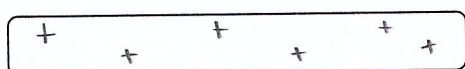


# Electric Charges & Electrostatics

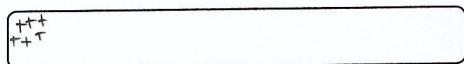
- Electrostatics is the study of charges when not in motion
- \* We know that objects with similar charges will repel each other (ie. a negatively charged object will repel another negatively charged object) and that objects with the opposite charges will attract each other (ie. a positively charged object will attract a negatively charged object) *called electrostatic repulsion or attraction,*
- Materials/objects can be classified as conductors or insulators

- **Conductors** are materials that allow electrons to flow with ease
  - Examples include metals



*charges evenly distribute*

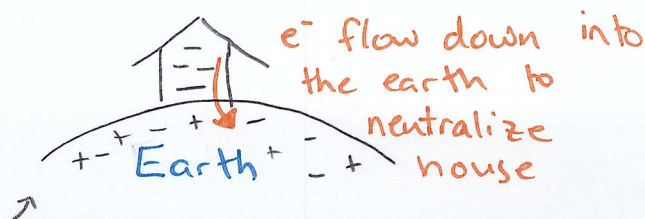
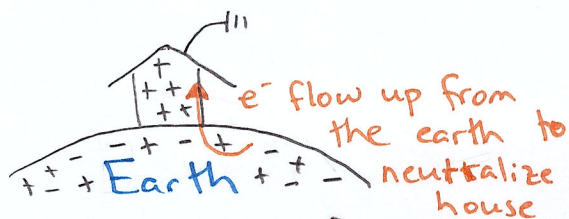
- **Insulators** are materials that do not allow electrons to flow with ease
  - Examples include glass, plastic, rubber



*charges do not distribute*

- \* Electrical charges are always due to a transfer of electrons! Protons are not free to move/transfer from one material to another
  - A negative charge is caused by an excess of electrons
  - A positive charge is caused by a shortage of electrons
  - A neutral object has no net charge (positive charge = negative charge)  
*# protons = # electrons*
- **Grounding:** the process of connecting a charged object to the Earth which will cause the grounded object to become neutralize in terms of charge.

