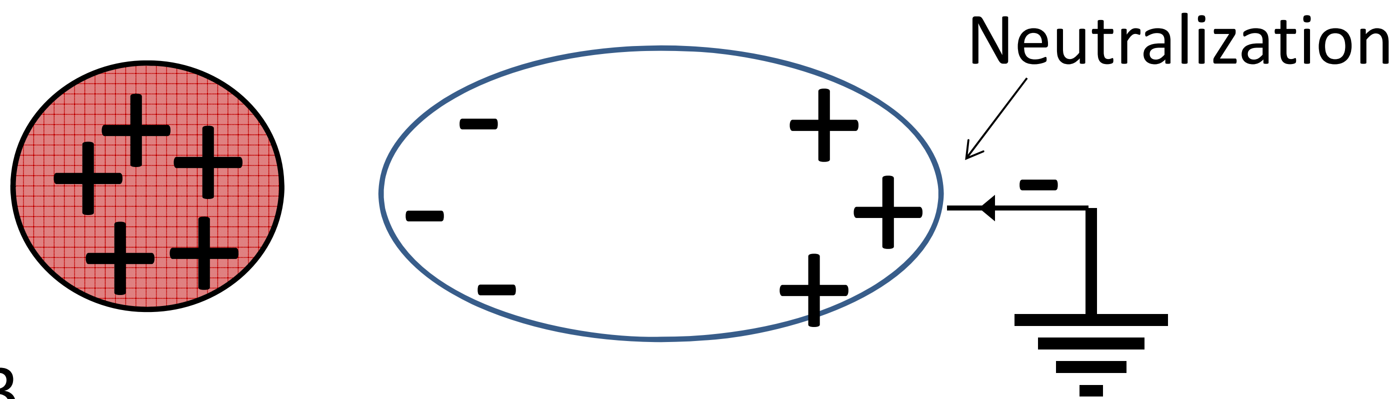
Because of polarization, the neutral object is attracted to the charged object (no matter whether the charged object is positively or negatively charged).

Charging a conductor by induction (no contact)

