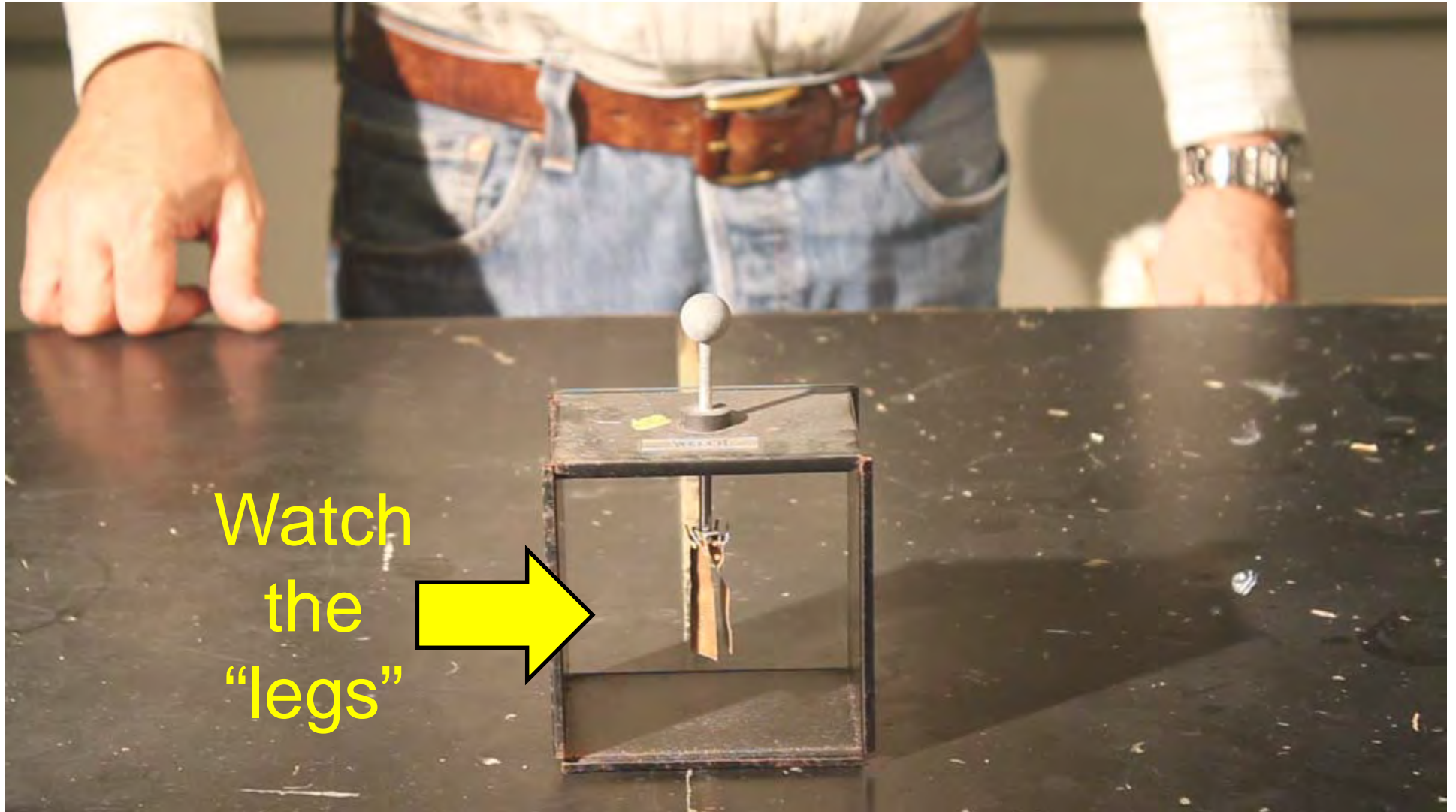


Induction & Lightning

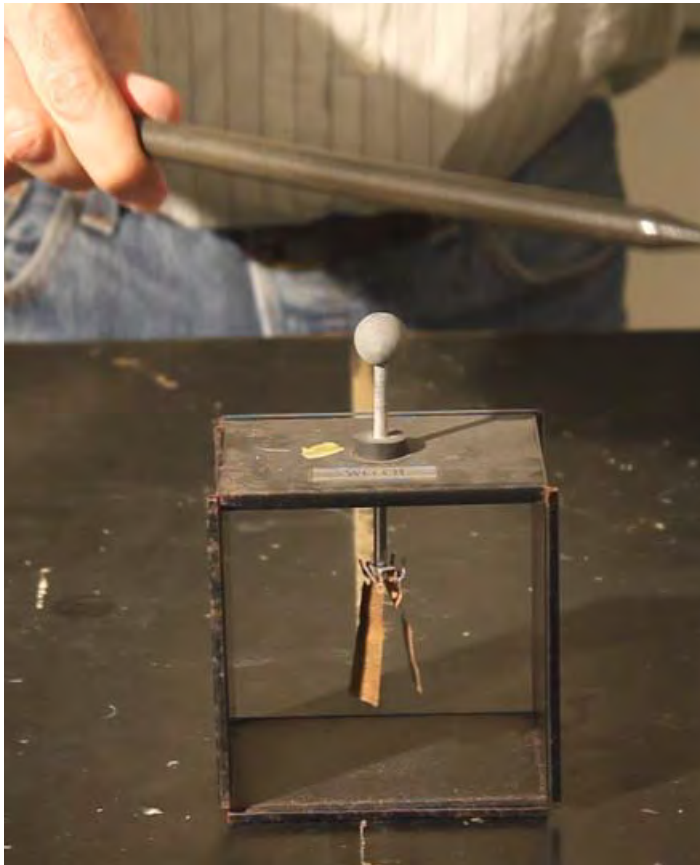


National Science Foundation
WHERE DISCOVERIES BEGIN

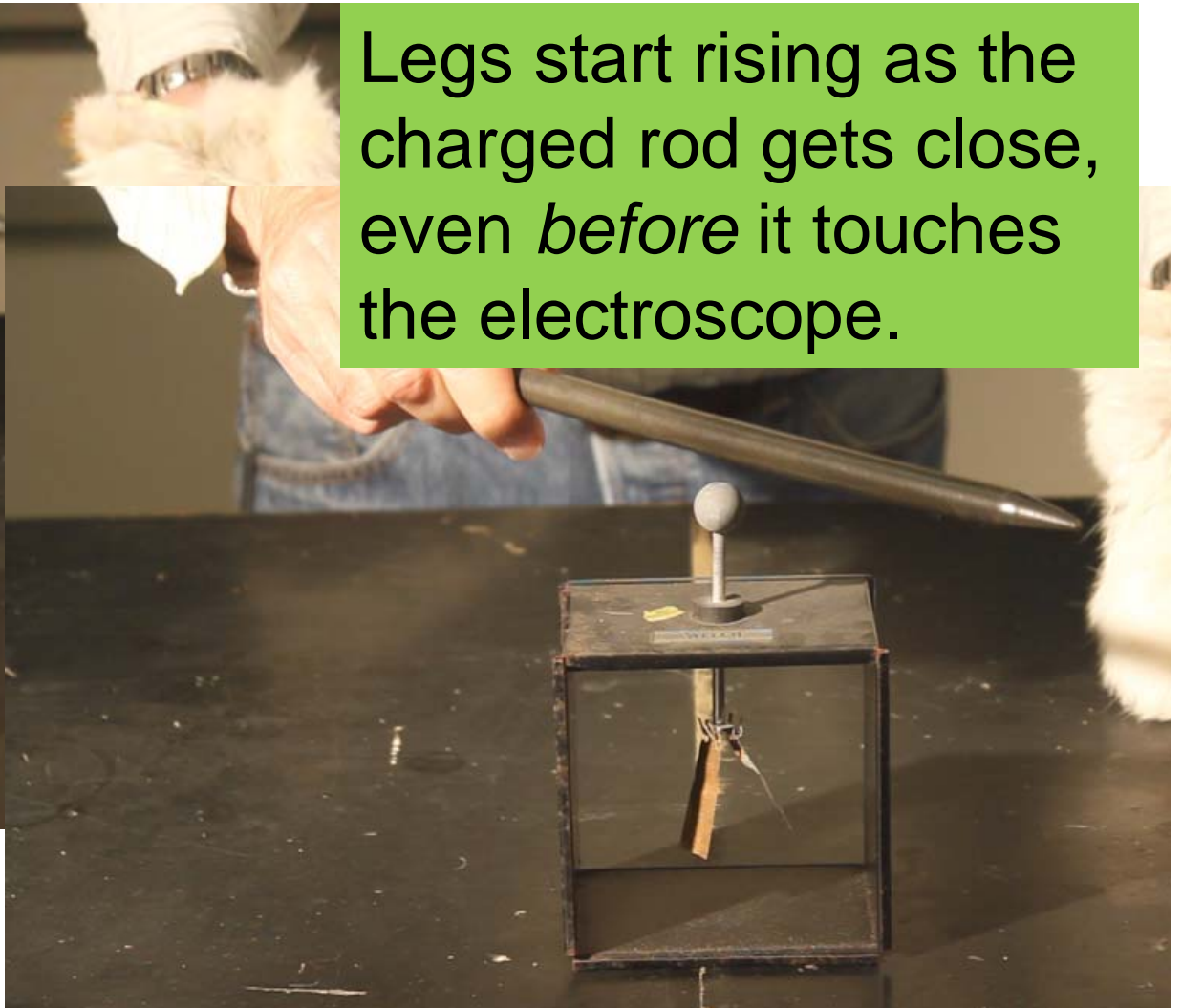
Electroscope



Electrostatic Induction

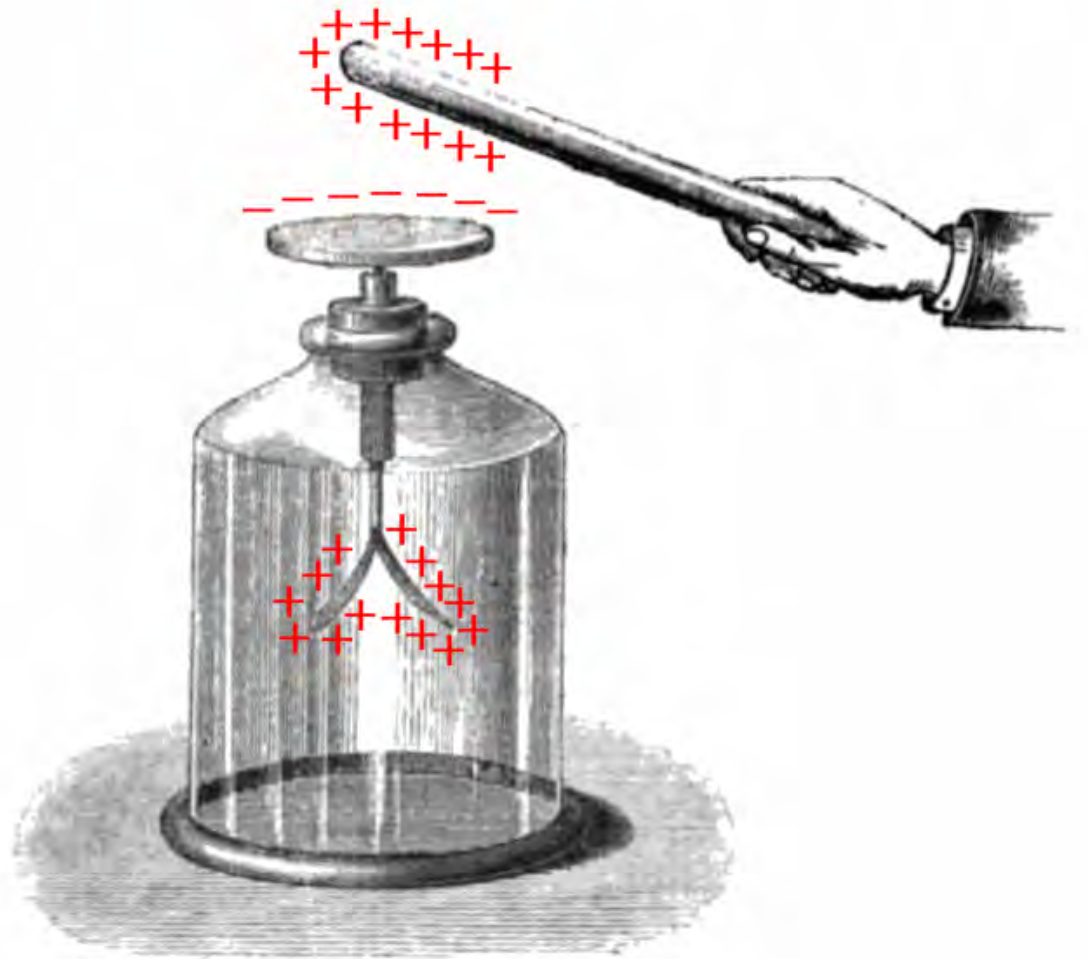


Legs start rising as the charged rod gets close, even *before* it touches the electroscope.



Electrostatic Induction

Positive charge on the rubber rod attracts negative charge to the top of the electroscope, creating excess positive charge on the legs.