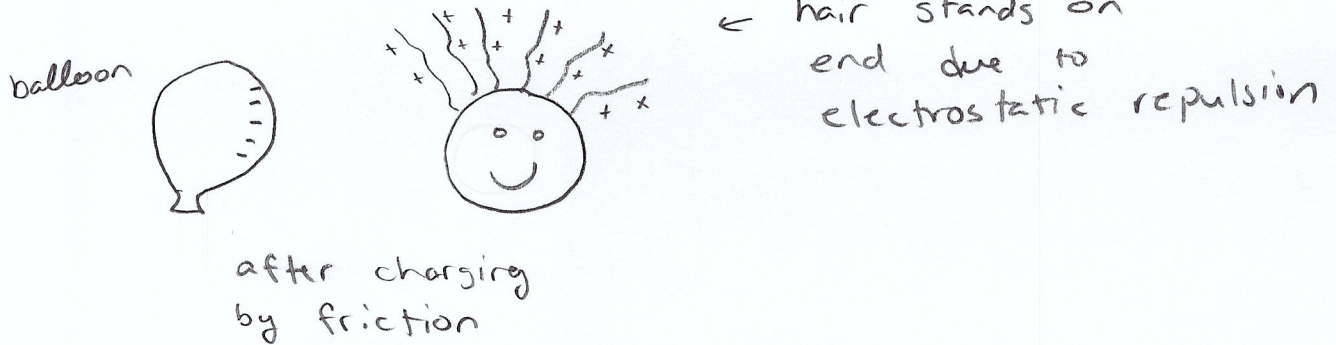
*Symbol for grounding*



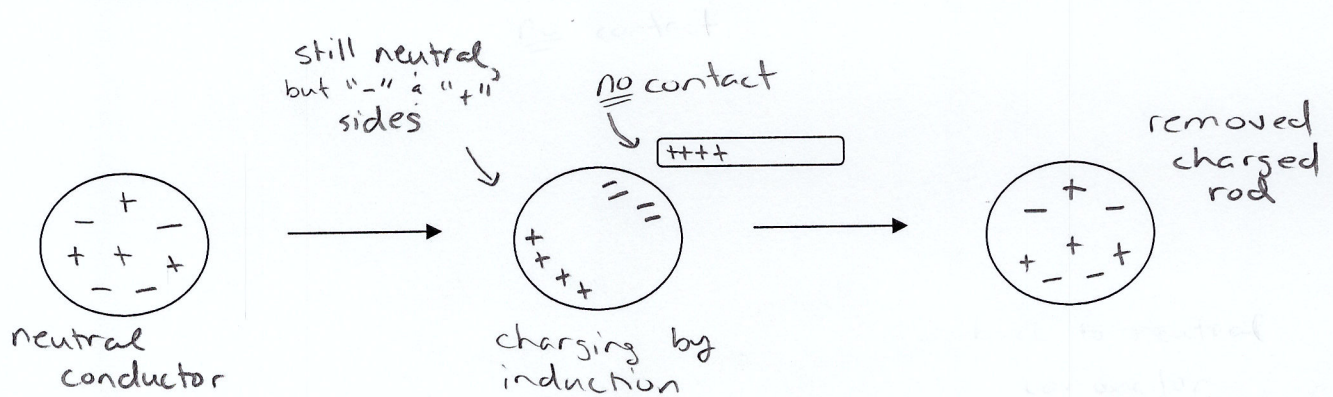
*excess pool where charges can be removed or added*

- \* There are three ways to charge an object

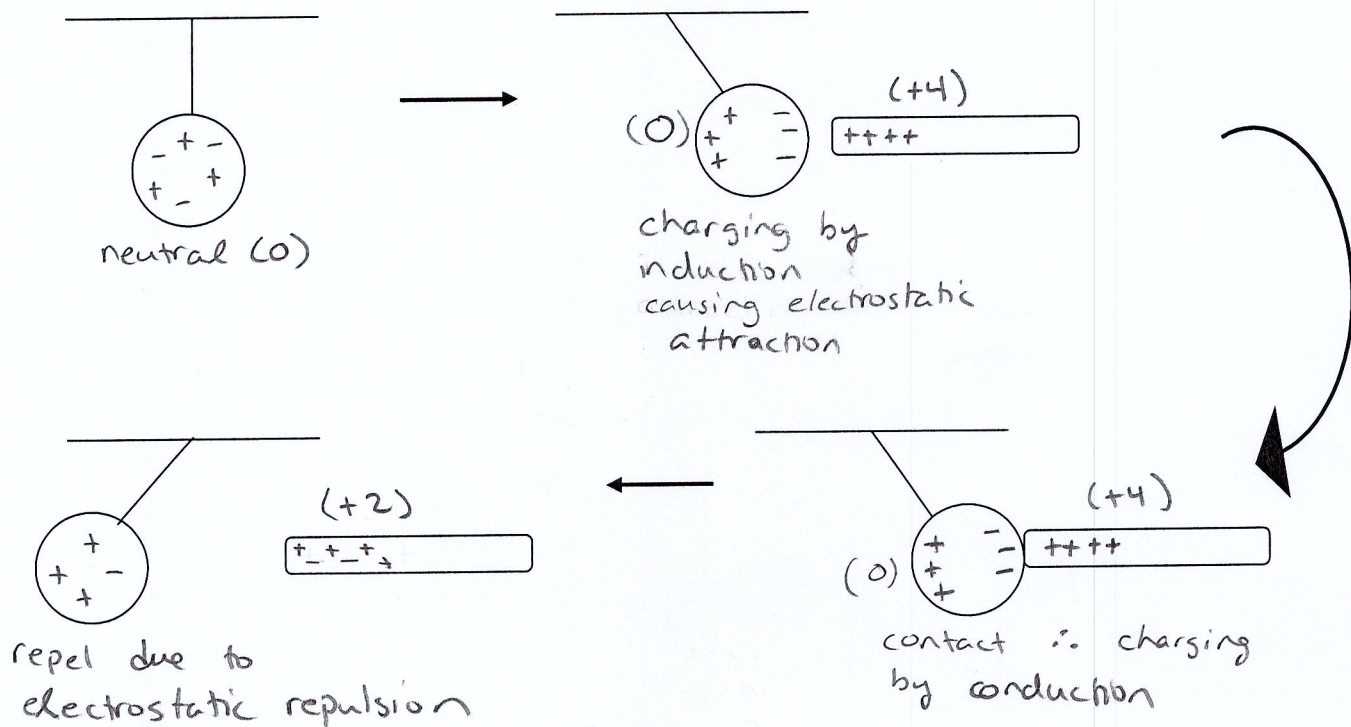
1. **Charging by Friction:** transfer of electrons by rubbing two different objects together
  - o When a rubber rod is rubbed with fur or wool, the rod becomes negative and the wool becomes positive



