

# Electricity

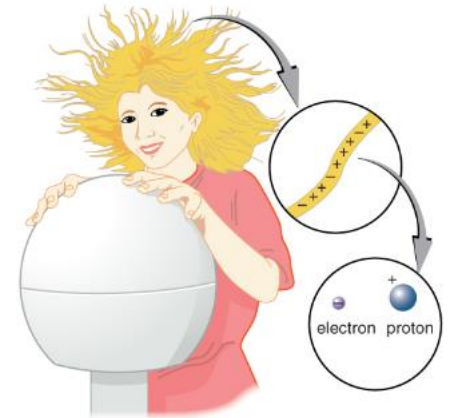
A form of energy resulting from the existence of charged particles (such as electrons or protons).



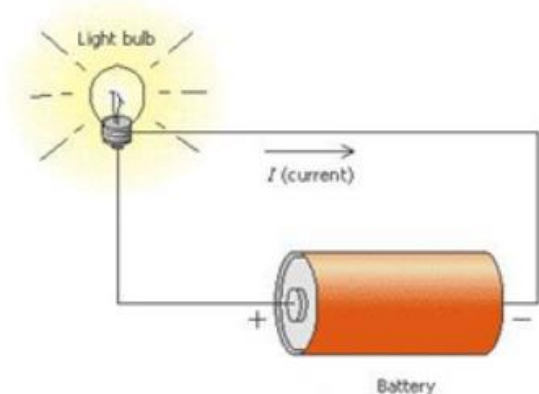
# Two main types of electricity

**1) Static Electricity** - generally defined as the build-up of electric charge on the surface of a material.

- It is called static electricity because the charges don't move.



**2) Current Electricity** - defined as the controlled flow of an electric charge.



# Static Charges

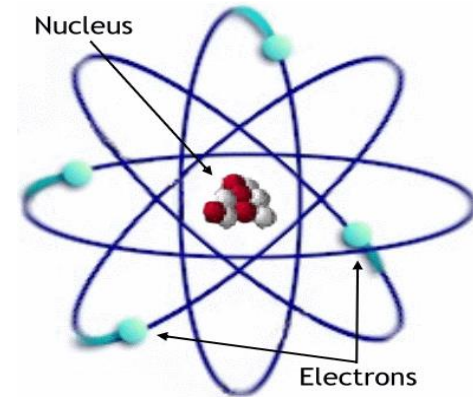
- Can you think of some instances when you have been affected by static charges?
  - Clothes coming out of a dryer
  - Rubbing your feet on the carpet
  - Touching a lock with a key and seeing a spark
  - Lightening
    - when a static charge builds up in the ground during a thunderstorm



# Positive and Negative Charge in Atoms

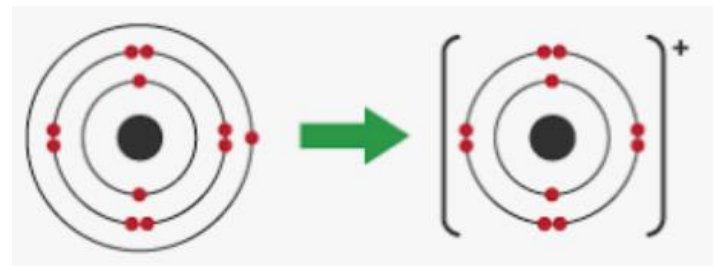
All matter is made of atoms which contain:

- Protons (positively charged)
- Neutrons (no charge)
- Electrons (negatively charged)