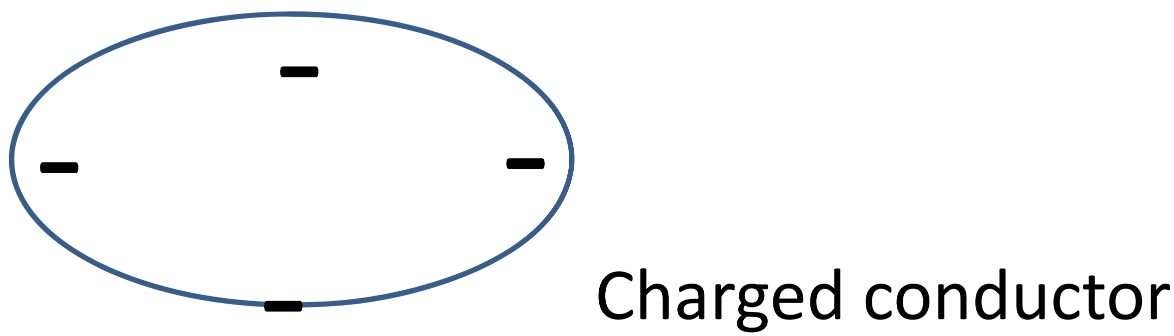
Step 1 – Polarize the conductor



Step 2



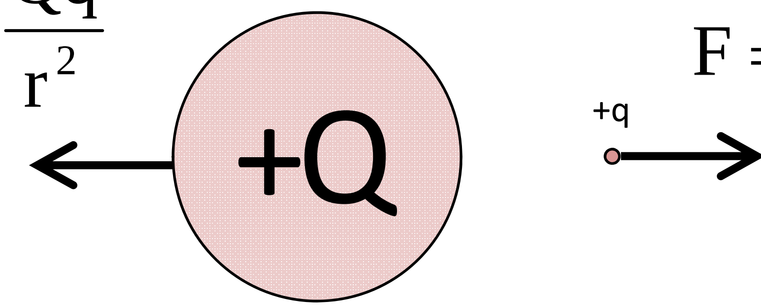
Step 3



Class 5: Electric Fields

Concept of Fields

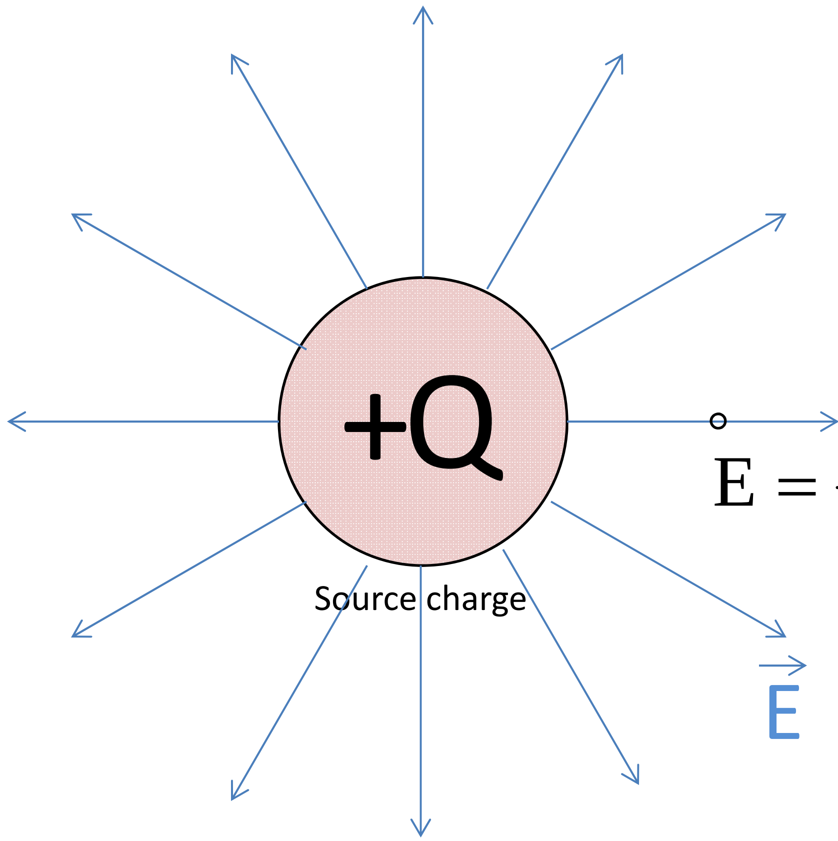
$$F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$$



$$F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$$

Why these two charges can experience a force from the other even though they are not in physical contact?

Concept of Fields



There are fields attached to a charge. The fields (geometry and intensity) depend on the charge distribution.

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$ ←Magnitude equation

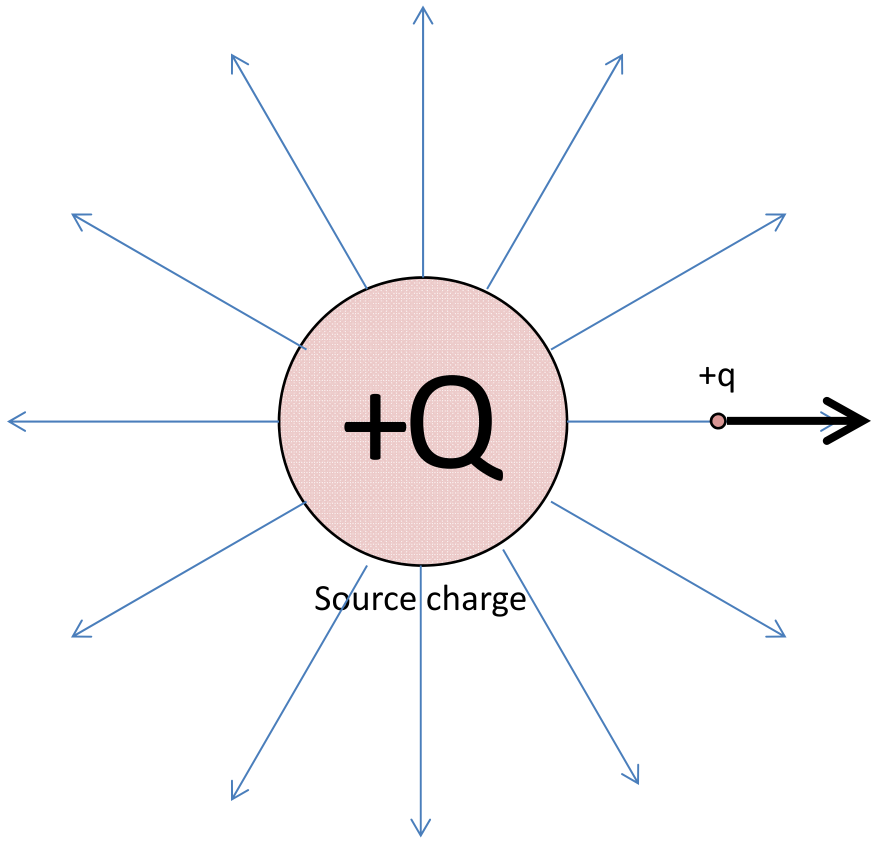
$\vec{E}$

Electric field is a vector.
Unit of electric field: N/C

The charges that give rise to the electric fields are called the *source* charges.

Charge	$\Rightarrow$	Electric field
Mass	$\Rightarrow$	Gravitational field

Concept of Fields



Electric field E due to source charge Q

$$F = \left(\frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} \right) q$$

$$= q\,E$$

When another charge is put in the field, it will experience an electric force. The force depends on the charge and the electric field at that point.

Let us call the charges that are being placed in an electric field to experience the force the *external* charges.
In the above figure, Q is the source charge and q is the external charge.