PHY 1120 - Dr. Rowley

Chapter 18 - Class Expectations

Summer 2020

Introduction

- Dr. Eric Rowley - eric.rowley@wright.edu
- Office: Online
- Office Hours:
  - 11:30 AM - 12:30 PM (M - R),
  - 5:00 PM - 7:00 PM (M - R)
  - **or by appointment**

Course Philosophy

- Collaborative Learning
- Challenging Content
- Opportunity to Learn from Mistakes

Course Structure

- HW is for Completion (and unlocks exam corrections, PSP is for Accuracy.
- Keys will be posted as soon as the assignments are due.
- 4 Exams (instead of 3)
- Calendar and Syllabus will be posted this afternoon.

Course Expectations

- Fast paced - 2-3 chapters a week
- Group learning with Independent assessment
- Trust

Group Work

- A 0.52 kg toy experiences an acceleration of +2.5 m/s^2 in the x-direction and an acceleration of -8.2 m/s^2 in the y-direction.
  - What is the magnitude and direction of the net acceleration of this toy?
  - What is the net force on this toy?

Group Work

- A 0.52 kg toy experiences an acceleration of +2.5 m/s² in the x-direction and an acceleration of -8.2 m/s² in the y-direction. What is the magnitude and direction of the net acceleration of this object?

$$m = 0.52 \text{ kg}$$

$$a_x = +2.5 \, m/s^2$$

$$a_y = -8.2 \, m/s^2$$

$$a_{net} = \sqrt{a_x^{\,2} + a_y^{\,2}}$$

$$a_{net} = \sqrt{\left(2.5 \, m/s^2\right)^2 + \left(-8.2 \, m/s^2\right)^2}$$

$$\boxed{a_{net} = 8.57 \, m/s^2}$$

Group Work

- A 0.52 kg toy experiences an acceleration of +2.5 m/s² in the x-direction and an acceleration of -8.2 m/s² in the y-direction. What is the magnitude and direction of the net acceleration of this object?

$m = 0.52\ \text{kg}$

$a_x = +2.5\ ^{m}/_{s^2}$

$a_y = -8.2\ ^{m}/_{s^2}$

$$a_{net} = 8.57\ ^{m}/_{s^2}$$

$$\theta = \tan^{-1}\left(\frac{a_y}{a_x}\right)$$

$$\theta = \tan^{-1}\left(\frac{8.2\ ^{m}/_{s^2}}{2.5\ ^{m}/_{s^2}}\right)$$

$$\theta_{net} = 73^\circ \text{ below +x-axis}$$

Group Work

- What is the net force on the 0.52kg toy?

$$a_{net} = 8.57\,{}^{m}/_{s^2} \text{ @ } 73° \text{ below +x-axis}$$

$$F_{net} = ma_{net}$$

$$F_{net} = \left(0.52kg\right)\left(8.57\,{}^{m}/_{s^2}\right)$$

$$\boxed{F_{net} = 4.46\,N \text{ @ } 73° \text{ below +x-axis}}$$

Chapter 18 - Objectives

- Illustrate understanding of basic electro-statics including the Inverse Square Law
- Apply Coulomb's Law to determine the force between charged particles
- Compare and Contrast the Universal Law of Gravitation and Coulmob's Law
- Use understanding of Electric Fields to solve force and field problems.
- Solve Electrical Potential problems

History of Electricity

- ~2750 BCE - Ancient Egyptians, Electric Eels
- ~600 BCE - Ancient Mediterraneans, Amber rubbed with cat fur would attract feathers.
- 1600 CE - William Gilbert, English Physicists, first scientific study of static electricity.

History of Electricity

- ~1750 CE - Benjamin Franklin, American Physicist, conducted extensive researching involving electricity.
  - Studied the electrical nature of lightning (kite and key) and examined the nature of the Leyden Jar (to be discussed later)

Nature of Electricity

- Rubber rod rubbed with wool. Glass rod rubbed with silk.

