Electricity and Magnetism

C. Electric Circuits *(Ch 18)*

Steady-State Direct Current Circuits with Batteries and Resistors:

Students should understand the behavior of series and parallel combinations of resistors so they can:

- Identify on a circuit diagram whether resistors are in series or in parallel. *(18.2 – 18.3)*
- Determine the ratio of the voltages across resistors connected in series or the ratio of the currents through resistors connected in parallel. *(18.2 – 18.3)*
- Calculate the equivalent resistance of a network of resistors that can be broken down into series and parallel combinations. *(18.2 – 18.3)*
- Calculate the voltage, current, and power dissipation for any resistor in such a network of resistors connected to a single power supply. *(18.2 – 18.3)*
- Design a simple series-parallel circuit that produces a given current through and potential difference across one specified component, and draw a diagram for the circuit using conventional symbols. *(18.2 – 18.3)*

Students should understand the properties of ideal and real batteries so they can:

- Calculate the terminal voltage of a battery of specified emf and internal resistance from which a known current is flowing. *(18.1)*

Students should be able to apply Ohm's Law and Kirchhoff's rules to direct-current circuits in order to determine a single unknown current, voltage, or resistance. *(18.4)*

Students should understand the properties of voltmeters and ammeters so they can: *(17.3)*

- State whether the resistance of each is high or low.
- Identify or show correct methods of connecting meters into circuits in order to measure voltage or current.

Capacitors in Circuits:

Students should be able to analyze circuits containing several capacitors and resistors so they can:

- Determine voltages, currents, and stored charge immediately after a switch has been closed and also after steady-state conditions have been established. *(18.5)*

Equations – Electric Circuits *(Ch 18)*:

$$\frac{1}{R_p} = \sum \frac{1}{R_i} \qquad R_s = \sum R_i$$

D. Magnetic Fields *(Ch 19)*

Forces on Current-Carrying Wires in Magnetic Fields:

Students should understand the force exerted on a current-carrying wire in a magnetic field so they can:

- Calculate the magnitude and direction of the force on a straight segment of current-carrying wire in a uniform magnetic field. *(19.4)*
- Indicate the direction of magnetic forces on a current-carrying loop of wire in a magnetic field, and determine how the loop will tend to rotate as a consequence of these forces. *(19.5)*

D. Magnetic Fields *(Ch 19)* - CONT

Forces on Moving Charges in Magnetic Fields:

Students should understand the force experienced by a charged particle in a magnetic field so they can:

- Calculate the magnitude and direction of the force in terms of *q*, *v*, and *B*, and explain why the magnetic force can perform no work. *(19.3 & 19.6)*
- Deduce the direction of a magnetic field from information about the forces experienced by charged particles moving through that field. *(19.3)*
- Describe the paths of charged particles moving in uniform magnetic fields. *(19.6)*
- Derive and apply the formula for the radius of the circular path of a charge that moves perpendicular to a uniform magnetic field. *(19.6)*
- Describe under what conditions particles will move with constant velocity through crossed electric and magnetic fields.

Fields of Long Current-Carrying Wires:

Students should understand the magnetic field produced by a long straight current-carrying wire so they can:

- Calculate the magnitude and direction of the field at a point in the vicinity of such a wire. *(19.7)*
- Use superposition to determine the magnetic field produced by two long wires. *(19.7)*
- Calculate the force of attraction or repulsion between two long current-carrying wires. *(19.8)*

Equations – Magnetic Fields *(Ch 19)*:

$$F_B = q \cdot v \cdot B \cdot \sin\theta \qquad F_B = B \cdot I \cdot \ell \cdot \sin\theta \qquad B = \frac{\mu_0 \cdot I}{2\pi \cdot r}$$

E. Electromagnetism *(Ch 20)*

Electromagnetic Induction:

Students should understand the concept of magnetic flux so they can:

- Calculate the flux of a uniform magnetic field through a loop of arbitrary orientation. *(20.1)*

Students should understand Faraday's Law and Lenz's Law so they can:

- Recognize situations in which changing flux through a loop will cause an induced emf or current in the loop. *(20.2)*
- Calculate the magnitude and direction of the induced emf and current in: *(20.2 – 20.3)*
  - A square loop of wire pulled at a constant velocity into or out of a uniform magnetic field.
  - A loop of wire placed in a spatially uniform magnetic field whose magnitude is changing at a constant rate.
  - A loop of wire that rotates at a constant rate about an axis perpendicular to a uniform magnetic field.
  - A conducting bar moving perpendicular to a uniform magnetic field.

Equations – Electromagnetism *(Ch 20)*:

$$\phi_m = B \cdot A \cdot \cos\theta \qquad \mathcal{E}_{avg} = -\frac{\Delta\phi_m}{\Delta t} \qquad \mathcal{E} = B \cdot \ell \cdot v$$

*** AP Course Outline information is taken from the Teacher's Guide to Advance Placement Courses in Physics, published by the College Entrance Examination Board and Educational Testing Service. ***