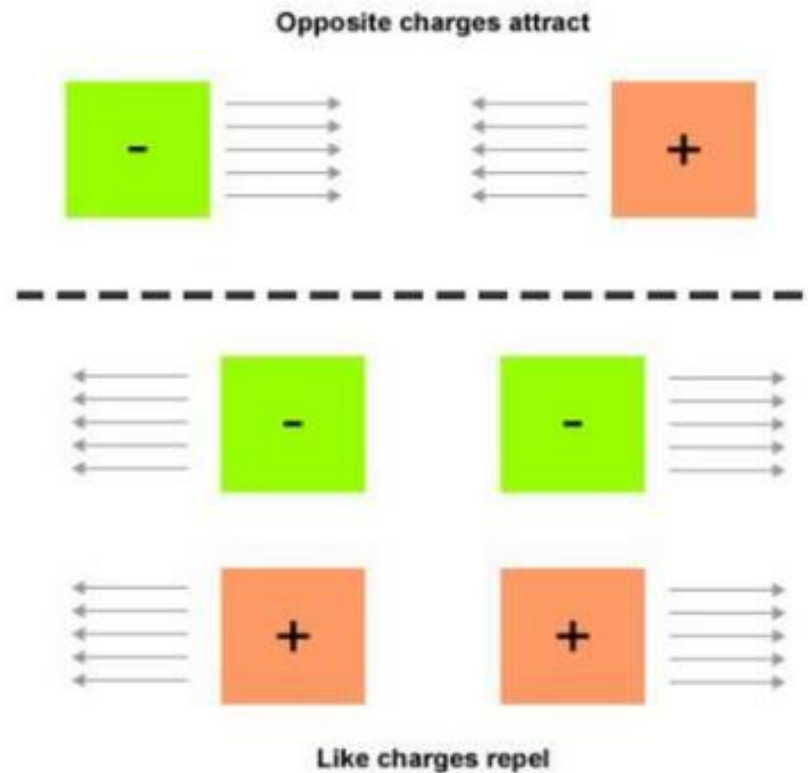
Atoms have a neutral charge, but if they lose an electron they become positively charged and if they gain an electron they become negatively charged.

Charged atoms are called ions.



# Laws of Static Electricity

- Opposite charges **attract**.
- Like charges **repel**.
- **Neutral** objects are attracted to **charged** objects.



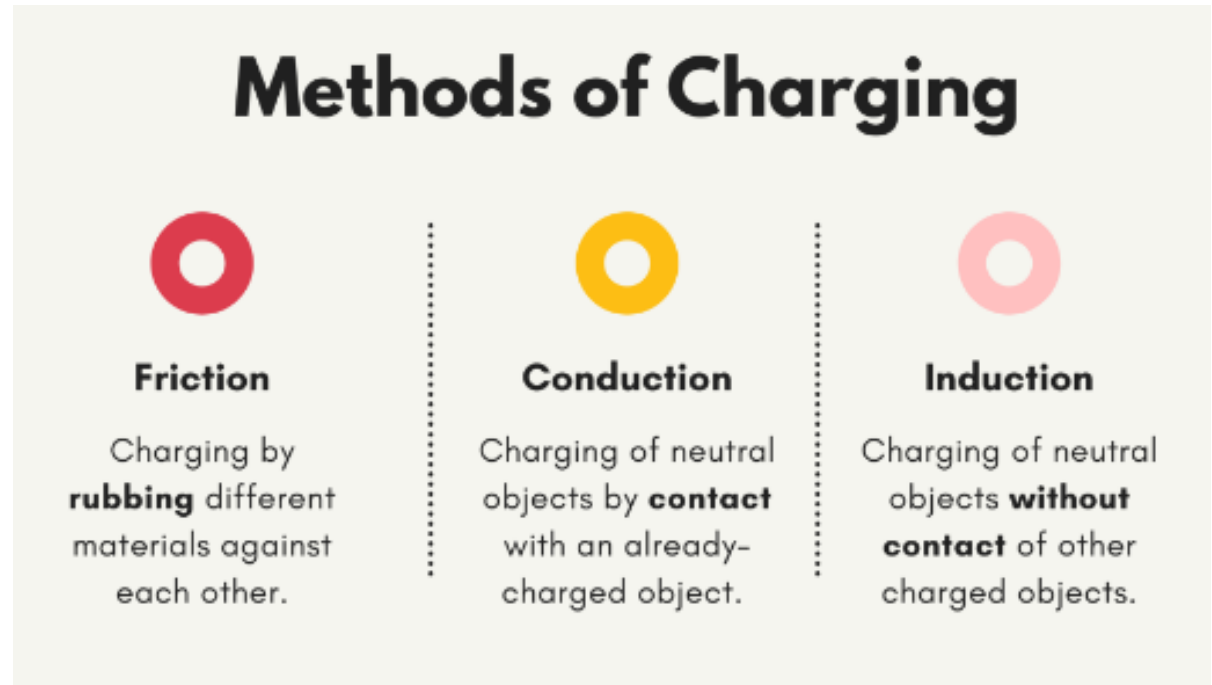
# How Can You Charge Objects?

