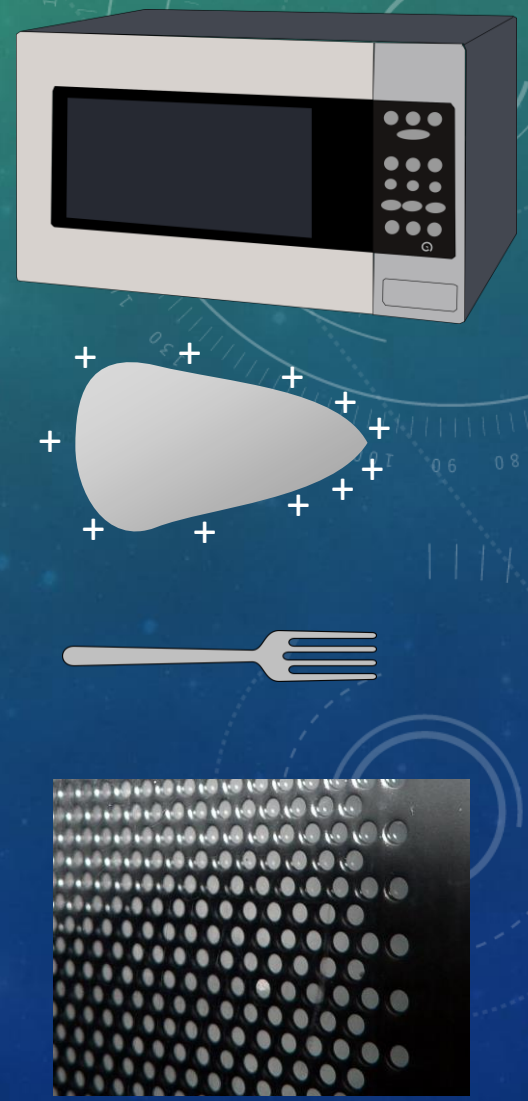
APPLICATIONS OF ELECTRO-STATICS

PES 1000 – PHYSICS IN EVERYDAY LIFE

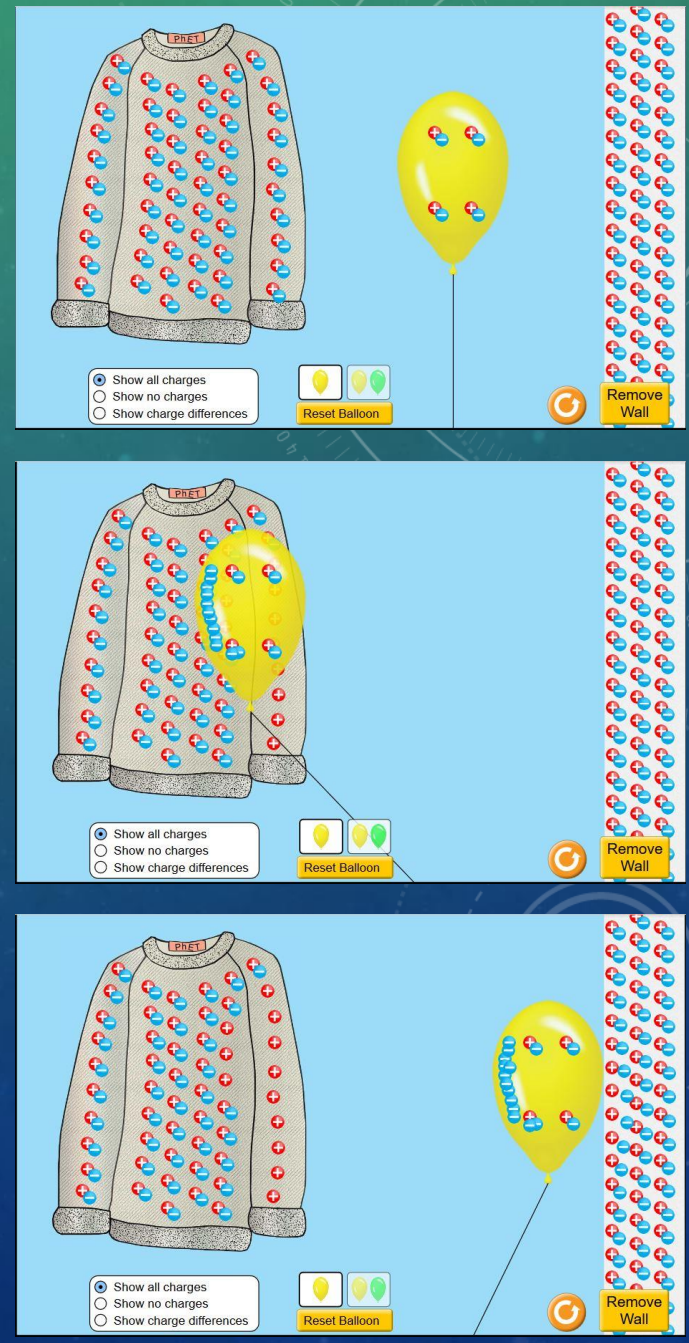
ELECTRIC FIELD NEAR SHARP POINTS

- It is good, common advice to not put metal in a microwave, including metal items like a fork.
  - The reason for this is based on a phenomenon we have discussed.
  - Electric fields near a sharp point are very strong, and charge tends to accumulate there.
  - Microwaves have an oscillating electric field component. This field moves charges around within the fork and charge accumulates on the fork tines.
  - Charges can spark back and forth between the tines.
