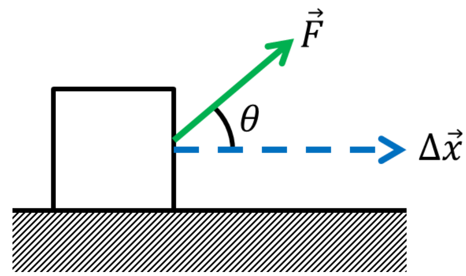
Honors Physics Final Review Summary

Work Done By A Constant Force:

- Work describes a force's tendency to change the speed of an object.

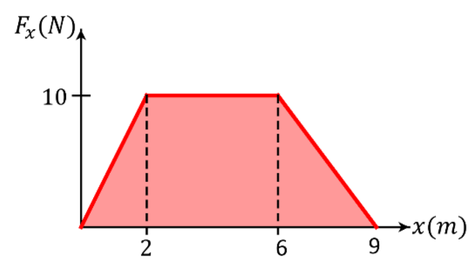
  Work is done only when an object moves in response to a force, and a component of the force points in the direction of the motion.



$$W = F\,\Delta x\cos\theta$$

Work Done By A Variable Force:

- When the forces changes as the object moves, the work done by the force is found by calculating the area under a force vs. position graph.



$$W = Area$$

Work-Energy Theorem:

- The Work-Energy Theorem says:

$$\sum W = \Delta KE$$

  Where $\sum W$ is the total work done by all forces.

- Conservatives forces conserve energy when they do work on a system. Non-conservative forces change the total energy when they do work on a system.

  The change in energy caused by work done by a non-conservative force is given by:

$$\sum W_{n.c} = \Delta E$$

Energy:

- In the absence of non-conservative forces, or when non-conservatives forces do no work on an object, energy is conserved.
  The types of energy we studied this year are:
  - $KE = \frac{1}{2} m\, v^2$ (Kinetic Energy)
  - $PE_g = m\, g\, h$ (Gravitational Potential Energy)
  - $PE_s = \frac{1}{2} k\, (\Delta x)^2$ (Spring Potential Energy)

Power:

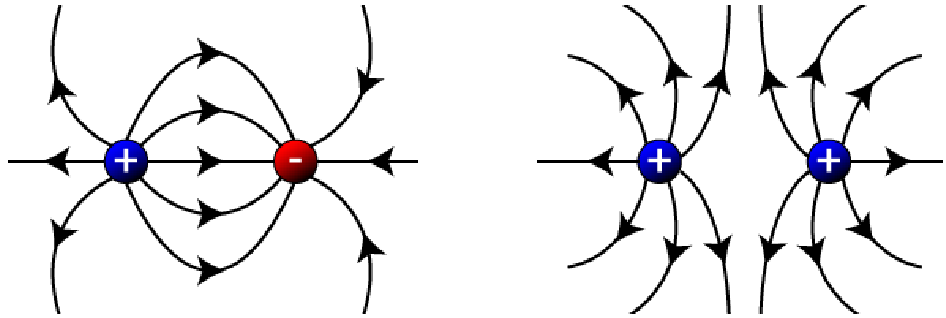
- Power describes the rate at which work is being done. There are several formulas for calculating power, including:
  - $P = \frac{W}{\Delta t}$
  - $P = F\, v$
  - $P = \frac{\Delta E}{\Delta t}$ (For non-conservative)

Electrostatic Force:

- Between point charges:
  - $\left|\vec{F}_C\right| = k \frac{q_1\, q_2}{r^2}$ (Coulomb's Law)
  - Attractive for opposite charges, repulsive for like charges
- Caused by an electric field:
  - $\vec{F}_E = q\, \vec{E}$

Electric Fields:

- The electric field generated by a point charge
  - $E = k \frac{q}{r^2}$ (for point charges)



- Rules for drawing electric field lines:
    1. Point away from positive charges, towards negative charges
    2. Lines start and end on either a charge or at an infinite distance away
    3. Electric field lines never cross

Electrostatic Energy:

- Between point charges:
    - $PE_E = k\frac{q_1 q_2}{r}$

Electrostatic Potential (Voltage):

- Created by a point charge:
    - $V = k\frac{q}{r}$
- Relationship to Energy:
    - $\Delta PE = q\,\Delta V$
- Equipotential lines always point perpendicular to the electric field lines

Electrostatics & Conductors:

- Inside a conductor:
    - $|\vec{E}| = 0\frac{N}{C}$
    - $V = constant$

Current:

- Defined as: $I = \frac{\Delta q}{\Delta t}$

Magnetic Force:

- Force on a moving charge:
  - $F_B = q\ v\ B \sin\theta$
- Force on a wire:
  - $F_B = B\ I\ L \sin\theta$
- The direction of the force is found using the Right Hand Rule:
  1. First point the fingers on the right hand in the direction of the velocity
  2. Orient your hand so that your palm faces the direction of the magnetic field
  3. You thumb will point in the direction of the magnetic force

Circular Motion In a Magnetic Field:

- When a charged particle moves perpendicular to a magnetic field, the particle undergoes circular motion:
  - $q\ v\ B = m\frac{v^2}{r}$

Electromagnetic Induction:

- Magnetic flux describes the amount of magnetic field "flowing" through a surface. The magnetic flux is calculated according to the formula:
  - $\Phi = B\ A \cos\phi$
- A voltage is induced inside a coil when the magnetic flux through the coil changes. The induced voltage is given by the formula:
  - $V = N\frac{\Delta\Phi}{\Delta t}$

  Where Φ is the magnetic flux, and N is the number of turns in the coil.

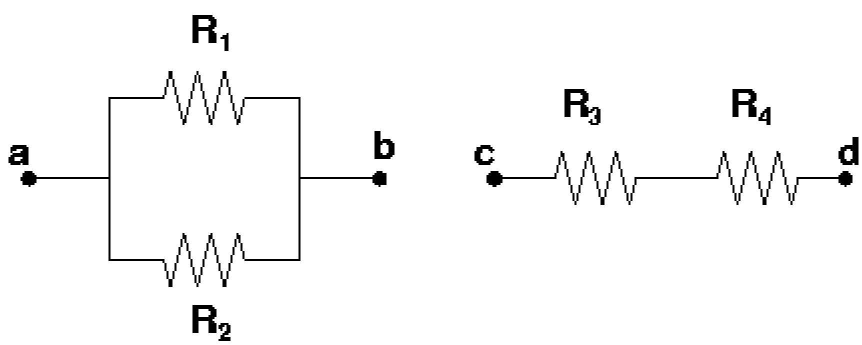
- When a rod, oriented perpendicular to the magnetic field, moves perpendicular to a magnetic field, a voltage is induced across the rod. This voltage is given by:
  - $V = v\ B\ L$

  Where L is the length of the rod.

- When a coil is inside a changing magnetic field, the induced voltage is given by:
  - $V = A\ \left(\frac{\Delta B}{\Delta t}\right)$
- The direction of the current generated by an induced voltage is given by Lenz's Law, which states that the current created by an induced voltage always generates a magnetic field which opposes the change in the magnetic flux.

Resistors:

- Resistance of a wire:
    - $R = \frac{\rho L}{A}$
      Where ρ is the resistivity of the wire, L is its length, and A is its cross-sectional area
- Ohm's Law: $\Delta V = I\,R$
- Power lost inside a resistor:
    - $P = I\,V = I^2 R = \frac{V^2}{R}$
- Equivalent Resistance:
    - $R_{eq} = R_1 + R_2 + \cdots$ (for resistors in series)
    - $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$ (for resistors in parallel)



Parallel Series

Circuits:

- Kirchoff's Laws:
    - Voltage drop around any closed loop in a circuit is always $0\ V$.
    - Current flowing into a junction must equal the current flowing out of the junction
- Measurements:
    - An ammeter is used to measure current
        - The ammeter has very little resistance
        - The ammeter must be connected in series with the circuit
    - A voltmeter is used to measure the voltage drop across a circuit
        - The voltmeter must be connected in parallel with the circuit
        - The voltmeter has a very large resistance

Capacitors:

- In DC circuits, capacitors are used to store energy.
- The charge on the plates of a capacitor is given by:

$$q = \Delta V \cdot C$$

- Capacitance describes the object's ability to hold charge. As a result, capacitance increases when there is more room to hold charge (when A increases), and decreases when the distance between the plates decreases (since the oppositely charged plates are drawn towards each other.) For a parallel plate capacitor:

$$C = \frac{\epsilon_0 A}{d}$$

- The energy stored in a capacitor is given by:

$$PE = \frac{1}{2} q \, \Delta V$$

which we may rewrite as:

$$PE = \frac{C \, (\Delta V)^2}{2} = \frac{q^2}{2\,C}$$