2. **Charging by Induction:** if a charged object is brought near but does not touch a conductor, the electrons on the neutral conductor will rearrange themselves based on the electrostatic repulsion or attraction of the charged object. Essentially, the neutral conductor will temporarily become polar (has a more positive side and a more negative side). The neutral conductor has not gained or lost electrons, but has only rearranged the position of the electrons.



3. **Charging by Contact/Conduction:** when two differently charged objects are brought in contact with each other, electrons will flow away from the more negative object until both objects are of the same charge (i.e. equal charge)
  - o Charging by contact/conduction is based on the law of conservation of charge (principle #7)



EXAMPLE: Object W has a charge of  $-2.0\mu\text{C}$ , object X has a charge of  $-9.0\mu\text{C}$ , object Y has a charge of  $+6.0\mu\text{C}$ , and charge Z has a charge of  $+12.0\mu\text{C}$ . Objects Y and Z come in contact with each other and then separate. Charges W, Z and X then come in contact and are separated. What is the charge on each object at this point?

\* example of conservation of charge! (principle #7)

Charge on Y & Z after contact =  $\frac{\text{total charge}}{\# \text{ objects}} = \frac{(+6.0\mu\text{C}) + (+12.0\mu\text{C})}{2} = +9.0\mu\text{C}$

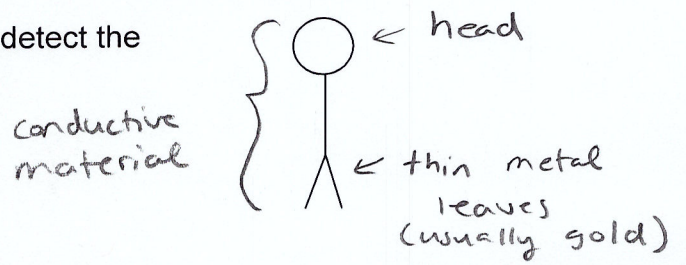
\* important!

Charge on W, X, Z after contact =  $\frac{(-2.0\mu\text{C}) + (+9.0\mu\text{C}) + (-9.0\mu\text{C})}{3} = -0.6\mu\text{C}$

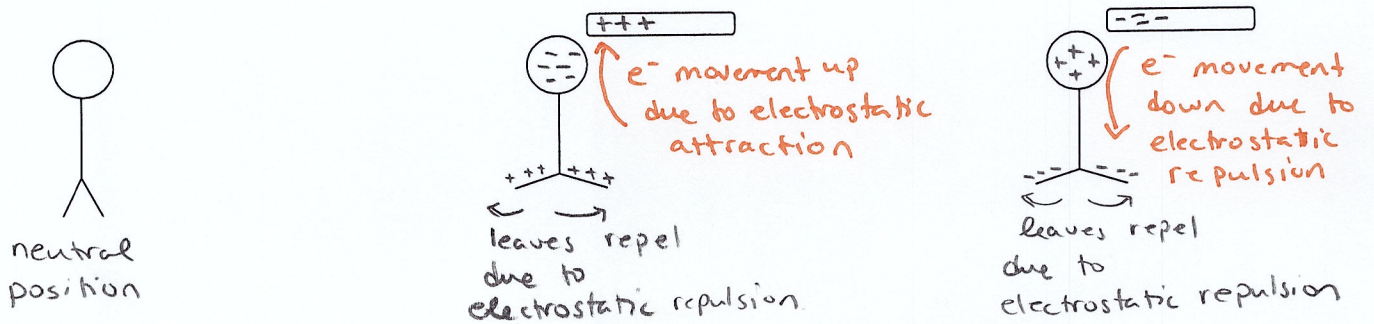
∴  $W, X, Z = -0.67\mu\text{C} \quad ; \quad Y = +9.0\mu\text{C}$