There are 3 ways objects can be charged.

(1) Friction

(2) Conduction

(3) Induction



In each of these, only the electrons move.

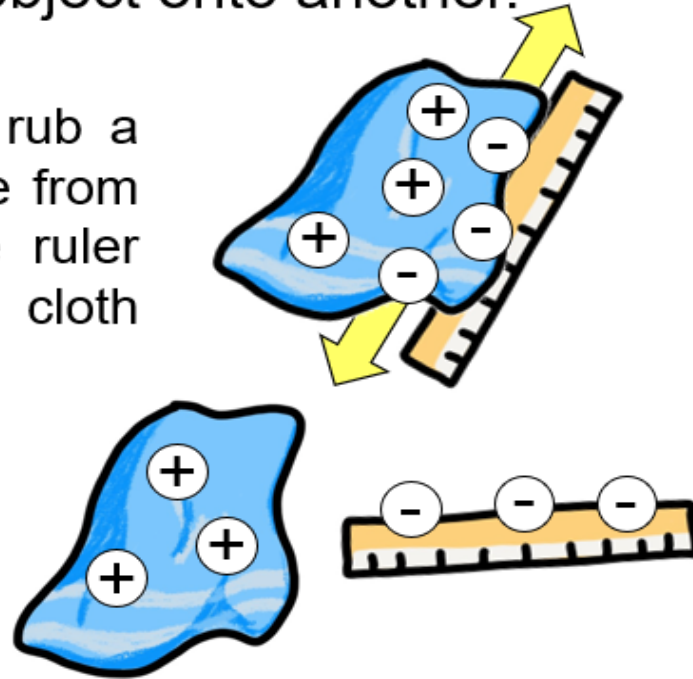
**\*\*The protons stay in the nucleus\*\***



# (1) Friction

- Charging by friction occurs when **electrons** are “wiped” from one object onto another.

e.g., If you use a cloth to rub a plastic ruler, electrons move from the cloth to the ruler. The ruler gains electrons and the cloth loses electrons.

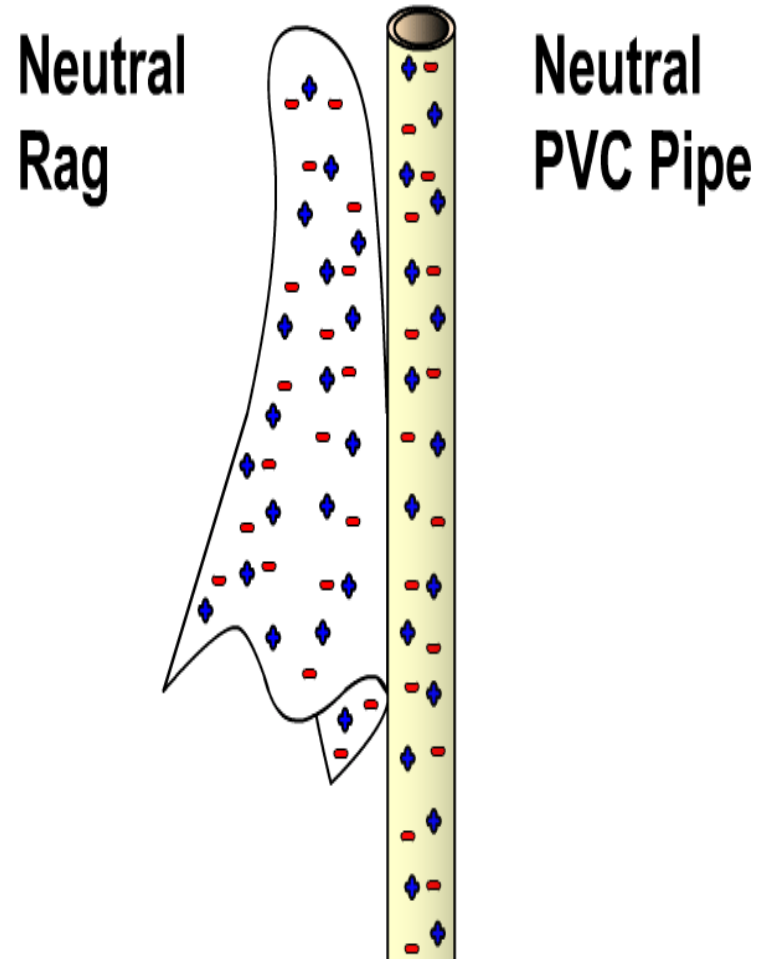


Electrons are most often **transferred** through friction, when objects rub against each other.

