# Static Electricity

Turn off all electronic devices



## Observations about Static Electricity

Objects can accumulate static electricity

Clothes in the dryer often develop static charge

Objects with static charge may cling or repel

Static electricity can cause shocks

Static electricity can make your hair stand up



## 6 Questions about Static Electricity

1. Why do some clothes cling while others repel?
2. Why do clothes normally neither cling nor repel?
3. Why does distance weaken static effects?
4. Why do clingy clothes stick to uncharged walls?
5. Why do clingy clothes crackle as they separate?
6. Why do some things lose their charge quickly?



## Question 1

Q: Why do some clothes cling while others repel?

A: They carry electric charges that attract or repel.

Electric charges comes in two types:

- Charges of the same type ("like charges") repel
- Charges of different types ("opposite charges") attract
- Franklin named the types "positive" and "negative"

Charge is actually a single conserved quantity

- "Positive charge" is a positive amount of charge (e.g., +5 units)
- "Negative charge" is a negative amount of charge (e.g., –3 units)



## Question 2

Q: Why do clothes normally neither cling nor repel?

A: Clothes normally have zero net charge.

Electric charge is

- intrinsic to some subatomic particles
- quantized in multiples of the fundamental charge
- +1 fundamental charge for a proton, –1 fundamental charge for an electron

An object's net charge is the sum of its individual charges

- Typical objects have equal numbers of protons and electrons
- Typical objects have zero net charge and are said to be electrically neutral



## Charge Transfers

Contact can transfer electrons between objects

- Surfaces have different chemical affinities for electrons
- One surface can steal electrons for another surface
  - Surface receiving those electrons acquires negative charge
  - Surface losing those electrons acquires positive charge

Rubbing different objects together ensures

- excellent contact between their surfaces
- significant charge transfer from one to the other.

A dryer charges clothes via these effects

# Question 3

Q: Why does distance weaken static effects?

A: Forces between charges decrease as $1/\text{distance}^2$.

These electrostatic forces obey Coulomb's law:

$$\text{force} = \frac{\text{Coulomb constant} \cdot \text{charge}_1 \cdot \text{charge}_2}{(\text{distance between charges})^2}$$

Electric charge is measured in coulombs

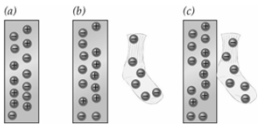
One fundamental charge is $1.6 \times 10^{-19}$ coulombs



# Question 4

Q: Why do clingy clothes stick to uncharged walls?

A: The charged clothes polarize the wall.




When a negatively charged sock nears the wall,

- the wall's positive charges shift toward the sock,
- the wall's negative charges shift away from it,
- and the wall becomes electrically polarized.
- Opposite charges are nearest → attraction dominates



# Question 5

Q: Why do clingy clothes crackle as they separate?

A: Separating opposite charges boosts voltages.

Charge has electrostatic potential energy

Voltage measures electrostatic potential energy per unit of charge

- Work raises the voltage of positive charge
- Work lowers the voltage of negative charge

Voltage is measured in volts (joules/coulomb)



# Question 6

Q: Why do some things lose their charge quickly?

A: Charge can escape through electric conductors.

Insulators have no mobile electric charges

Conductors have mobile electric charges,

- that are usually electrons (e.g., metals)
- that can be ions (e.g., salt water)
- that will accelerate (and flow) toward lowest electrostatic potential energy

Conductors allow charges to cancel or escape



# Summary about Static Electricity

All objects contain countless charges

Objects can transfer charge during contact

Clothes often develop net charges during drying

Oppositely charged clothes cling to one another
and they spark as separation raises their voltages.

Conductivity tends to let objects neutralize.