	Glass	Rubber
Glass	None	None
Rubber	None	None

	Glass w/Silk	Rubber w/Wool
Glass w/ Silk	Repel	Attract
Rubber w/Wool	Attract	Repel

Nature of Electricity

- Reaction is not based on the nature of the rods themselves but based on the interaction between the rods and the silk/wool.
- Benjamin Franklin called the charge on Glass, Positive and the charge on Rubber, Negative.
- **Opposites Attract, Likes Repel**

Law of Conservation of Charge

- No net charge can be created or destroyed
- So, charge can only be moved from one region to the next giving localized regions of charge.
- …but, which charge is moving?

DISCUSS

Atomic Theory

- What was the current Atomic Theory when Benjamin Franklin was doing his research? How does that differ from our understanding today?
  - Democritus (~400 BCE) - Atomic Hypothesis
  - Atoms are small indivisible, indestructible fundamental building blocks that make up all things.

Atomic Theory

- Isaac Newton (1704 CE)
  - The mechanical universe is composed of small, solid masses in motion.
- John Dalton (1803 CE)
  - Elements & Compounds

Atomic Theory

- Modern Model: Protons (+) and Neutrons (0) contain the majority of the mass of an atom and reside in the center of the atom. Electrons (-) are much smaller and have much less mass than Protons and Neutrons and exist in probabilistic "clouds" surrounding the nucleus.

Refreshers

$1\,fm = 1x10^{-15}\,m$

- Determine the volume of a proton and the volume of an electron. $r_{proton} = 1$ femtometer, $r_{electron} = 0.001$ fm

$$V = \frac{4}{3}\pi r^3 \qquad r_{proton} = 1x10^{-15}\,m \qquad r_{electron} = 1x10^{-18}\,m$$

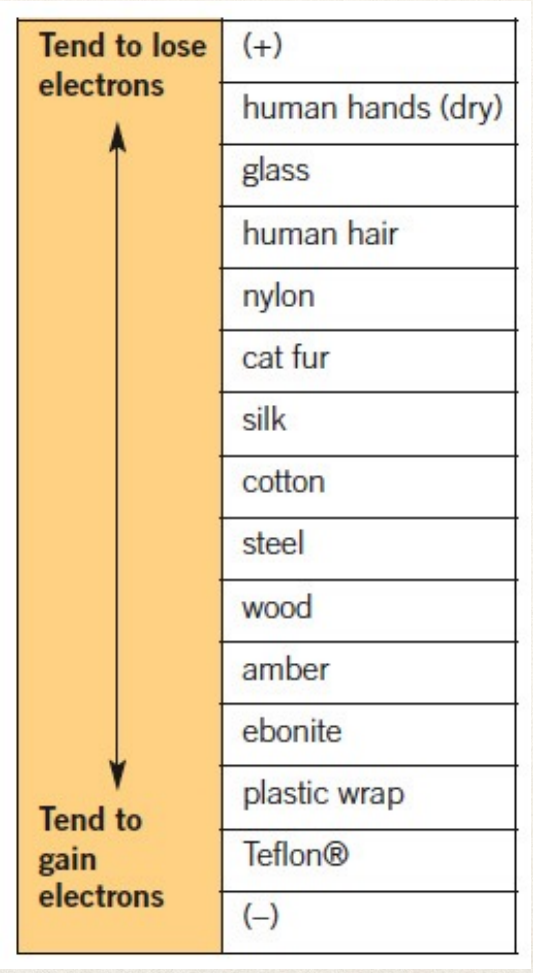
$$V = \frac{4}{3}\pi\left(1x10^{-15}\,m\right)^3 \qquad V = \frac{4}{3}\pi\left(1x10^{-18}\,m\right)^3$$

$$V = 4.19x10^{-45}\,m^3 \qquad V = 4.19x10^{-54}\,m^3$$

Electrons

- Electrical Charge is based on moving electrons.
- Can we explain Franklin's observations?
  - Wool & Rubber
  - Silk & Glass

TriBOELECTICAL Series



Electrons

- If you rub cat fur on glass, which ends up positive, which is negative, and how does the charge move?