Friction results in **losing electrons** or **gaining electrons**.

# Charging By Friction

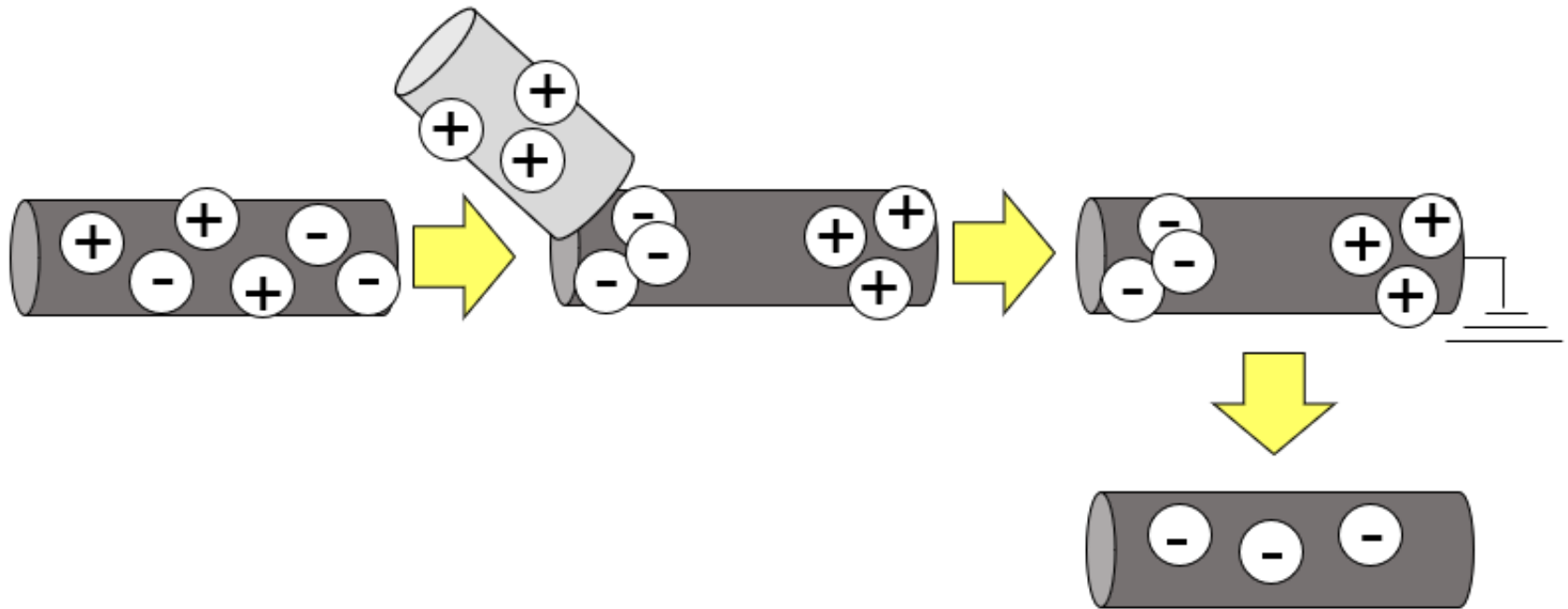
- Different materials have a different affinity for electrons. Some hold on to their electrons tighter than others.
- **Greater affinity for electrons:** hold electrons stronger and often gain electrons by friction and **become negative**.
- **Less affinity for electrons:** hold electrons weaker and often lose more electrons by friction and **become positive**.





## (2) Conduction

- Charging by conduction happens when electrons move from one object to another **through direct contact (touching)**.



