#10 AP-C Current, Resistance and DC Circuits

AP-C Objectives (from College Board Learning Objectives for AP Physics)

1. Current, Resistance, Power
   a. Understand the definition of electric current and relate magnitude and direction of the current to the rate of flow of positive and negative charge.
   b. Understand conductivity, resistivity and resistance.
      i. Relate current and voltage for a resistor.
      ii. Write the relationship between electric field strength and current density in a conductor and describe, in terms of the drift velocity of electrons, why such a relationship is plausible.
      iii. Describe how the resistance of a resistor depends upon its length and cross-sectional area, and apply this result in comparing current flow in resistors of different material or geometry.
      iv. Derive an expression for the resistance of a resistor of uniform cross-section in terms of its dimensions and the resistivity of the material from which it is constructed.
      v. Derive and apply expressions that relate the current, voltage, and resistance to the rate at which heat is produced when current passes through a resistor.
2. Steady-state direct current circuits with batteries and resistors only
   a. Understand the behavior of series and parallel combinations of resistors in order to
      i. Analyze a circuit consisting of both series and parallel resistive elements in order to find current, voltage, resistance, and power dissipated for any/all appropriate elements.
      ii. Design a simple circuit consisting of series and parallel elements to provide a given current through and potential difference across a specified component, and draw a schematic diagram for the circuit.
   b. Understand the properties of ideal and real batteries in order to
      i. Calculate the terminal voltage of a battery of specified emf and internal resistance from which a known current is flowing.
      ii. Calculate the rate at which a battery is supplying energy to a circuit or is being charged up by a circuit.
   c. Apply Ohm's Law and Kirchhoff's Rules to DC circuits in order to:
      i. Determine a single unknown current, voltage, or resistance.
      ii. Set up and solve simultaneous equations to determine two unknown currents.
   d. Understand the properties of voltmeters and ammeters in order to:
      i. State whether the resistance of each type of meter is high or low.
      ii. Identify or demonstrate correct methods of connecting meters into circuits in order to measure voltage or current.
      iii. Assess qualitatively the effect of finite meter resistance on a circuit into which these meters are connected.
3. Capacitors in Circuits
   a. Understand the initial and steady-state behavior of capacitors connected in series or in parallel in order to
      i. Calculate the equivalent capacitance of a series or parallel combination.
      ii. Describe how stored charge is divided between capacitors connected in parallel.
      iii. Determine the ratio of voltages for capacitors connected in series.
      iv. Calculate the voltage or stored charge, under steady-state conditions, for a capacitor connected to a circuit consisting of a battery and resistors.
   b. Understand the charging or discharging of a capacitor through a resistor in order to
      i. Calculate and interpret the time constant of the circuit.
      ii. Sketch or identify graphs of stored charge or voltage for the capacitor or resistor.
      iii. Write expressions to describe the time dependence of the stored charge, voltage, or current for elements in an RC circuit.
      iv. Analyze the behavior of circuits containing several capacitors and resistors, including analyzing or sketching graphs to indicate how voltages, currents, and charges vary with time.