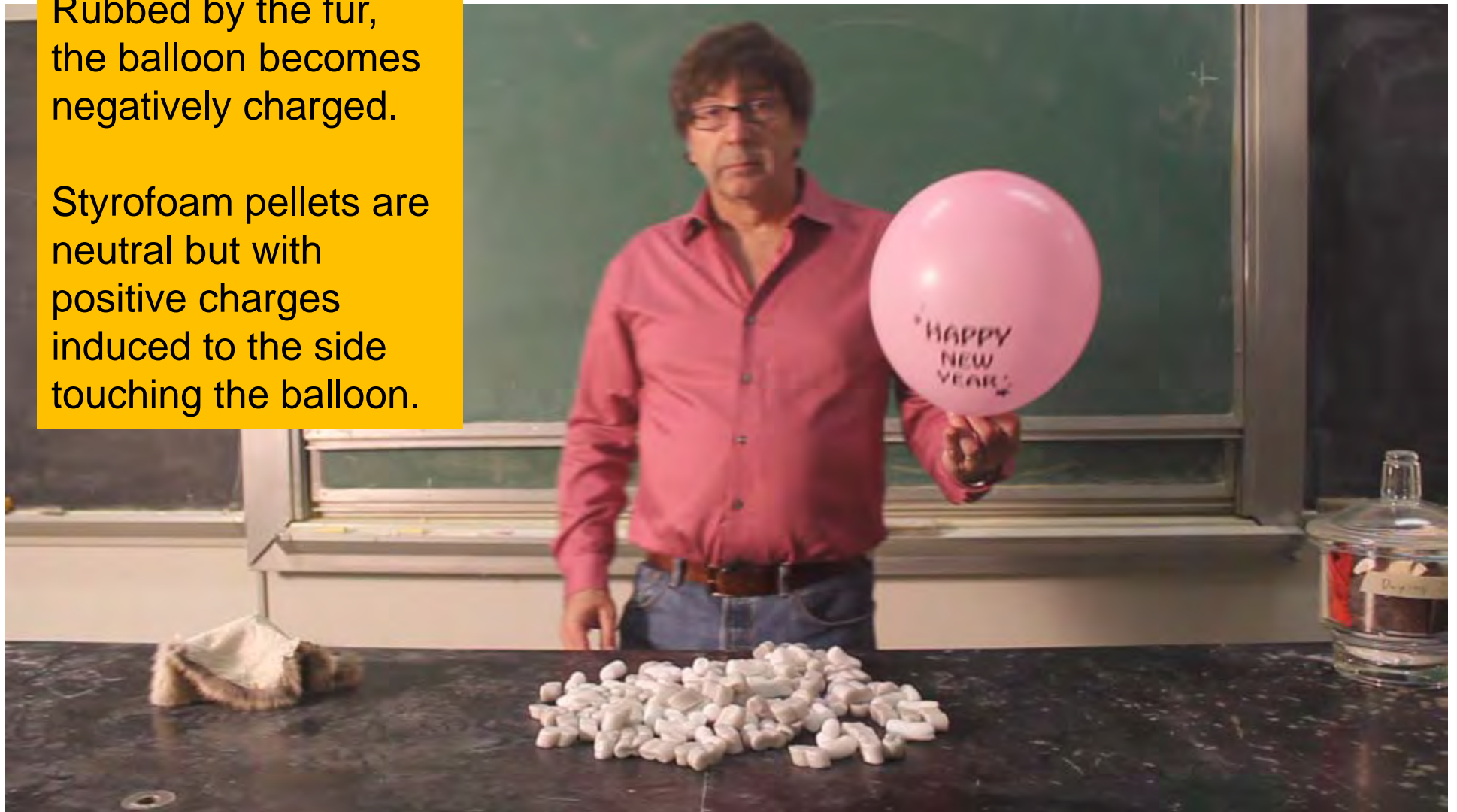


From Wikipedia

Static Cling

Rubbed by the fur,
the balloon becomes
negatively charged.

Styrofoam pellets are
neutral but with
positive charges
induced to the side
touching the balloon.



Static Cling

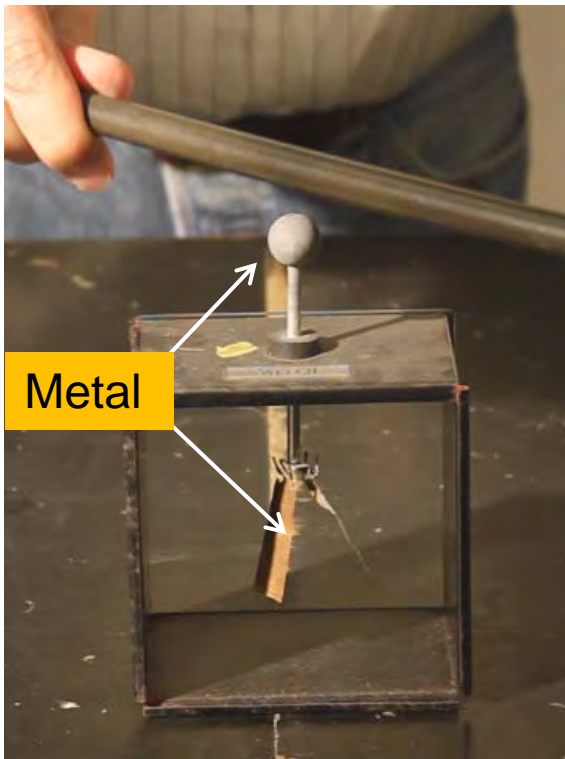
Rubbed by the fur, the balloon becomes negatively charged.

The wall is neutral but with positive charges induced to the surface touching the balloon.

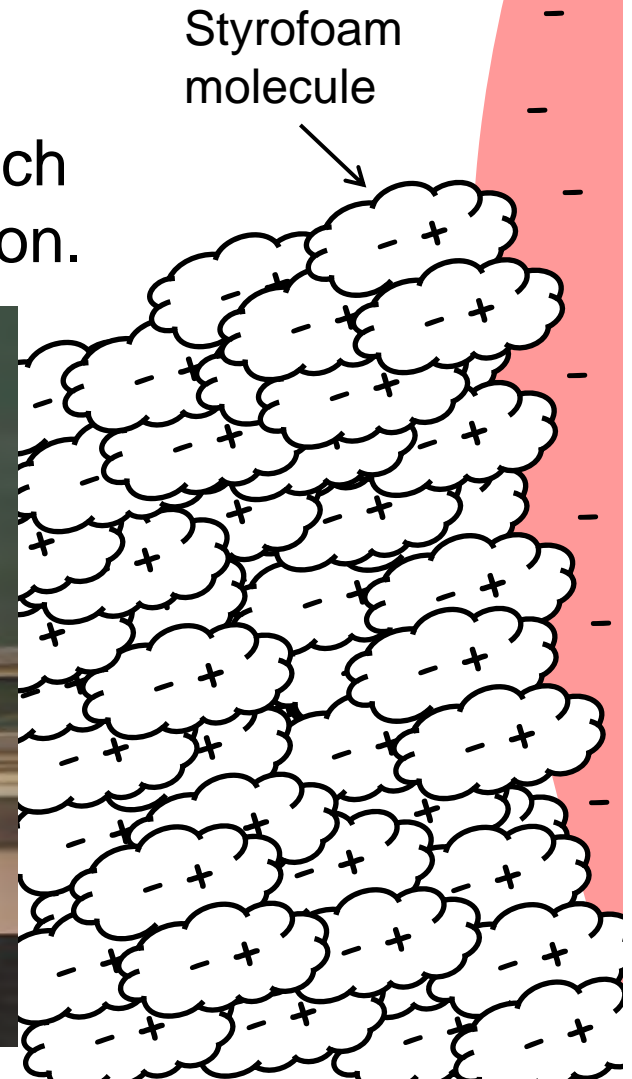


Conductors vs. Insulators

In conductors the electrons move easily by induction.