- Microwaves, as we will find, have a large wavelength and so are not able to make their way past the metal grill on the window, while light waves have small enough wavelengths to escape.



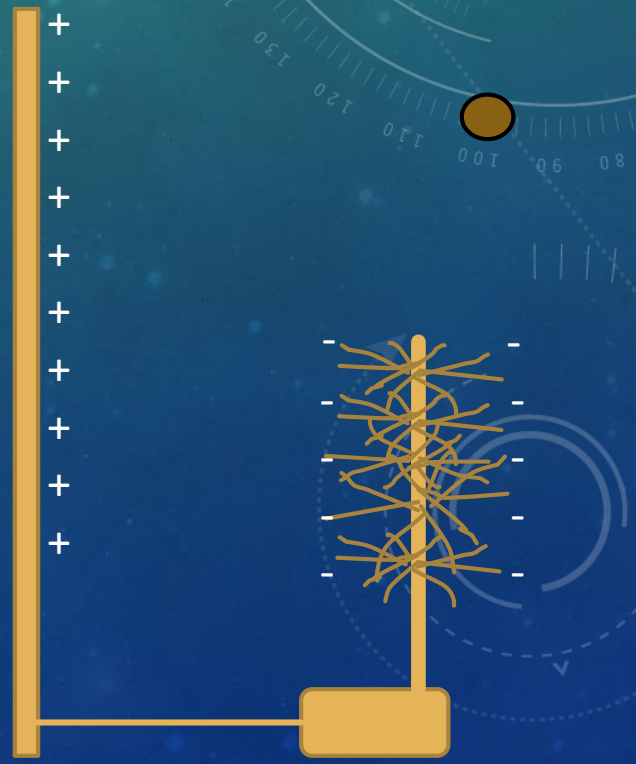
BALLOON STUCK TO WALL

- Balloon, sweater, and wall are all neutrally charged.
- The balloon is rubbed on the sweater, and it picks up some excess electrons.
- The sweater has a net positive charge, and the balloon has a net negative charge.
- When the balloon is brought near the wall, electrons in the wall by the balloon move away, leaving the wall surface with a local positive charge.
- Positive and negative attract, so the balloon remains stuck to the wall.