Glass = +

Cat Fur = -

Electrons move from Glass to Fur

TriBOELECTICAL Series

Conductors/Insulators

- **Conductors:** Electrons are **free to move** around the material. Charge exists on the surface of the conductor but not within the conductor (Electrostatics)
- Primarily metals, graphite, some specialty ceramics

Conductors/Insulators

- **Insulators:** Electrons are **"locked in"** and not free to move.
- Wood, Glass, Plastic, MOST Ceramics

Conductors/Insulators

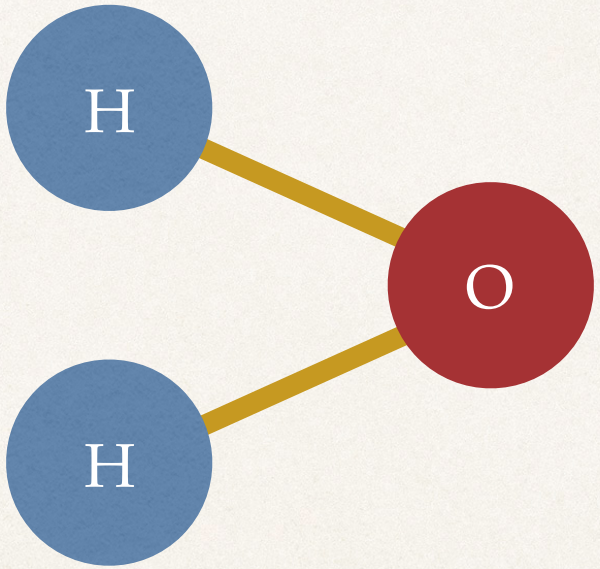
- **Semi-conductors:** Have properties between conductors and insulators. Can be carefully controlled.

Conduction & Induction

- **Conduction** - Charge transfer due to direct contact.
- **Induction** - Separation of charge due to another charge being placed in close proximity to the object of interest.
  - The separation can be permanent if the induction is coupled with conduction.

Polar vs. Non-polar

- Polar Molecules are slightly positive on one end, slightly negative on the other end.

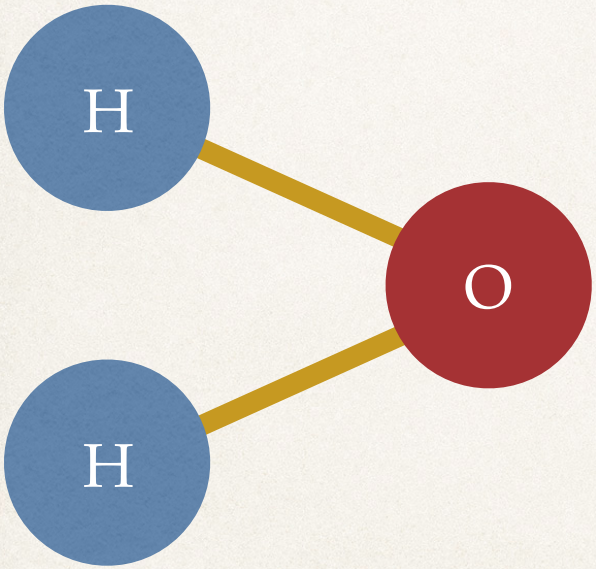


$\delta^+ <—> \delta^-$

Why?

Polar vs. Non-polar

- Polar Molecules are slightly positive on one end, slightly negative on the other end.



- Hydrogen (+1 Ion)
- Oxygen (-2 Ion)

Group Work

- I comb my hair (with a plastic comb) then bring the comb near a stream of water. What is happening here and why? Be as detailed as possible.