For insulators the electrons shift in each molecule by induction.



Electrophorus

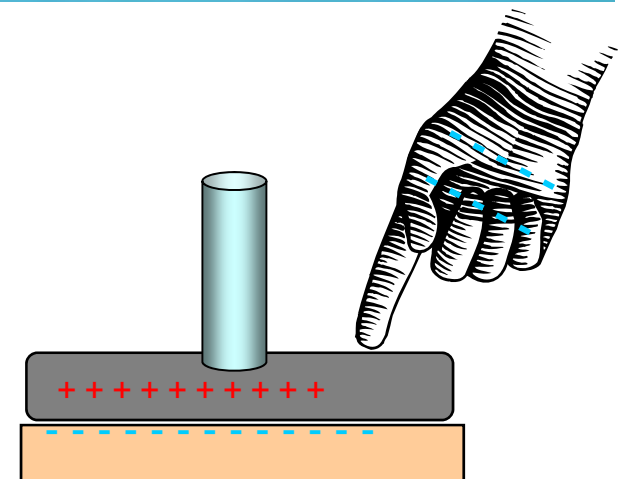
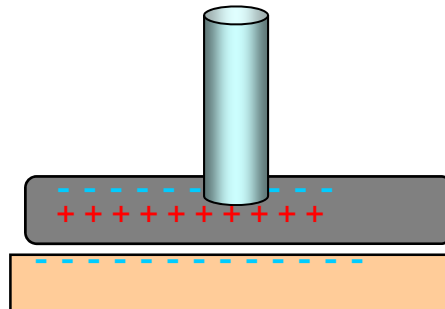
The electrophorus consists of a plastic plate and a metal disk with an insulated handle.



Charge plastic plate
by rubbing it with fur



Bring metal disk to
plate; separate charge



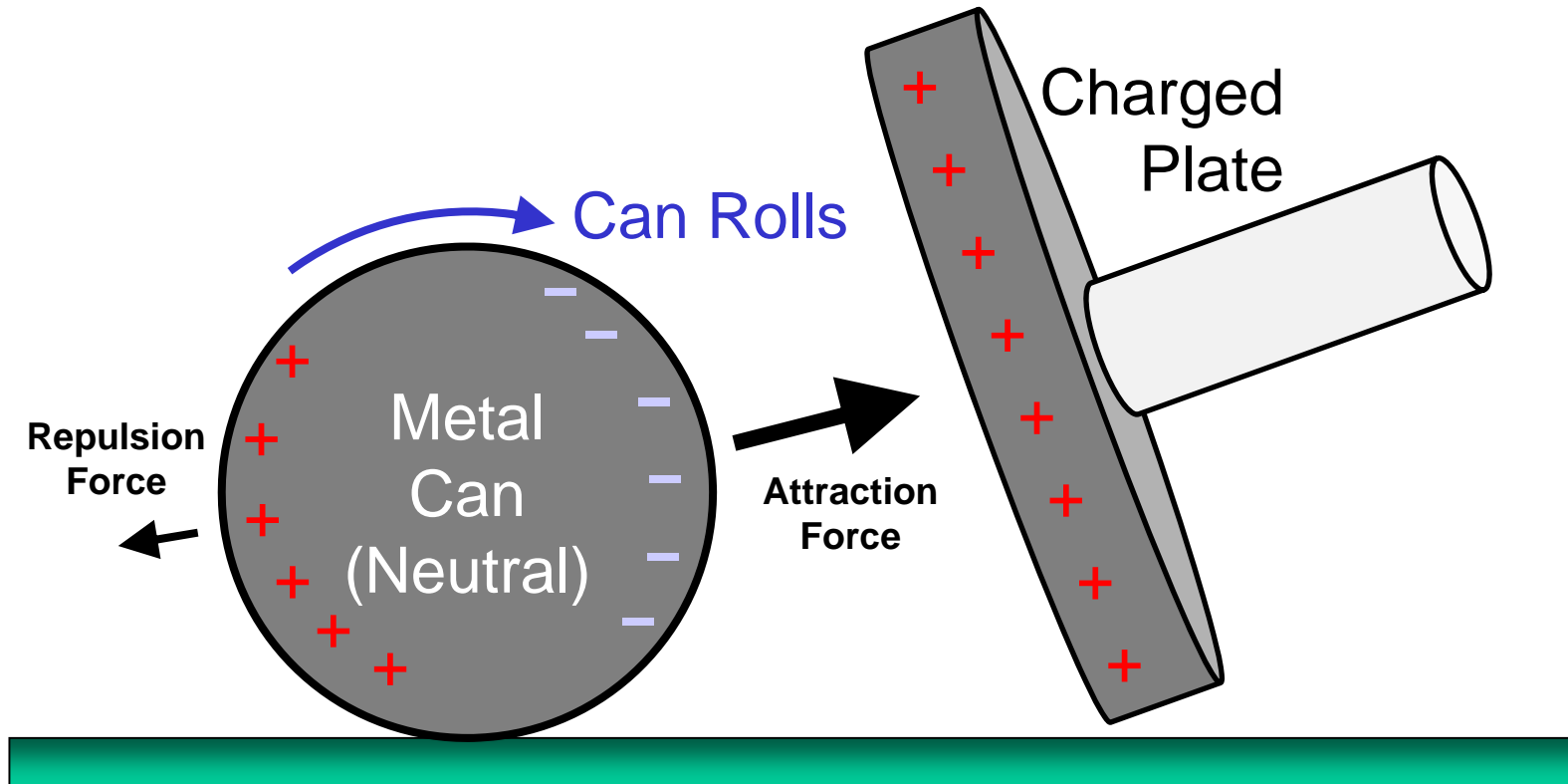
Remove electrons;
plate positively charged