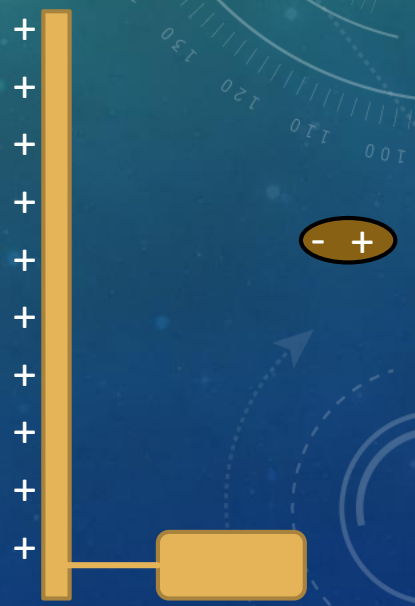
AIR CLEANERS

- Ionic air cleaner
  - Electrons are drawn from a plate and placed onto a nearby brush.
  - Charge (electrons) are on sharp points, so they are motivated to leap off.
  - A passing dust mote will gain a negative charge and be drawn toward the positive plate.
  - The negative charge jumps to the plate, but then is circulated back to the brush.



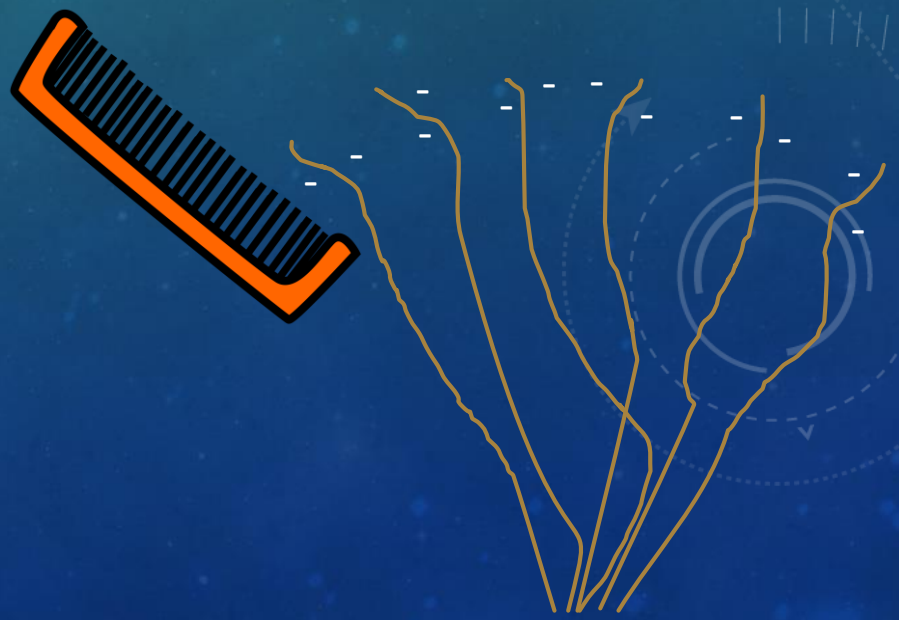
AIR CLEANERS

- Polarizing air cleaner
  - Positive charge is placed onto a plate.
  - Dust motes in the region of the plate become polarized. Electrons move to the side toward the plate, leaving the other side positive.
  - The negative end is closer to the plate, so the mote is drawn to the plate. It usually sticks there, like a charged balloon.
- In both cases, the moving particles draw air along with themselves, causing a current which brings in more dust motes. Thus a fan is not required for these types of air cleaners.