\*\*\*Now try pg. 82 # 1-9\*\*\*

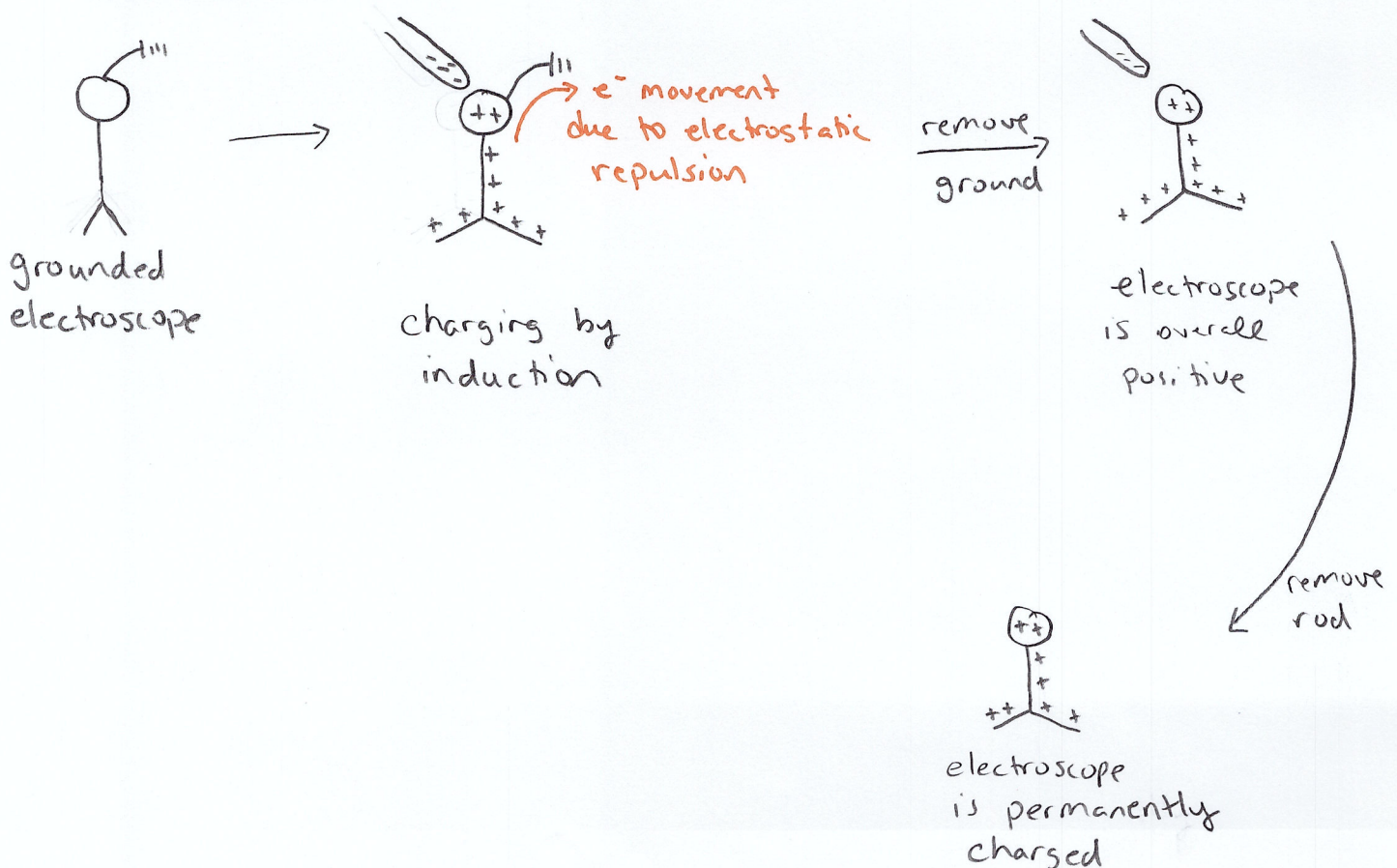
- An electroscope is an instrument used to detect the presence and nature (+ or -) of a charge



- A positively charged rod will attract electrons to the head of the electroscope, leaving the leaves positive and therefore will repel. A negatively charged rod will repel electrons from the head of the electroscope into the leaves, leaving the leaves negative and therefore will still repel.