Electrophorus

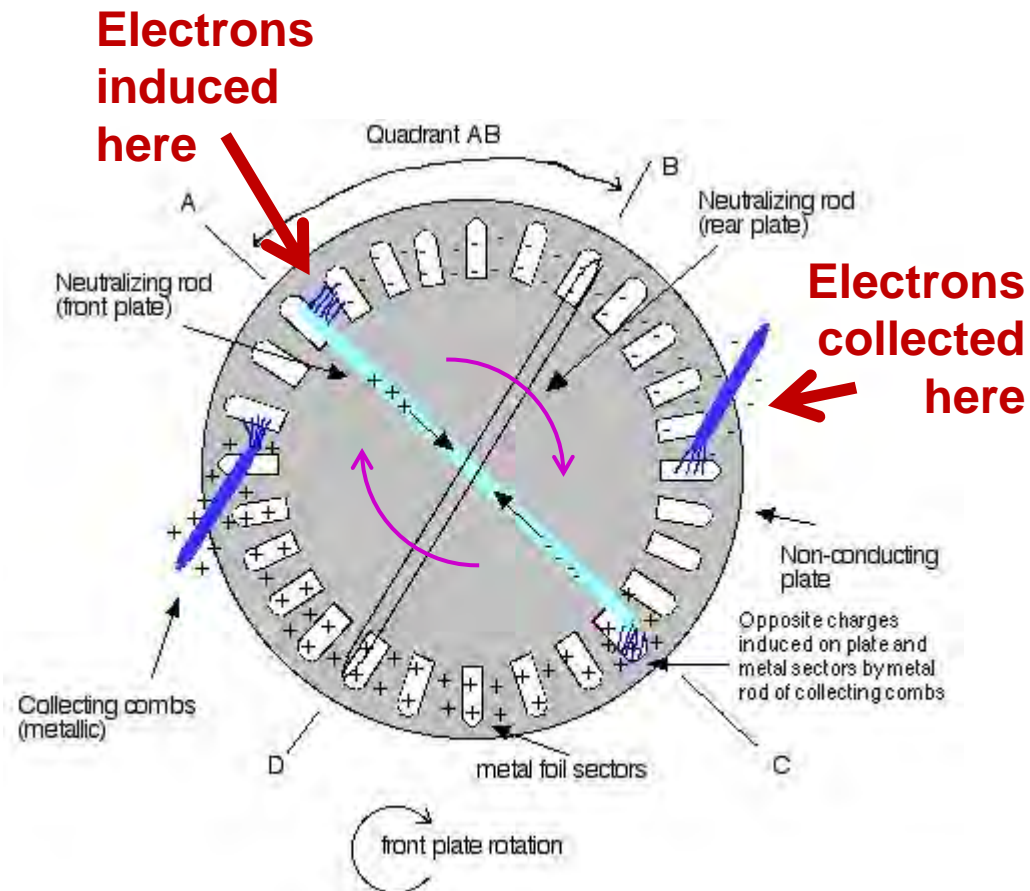


Coulomb's Law of Force

Charges separate in the can. Force of attraction is *stronger* since opposite charges are *closer*.



Wimshurst Machine



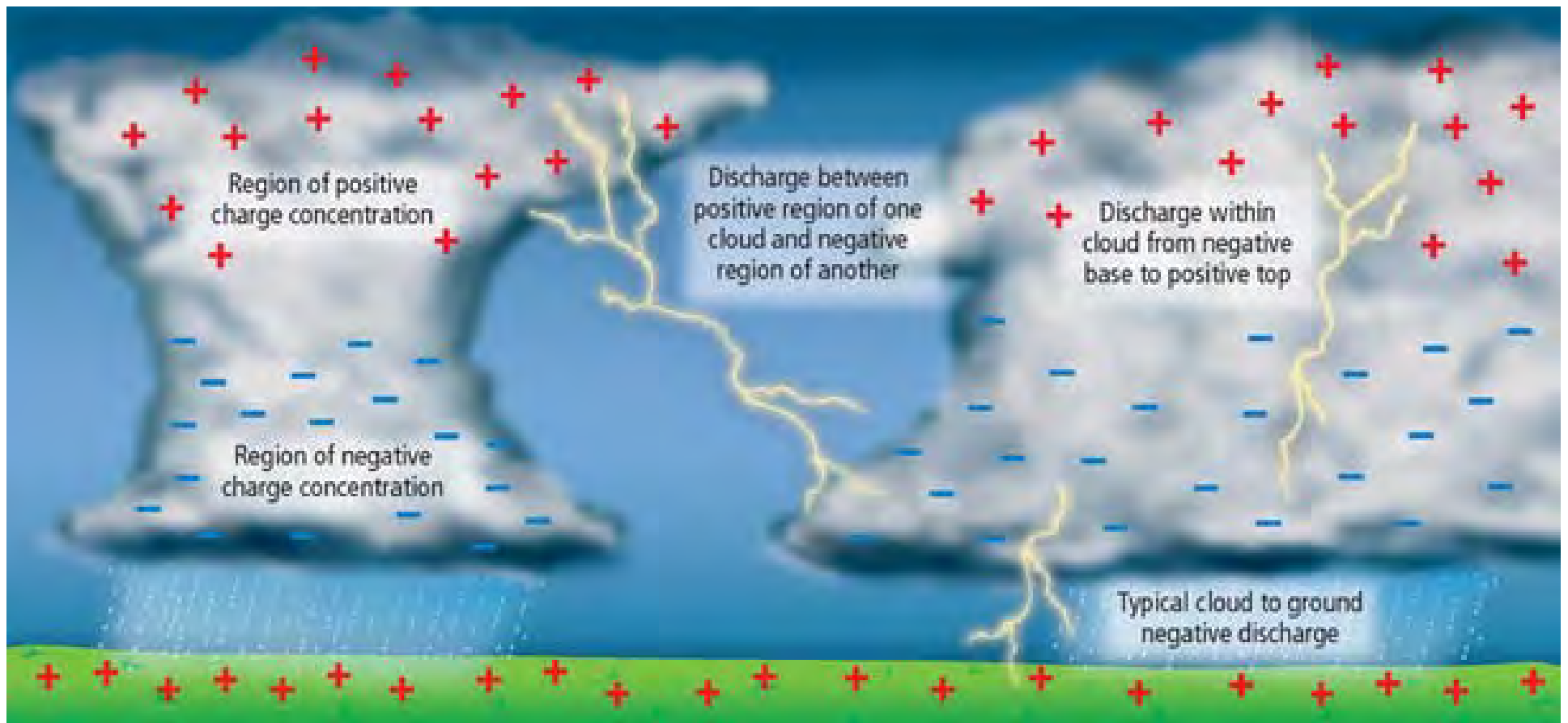
Charge induced on metal strips mounted on opposite sides of counter-rotating plates