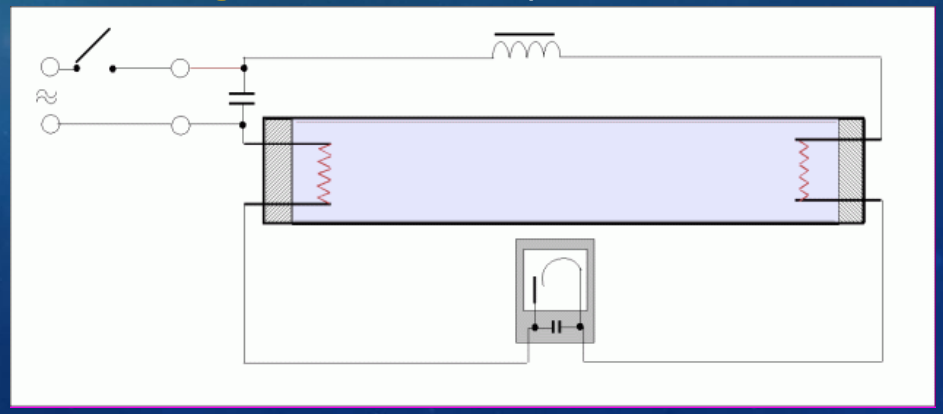
STATIC ELECTRIC CHARGE IN HAIR

- Wind blowing across hair can add or remove electrons, charging the strands of hair.
- The individual strands repel each other, standing on end.
- Passing a wet comb through the hair usually solves this problem.
- The electrons bind with the polarized water molecules, leaving the hair uncharged and manageable.



FLUORESCENT TUBE

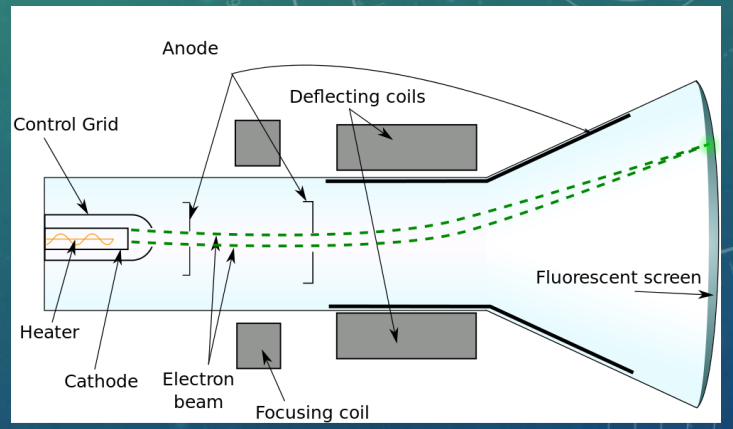
- A fluorescent tube has an electron source (the cathode) on one end and a positively charged node on the other (the anode). The tube has mercury in vapor form in the space between the nodes.
- A high voltage between the nodes causes electrons to jump from cathode to anode (forming a 'cathode ray').
- The electrons strike the mercury atoms' electrons, knocking them up to higher levels.
- As high level electrons drop back down, they release the extra energy in the form of ultra-violet light.
  - This type of tube is used for tanning.
- The tube for forming visible light has a fluorescent coating on the inner part of the tube that converts ultra-violet light into visible light.

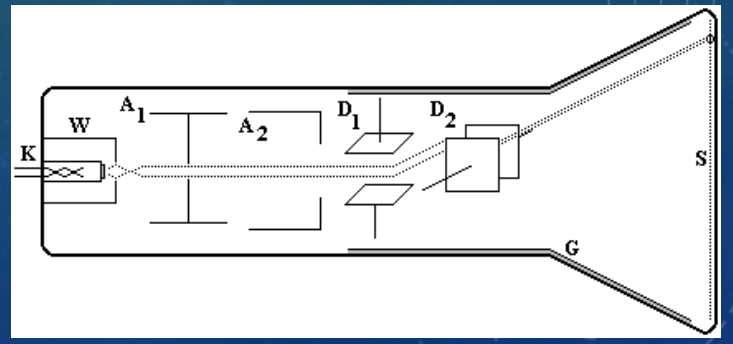


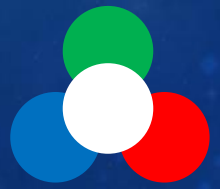
CATHODE RAY TUBE TV (CRT)

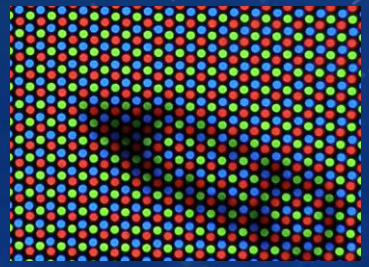
The idea behind fluorescent lights is the basis of the old style tube tv sets.