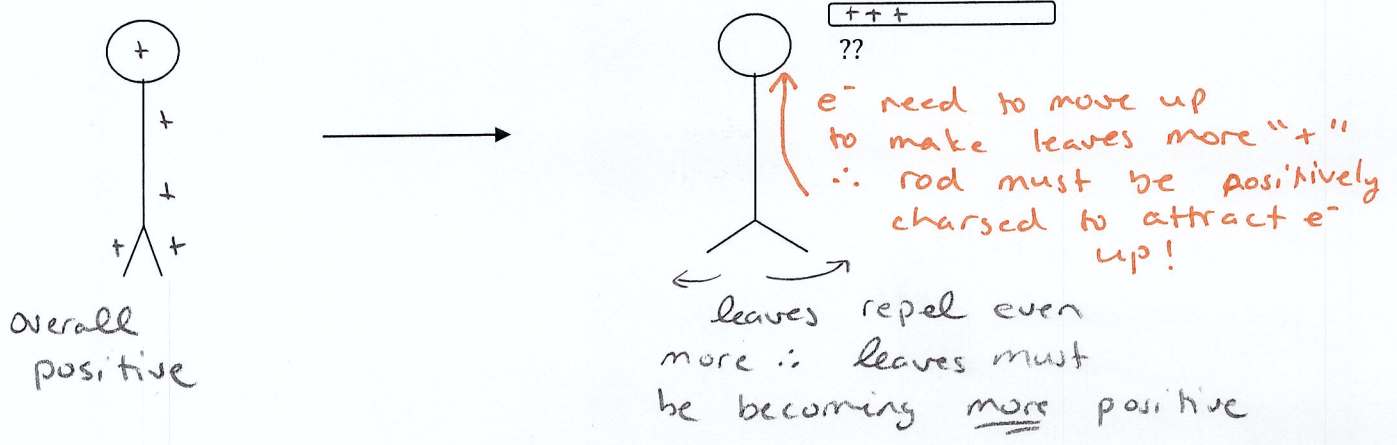


- If an electroscope is charged, it is more useful for determining the nature of a charged object. Inducing a charge on an electroscope can be accomplished by grounding.

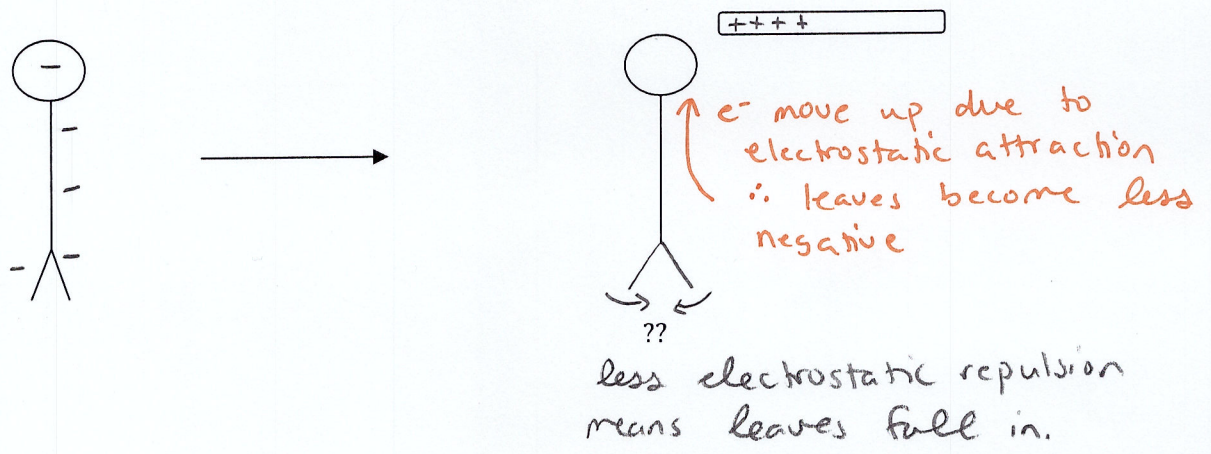


EXAMPLES:

a) If an electroscope is positively charged, determine the charge on the rod.



b) An electroscope is negatively charged and a positively charged rod is brought near the electroscope head. Determine which way the leaves will move.



\*\*\*Now try pg. 84 #10\*\*\*