Wimshurst Machine



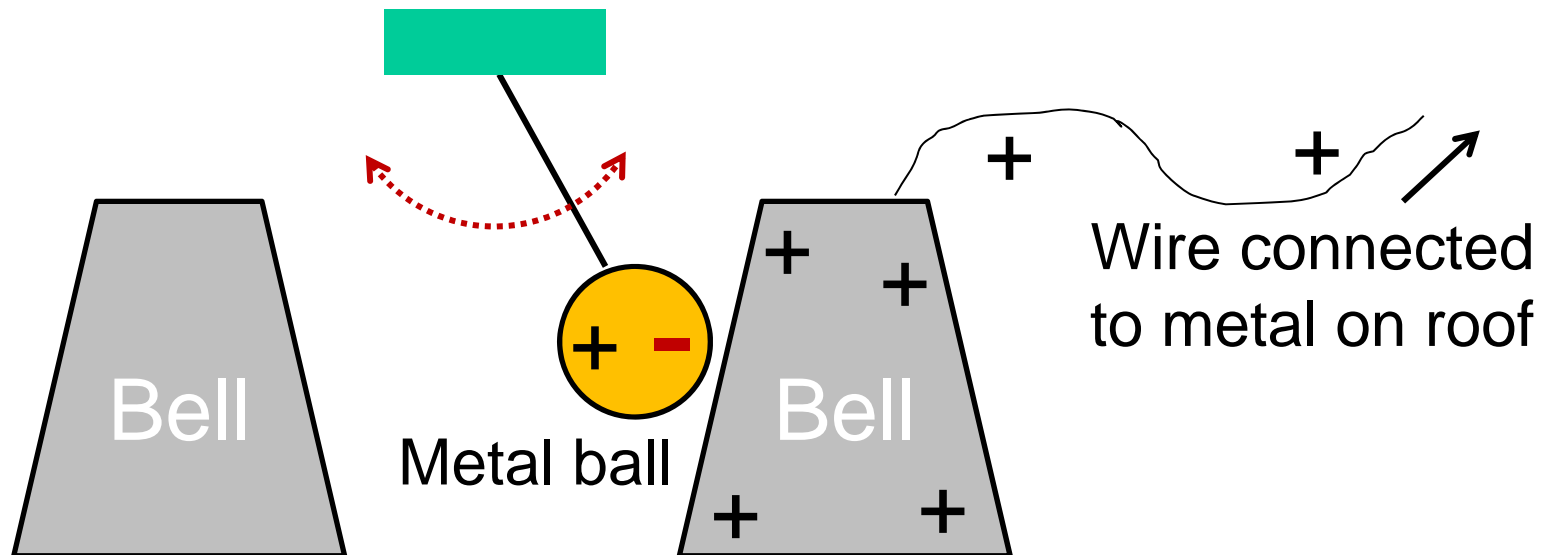
Lightning Storms



The lower part of the cloud is negatively charged.
This induces a positive charge on the ground.

Franklin's Bells

Benjamin Franklin invented this to detect the approach lightning storms.



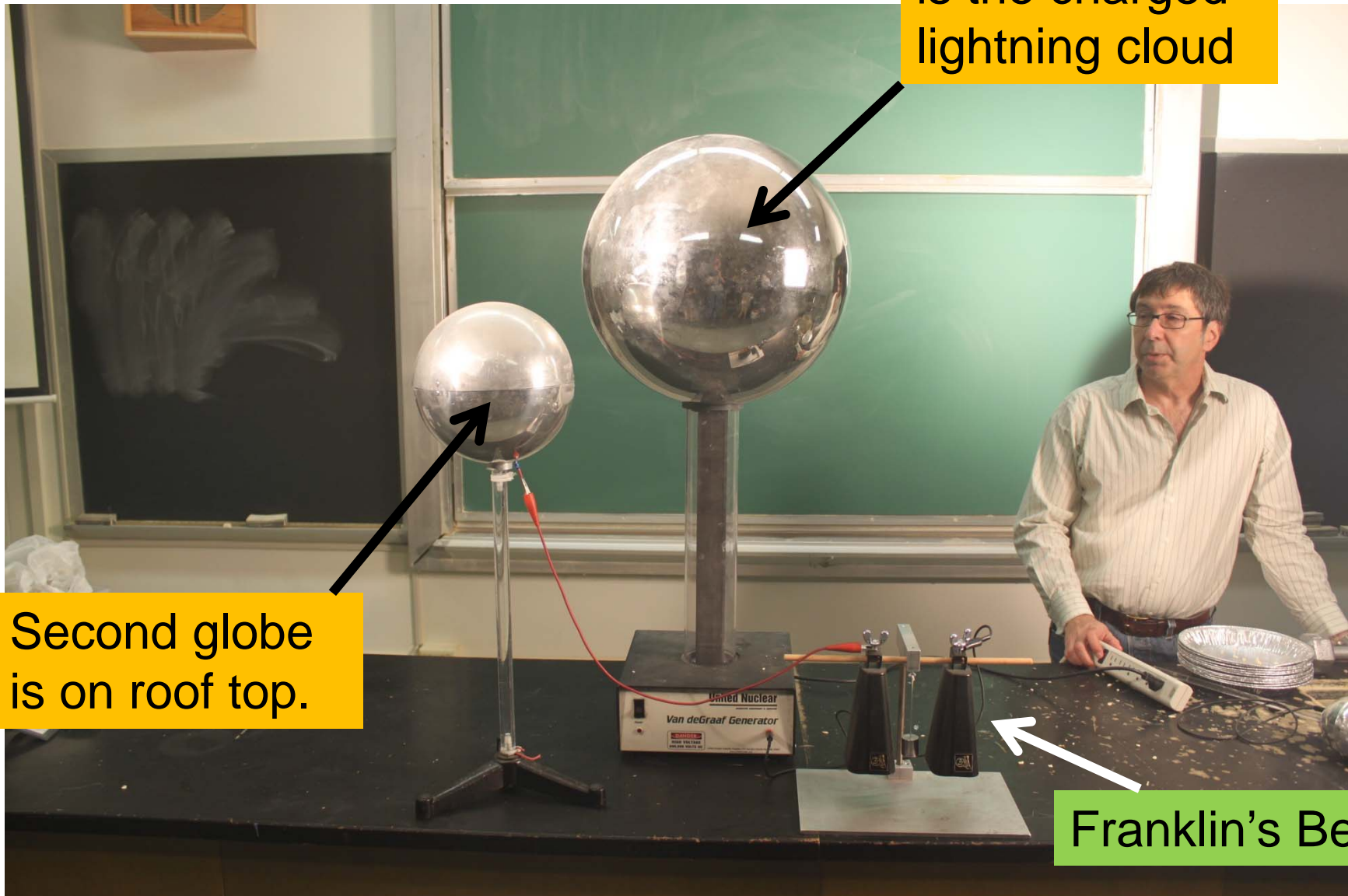
Bell is charged by induction from the lightning cloud.