- The cathode releases a beam of electrons.
- The beam is focused and deflected so that it strikes individual pixels on the TV tube.
- The inner part of the tube is coated with a fluorescent material, which lights up when hit by the beam.
- The 'electron gun' is controlled by parallel plates in the vertical direction and another pair of plates for the horizontal direction.
- The beam scans back and forth, lighting up certain pixels. As the light from each pixel begins to fade, the gun must come back and re-energize the pixel.
- Color TV has three differing fluorescent materials at each pixel location (red, green, and blue). The beam lights up some portion of each, forming all the possible colors by a combination of the basic colors.



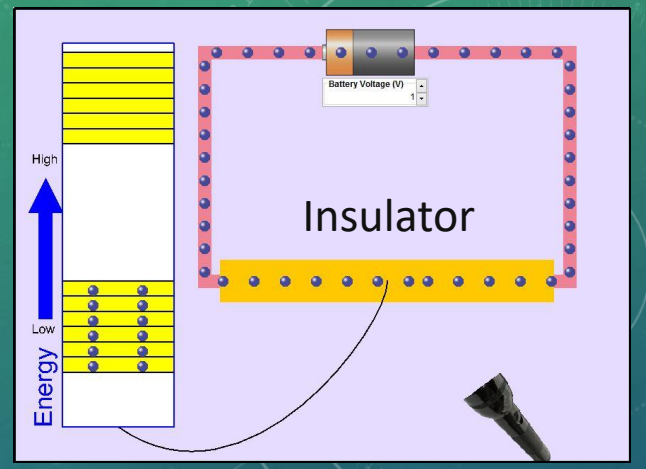


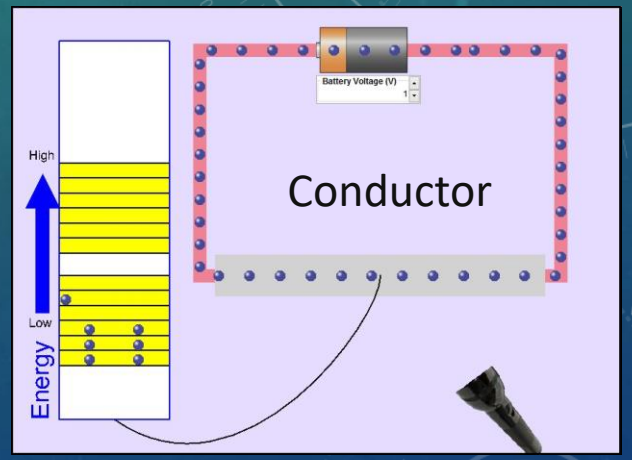




SEMI-CONDUCTORS

- Some materials are insulators under some conditions and conductors under other conditions.
  - Conditions could include:
    - Applied voltage – semi-conductor
    - Temperature – thermo-conductor
    - Illumination – photo-conductor
- In an insulator, the empty electron shells (conduction bands) are at too high an energy for electrons to move to them and conduct current.
- In a conductor, there are nearby empty conduction bands.
- In a photo-conductor, the conductions bands are far enough away that electrons won't spontaneously go there (insulator), but if light is shined on them, the added energy allows them to make the jump.