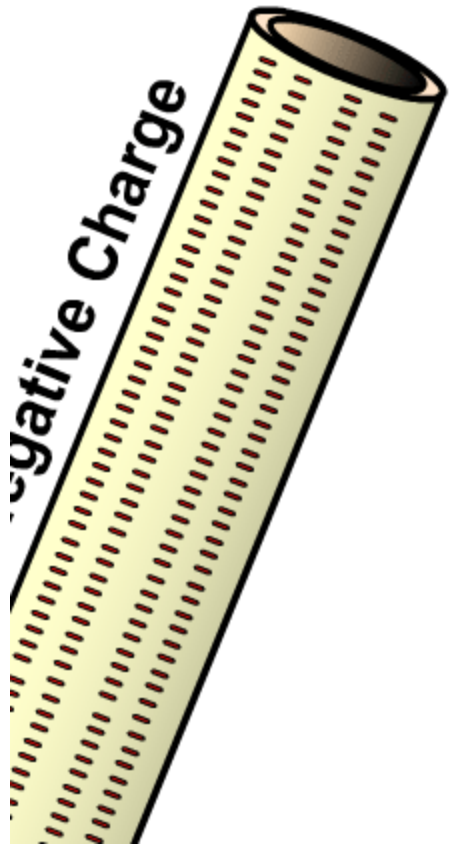
# Charging By Conduction:

- Contact
- Same charge
- Permanent (with electron transfer)

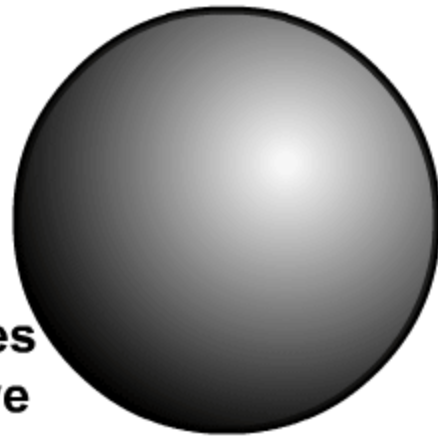
# Charge When Charged By Conduction:

- Negative creates negative
- Positive creates positive

# Conduction



Becomes  
Negative

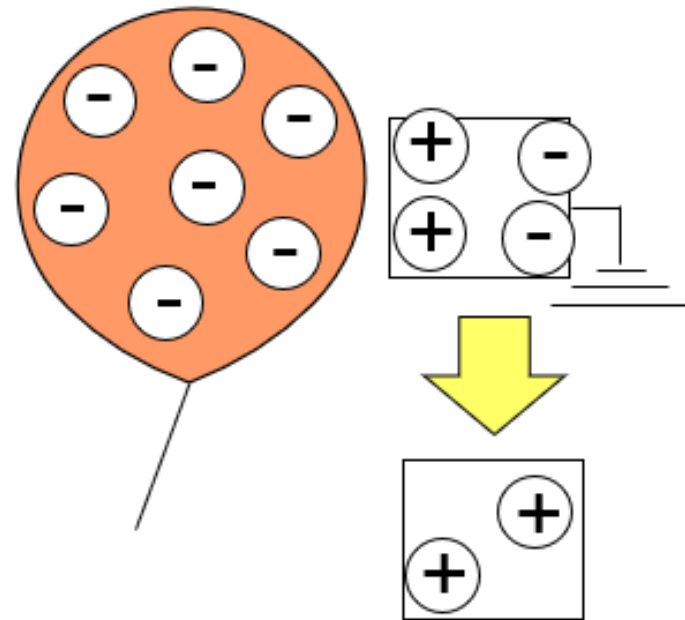


Electrons transfer to the object  
making it the same charge

### (3) Induction

- Charging by induction happens when charges in an uncharged object are rearranged **without direct contact** with a charged object.

e.g., If you charge up a balloon through friction and place the balloon near pieces of paper, the charges of the paper will be rearranged, and the paper will be attracted to the balloon.



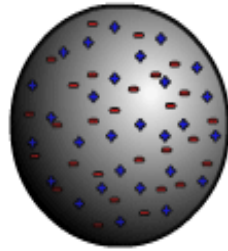
# Charging By Induction:

- No contact
- Opposite charge
- Temporary (no electron transfer)