Franklin's Bells

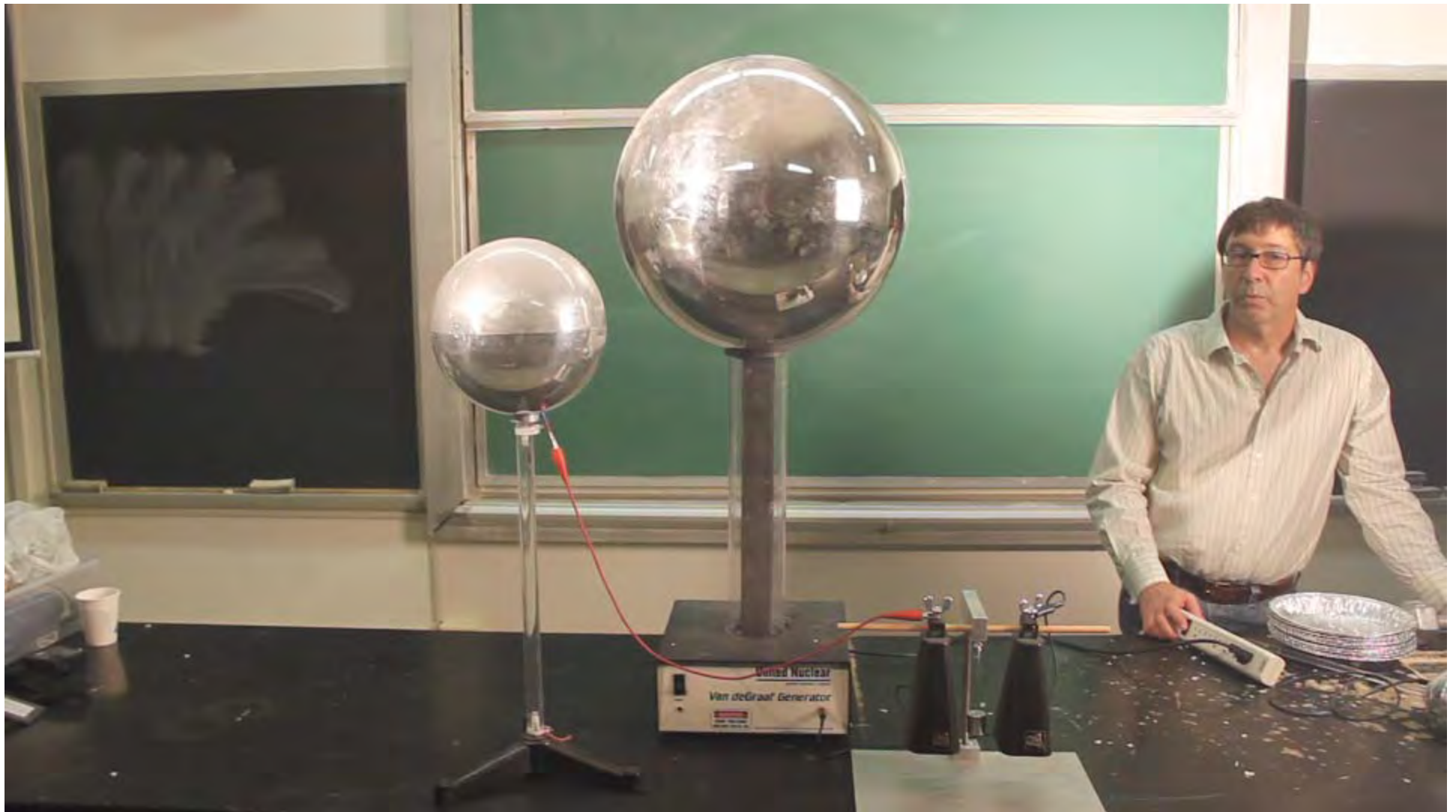
Van de Graaff is the charged lightning cloud

Second globe is on roof top.

Franklin's Bells



Franklin Bells



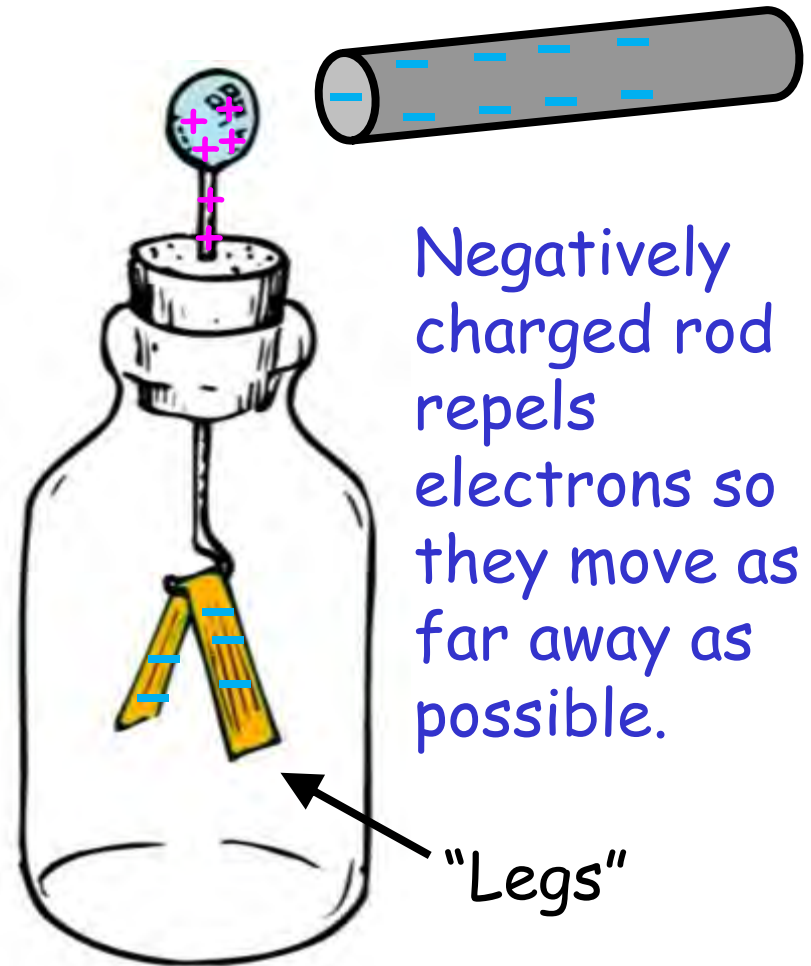
Summary

- Electrostatic induction is a redistribution of electrical charge in an object caused by the attraction to and repulsion from nearby charges.
- In conductors the electrons can easily move around the object due to electrostatic induction.
- In insulators the electrons shift within each molecule (dielectric polarization).
- Induction causes the attraction in static cling.
- Lightning clouds are negatively charged on the bottom, inducing positive charge on the ground.

Demo: Electroscope & Induction

The legs of the electroscope separate when charged rod brought *near* the electroscope.

