Chapter 10 Review

- Electrical Force – Coulomb's Law

$$F = \frac{kq_1q_2}{R^2} \tag{1}$$

  where k is Coulomb's constant ($k = 8.99 \cdot 10^9 \mathrm{N\,m^2/\,C^2}$), q_1 and q_2 are charges and R is the distance between the charges.
  - The force on particle is towards or away from the charge center of the other particle (don't forget equal and opposite).
  - Doubling either charge doubles the force.
  - Doubling the distance cuts the force to one quarter.

- The Three Rules of Electrostatics
  - There are only two kinds of charge.
  - Two objects charged alike repel each other
  - Two objects charged oppositely attract each other.

- Fields
  - A field is a representation of a function throughout space; a function of x, y and z.
  - A force field represents a force that would affect an appropriate object placed in the field.
  - A scalar field just has a single value at every point.
  - A vector field has a value and a direction at every point. **All force fields are vector fields!**

- Force due to an electric field:

$$\vec{F} = q\vec{E} \tag{2}$$

  - The electric field vector points in the direction that it would push a positive charge.
  - The electric field exists at all points in space.
  - The electric field at some point in space (x, y, z) due to many charges is just the vector sum of the electric field at that point due to each charge (principle of superposition).

- Voltage is the electrical potential difference between two points. The electrical potential *energy* between two points is the voltage times the charge (voltage is independent of the charge).

- Voltage related to electrical potential energy: $\Delta\mathrm{PE} = qV$

- In a constant electric field, the change in potential energy is: $\Delta\mathrm{PE} = qEd$

- Ohm's Law states that the current in a circuit is the voltage driving a circuit divided by the resistance, $I = V/R$, where I is the current in Amperes (A), V is the electrical potential difference in volts (V) and R is the resistance in ohms (Ω).
  - Increasing the voltage **increases** the current.
  - Increasing the resistance **decreases** the current.

- Power generated in a circuit is the current times the voltage ($P = IV$).
- Power dissipated (*i.e.*, turned into heat) by a resistive element of a circuit is $P = I^2R = V^2/R$ where I is the current through the resistor and V is the voltage drop across the resistor. If you use the second form ($P = V^2/R$), make sure that V is the actual voltage drop across the resistor and not the total voltage across the entire circuit.
- The force on a moving charge in a magnetic field is:

$$\vec{F} = kq\vec{v} \times \vec{B} = kqv_{\perp}B \tag{3}$$

- The direction of the force is found using the right hand rule.
  1. Point your fingers in the direction of the velocity of the charged particle.
  2. Curl your fingers in the direction of the magnetic field.
  3. Your thumb points in the force direction.