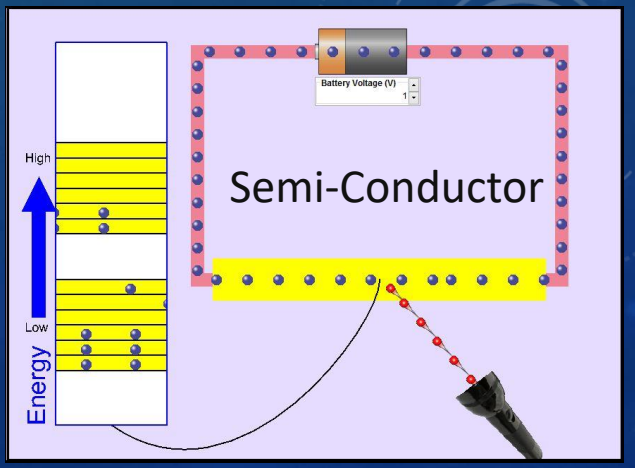
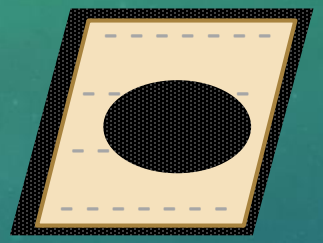
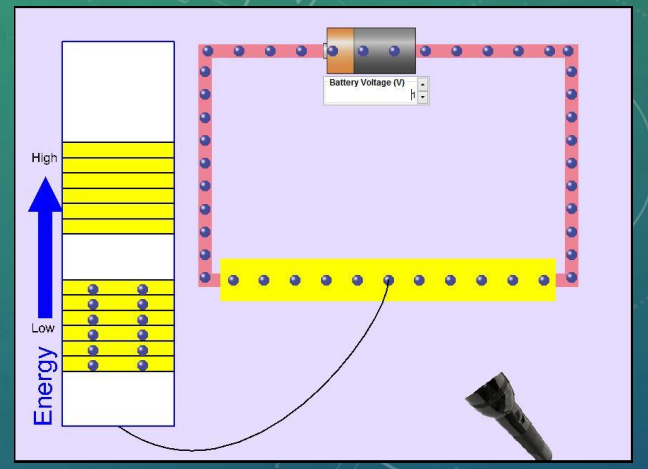
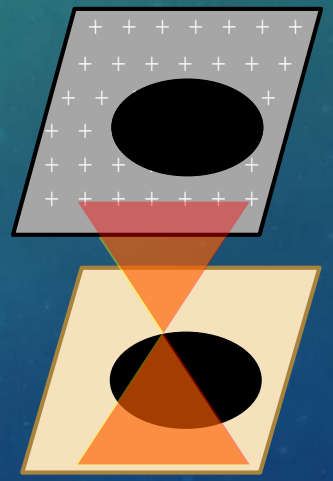


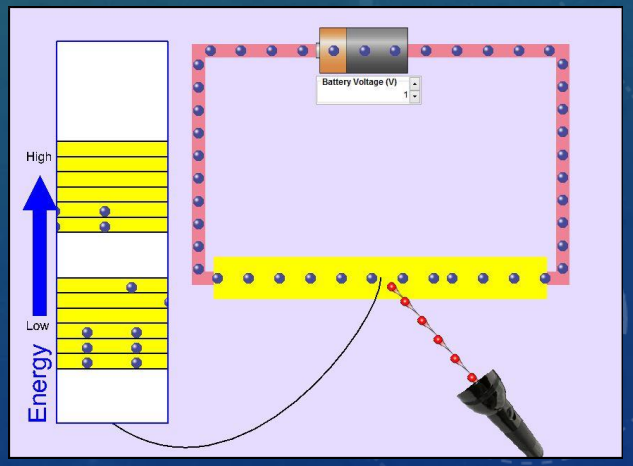
PHOTO-COPIER

- Photo-conductor
  - Empty conducting levels take too much energy for an electron to reach on its own, but with the additional energy from light, electrons begin to flow.
- Photo-copier
  - A metal plate is charged.
  - Light makes bright areas conductive, so charge only remains in dark areas.
  - Charged toner particles stick to these areas.
  - Oppositely charged paper attracts the toner particles.
  - Heat then fuses the toner in place.









CONCLUSION

- Electric charge is used to do many things that make life easier.
- Electric fields have the ability to move electrons and charged particles with ease.
- In many cases, when moving electrons interact with matter, light is produced.
- Some materials conduct charge, some do not, and others may conduct if conditions are right.