# Charge When Charged By Induction:

- Positive induces negative
- Negative induces positive

# Positive Induction



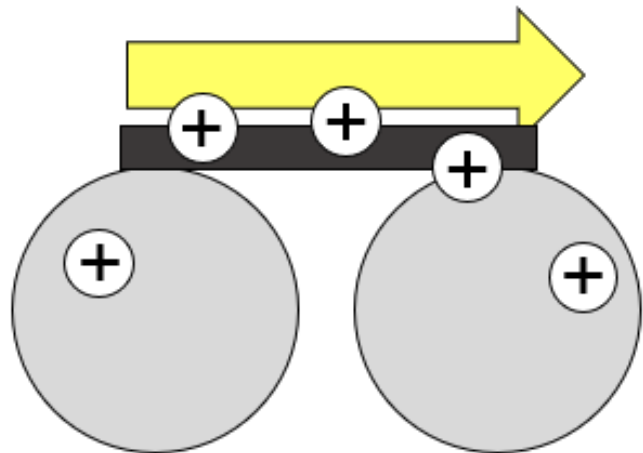
Electrons Move Away  
Side Becomes Positive



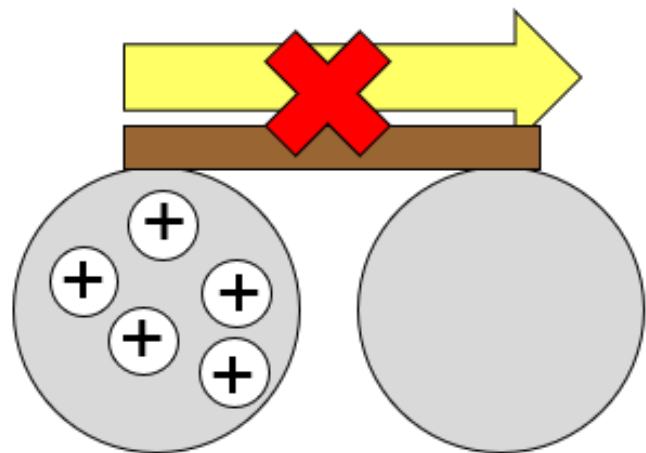
# Conductors and Insulators

## Conductors VS Insulators

- Charge flows freely  
e.g., metals, seawater, iron



- Almost no charge flows  
e.g., rubber, glass, wood

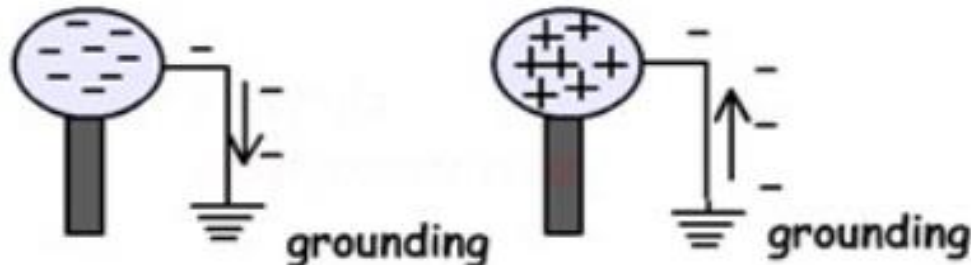




# Grounding

The removal of a charge by producing a conductive path to the ground.

- The earth both accepts and gives electrons to neutralize objects.
- If an object with a positive charge is grounded, electrons will flow up from the ground to neutralize it.
- If an object with a negative charge is grounded, electrons will flow down to the ground to neutralize it.



# Lightning

During a rainstorm, clouds develop regions of positive and negative charge due to the movement of air molecules, water drops, and ice particles.

The negative charges are concentrated at the base of the clouds, and the positive charges are concentrated at the top.

The negative charges repel electrons on the ground beneath them, so the ground below the clouds becomes positively charged.

As more charges build up, the air between the oppositely charged areas also becomes charged. When this happens, static electricity is discharged as bolts of lightning.

# Lightning



# Measuring Charge

- Unit of electric charge is called a **Coulomb (C)**
  - named after the French physicist Charles Augustin de Coulomb
- **1 C of charge** is equal to the removal or addition of  **$6.25 \times 10^{18}$  electrons**
- **That is 6250000000000000000 electrons !!**
- A typical lightning bolt carries **5 – 25 C**





# Some Applications of Static Electricity

Plastic sandwich wrap clings due to static charges.



Static devices are used in industry to remove pollutants from chimney stacks.

Air ionizers in homes.

Static charges are used in painting automobiles.





# Some Dangers of Static Electricity

When static charge builds up it can discharge and cause serious **shocks, explosions or fires.**

Those pumping flammables must ensure objects are **grounded** (connected to the Earth so that static charge is discharged).

Lightning is especially dangerous – buildings can be protected with **lightning rods.**