Charge induction pushes electrons into the legs.



Tesla Coils

Very high voltages achieved with large Tesla coils.

Homemade, backyard model



Fry's Superstore, Fremont CA



Portable Tesla Coil

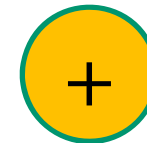
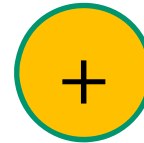


Faraday Cage

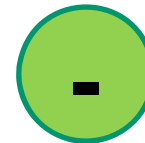
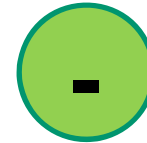


Review Question

Fill in the blanks:



Two objects with positive charge _____
each other and two objects with negative
charge _____ each other.



- A) Attract ... Repel
- B) Repel ... Attract
- C) Attract ... Attract
- D) Repel ... Repel

Demo: Electric Pinwheel

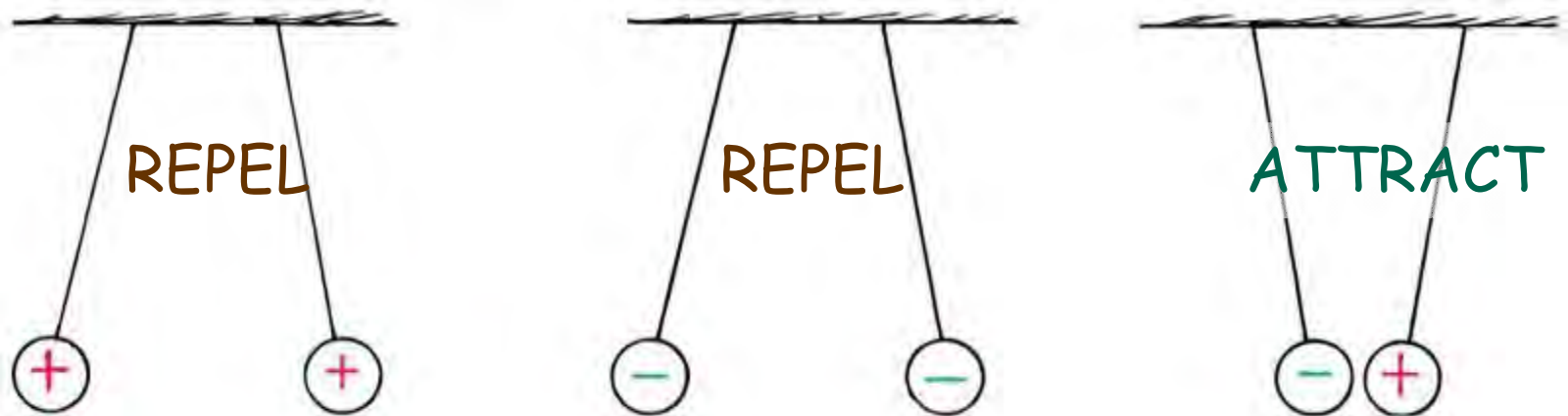
When the Van de Graaff is turned on, the electrostatic pinwheel resting on the black wood block begins to rotate. In the presence of an electric field the sharp points at the end of the three vanes of the pinwheel (pictured at right) give the surrounding air a charge which repels the points.



Electric Charges and Forces

D) Repel ... Repel

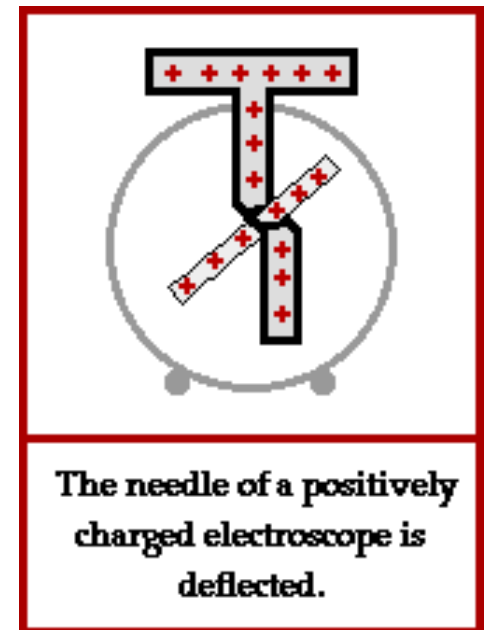
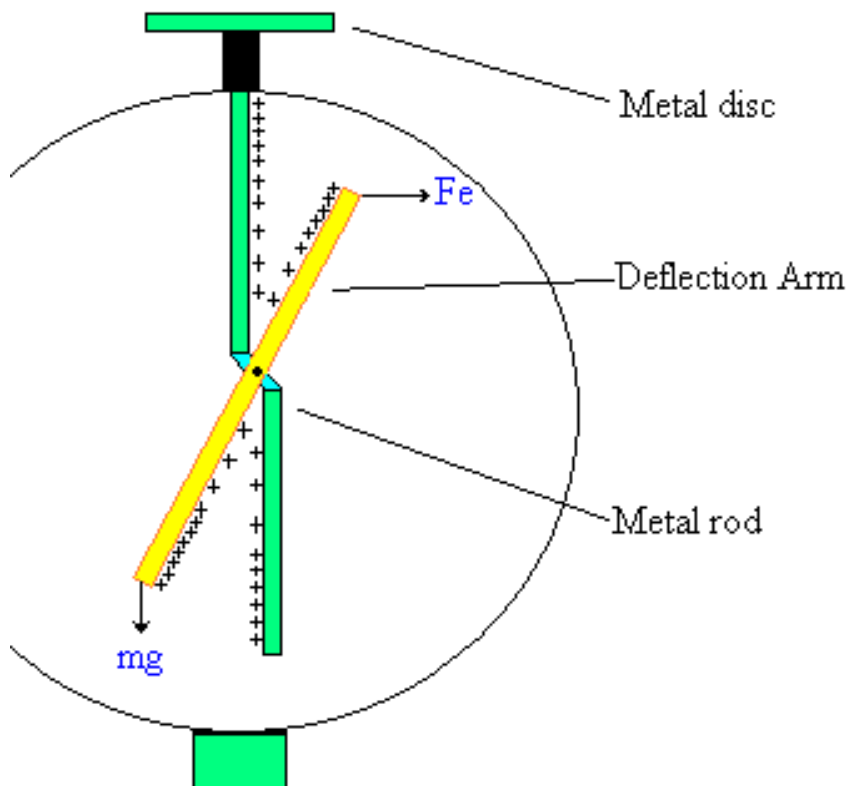
Like charges repel, opposite charges attract.



Note that by Action/Reaction, the force on each object is always equal in magnitude, opposite in direction.

Demo: Dial Electroscope

Alternative design for electroscope



Static Cling

Static electric charges
can cause attraction.
Charged object induces
opposite charges closer.

