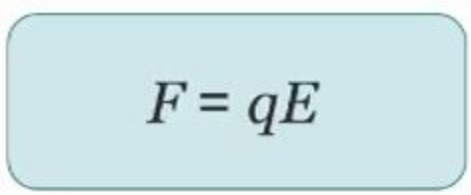
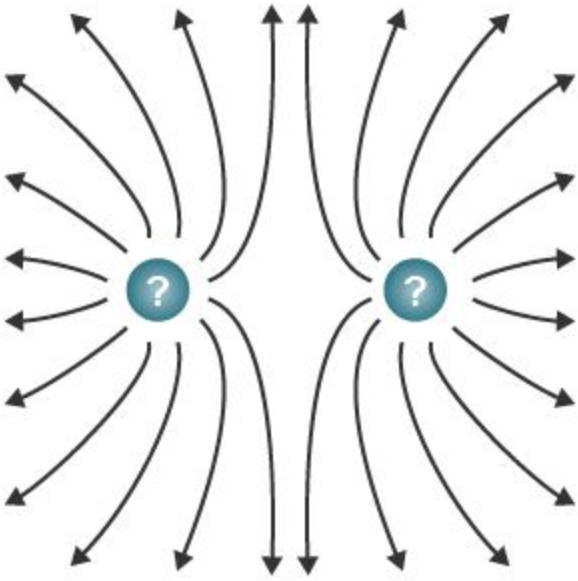
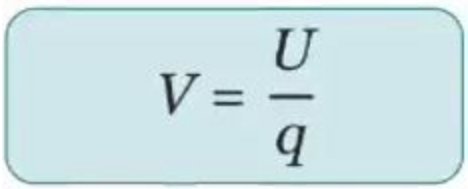
Electrostatics Notes

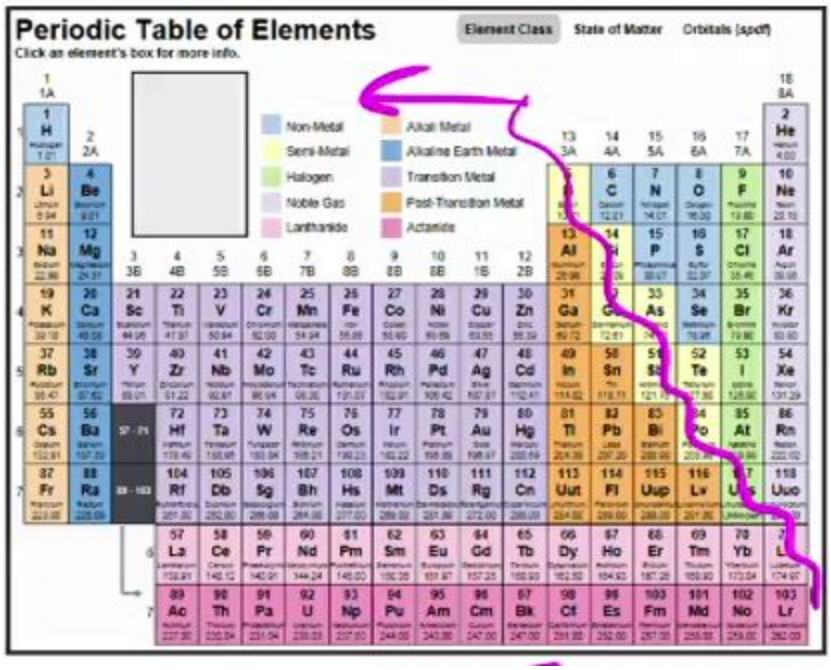
- Electrostatics - study of charged particles at rest
- Ion - atom or molecule with a net charge
    - Due to loss or gain of electrons
    - Can be passed from solar winds or Earth's core
- Question: An oxygen atom picks up two additional, free-floating electrons. Is the charge of the newly formed oxygen ion positive, negative, or neutral?
    - Negative, electrons have negative charges so the more of them you have the more negatively charged the ion will be.
- Electric field - the area around a charged object that can exert a force on other charged objects
- Electric force - force between two charged objects
    - Equation: 
        - F = electric force
            - Unit: N
        - Q = electric charge
            - Unit: coulomb (C)
        - E = electric field
            - Unit: N/C
- Question: A charge of 4.5 × 10^-5 C is placed in an electric field with a strength of 2.0 × 10^4 StartFraction N over C EndFraction. What is the electric force acting on the charge?
    - Given: q = 4.5 × 10^-5 C
      E = 2.0 x 10^4 N/C
    - Unknown: F = ?
    - Equation: F = qE
    - Substitute: F = (4.5 × 10^-5 C)(2.0 x 10^4 N/C)
    - Solve: F = 0.9 N
- Field lines - lines in a diagram that show the direction of flow of the electric field between two charged particles
    - Point away from positive
    - Point toward negative
        - When two charges are near each other:
            - Like charges bend away (repel)
            - Opposite charges combine (attract)

- Question: Based on the field lines, the electric charges indicated by the question marks are _____.



    - The same. Like charges bend away from (repel) each other when they are close.
- Electrically charged particles or ions can behave differently when they enter a magnetic field.
- Electric potential energy - potential energy an electric charge has due to its location in an electric field
    - Equation: $U = Fd$
        - U = electric potential energy
            - Unit: Joule (J)
        - F = electric force
            - Unit: N
        - d = distance between particle and source of electric field
            - Unit: m
- Question: A charge of 4.5 × 10^-5 C is placed in an electric field with a strength of 2.0 × 10^4 N/C. If the charge is 0.030 m from the source of the electric field, what is the electric potential energy of the charge?
    - Given: q = 4.5 × 10^-5 C
      E = 2.0 × 10^4 N/C
      d = 0.030 m
    - Unknown: U = ?
    - Equation: U = qEd

    - Substitute: U = (4.5 × 10^-5 C)(2.0 × 10^4 N/C)(0.030 m)
    - Solve: U = 0.027 J
- Electric potential - electrical potential energy of a charged particle divided by its charge
    - Equation: 
        - V = electric potential
            - Unit: Volt (V)
        - U = electric potential energy
            - Unit: J
        - q = electric charge
            - Unit: C
- Question: What is the electric potential of a 4.5 × 10^-5 C charge that has an electric potential energy of 0.027 J?
    - Given: q = 4.5 × 10^-5 C
      U = 0.027 J
    - Unknown: V = ?
    - Equation: V = U/q
    - Substitute: V = (0.027 J)/(4.5 × 10^-5 C)
    - Solve: V = 600 V
- Conductor - any material that allows electricity or thermal energy to easily move through it
    - Ex. Metals, water, ionic solutions

- 

  - Just about everything to the left of this squiggly line is a metal
- Insulator - material that restricts the flow of electricity or thermal energy
  - Ex. rubber, glass, wood
- Question: Classify each substance as either a conductor or insulator.
  - A sample of mercury:
    - Conductor, it is a metal since it is to the left of the squiggly line
  - A piece of glass:
    - Insulator, that was one of the examples
  - A rubber hose:
    - Insulator, that was one of the examples
  - A negatively ionized lithium paste:
    - Conductor, it is a metal since it is to the left of the squiggly line
- You can charge objects by friction, a.k.a. rubbing things together
  - Ex. rubbing a glass rod with silk causes electrons to go from rod to silk fabric
    - Now the silk is negative and the rod is positive
- Conduction - electrons are transferred from one object to another by direct contact
- Induction - electric charges are transferred with nothing touching