Introduction: DC Circuits

Unit: DC Circuits

Topics covered in this chapter:

This chapter discusses DC Circuits, particularly those containing batteries, resistors and/or capacitors., how they behave, and how they relate to each other.

- *Electric Current & Ohm's Law* describes equations and calculations involving the flow of charged particles (electric current).
- *Electrical Components* shows pictures of and circuit diagram symbols for common electrical components.
- *EMF & Internal Resistance of a Battery* explains the difference between the voltage supplied by the chemical cells in a battery and the voltage that the battery is actually able to supply in a circuit.
- *Circuits*, *Series Circuits*, *Parallel Circuits*, and *Mixed Series & Parallel Circuits* describe arrangements of circuits that contain batteries and resistors (or other components that have resistance) and the equations that relate to them.
- *Measuring Voltage, Current & Resistance* describes how to correctly measure those quantities for components in a circuit.
- *Capacitance* and *Capacitors in Series & Parallel Circuits* describes capacitors and how they behave in circuits.

Use this space for summary and/or additional notes:

- *DC Resistor-Capacitor (RC) Circuits* describes calculations for time-varying circuits that contain a resistor and a capacitor.

One of the new challenges encountered in this chapter is interpreting and simplifying circuit diagrams, in which different equations may apply to different parts of the circuit.

Standards addressed in this chapter:

MA Curriculum Frameworks (2016):

HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-1. Use algebraic expressions and the principle of energy conservation to calculate the change in energy of one component of a system when the change in energy of the other component(s) of the system, as well as the total energy of the system including any energy entering or leaving the system, is known. Identify any transformations from one form of energy to another, including thermal, kinetic, gravitational, magnetic, or electrical energy, in the system.

HS-PS3-2. Develop and use a model to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles and objects or energy stored in fields.

HS-PS3-5. Develop and use a model of magnetic or electric fields to illustrate the forces and changes in energy between two magnetically or electrically charged objects changing relative position in a magnetic or electric field, respectively.

Use this space for summary and/or additional notes:

AP® only
AP® only

AP® Physics 2 Learning Objectives:

1.E.2.1: The student is able to choose and justify the selection of data needed to determine resistivity for a given material. [**SP 4.1**]

4.E.4.1: The student is able to make predictions about the properties of resistors and/or capacitors when placed in a simple circuit, based on the geometry of the circuit element and supported by scientific theories and mathematical relationships. [**SP 2.2, 6.4**]

4.E.4.2: The student is able to design a plan for the collection of data to determine the effect of changing the geometry and/or materials on the resistance or capacitance of a circuit element and relate results to the basic properties of resistors and capacitors. [**SP 4.1, 4.2**]

4.E.4.3: The student is able to analyze data to determine the effect of changing the geometry and/or materials on the resistance or capacitance of a circuit element and relate results to the basic properties of resistors and capacitors. [**SP 5.1**]

4.E.5.1: The student is able to make and justify a quantitative prediction of the effect of a change in values or arrangements of one or two circuit elements on the currents and potential differences in a circuit containing a small number of sources of emf, resistors, capacitors, and switches in series and/or parallel. [**SP 2.2**, **6.4**]

4.E.5.2: The student is able to make and justify a qualitative prediction of the effect of a change in values or arrangements of one or two circuit elements on currents and potential differences in a circuit containing a small number of sources of emf, resistors, capacitors, and switches in series and/or parallel. [**SP 6.1**, **6.4**]

4.E.5.3: The student is able to plan data collection strategies and perform data analysis to examine the values of currents and potential differences in an electric circuit that is modified by changing or rearranging circuit elements, including sources of emf, resistors, and capacitors. [**SP 2.2**, **4.2**, **5.1**]

5.B.9.4: The student is able to analyze experimental data including an analysis of experimental uncertainty that will demonstrate the validity of Kirchhoff's loop rule. [**SP 5.1**]

5.B.9.5: The student is able to use conservation of energy principles (Kirchhoff's loop rule) to describe and make predictions regarding electrical potential difference, charge, and current in steady-state circuits composed of various combinations of resistors and capacitors. [**SP 6.4**]

5.B.9.6: The student is able to mathematically express the changes in electric potential energy of a loop in a multi-loop electrical circuit and justify this expression using the principle of the conservation of energy. [**SP 2.1**, **2.2**]

Use this space for summary and/or additional notes:

AP® only

5.B.9.7: The student is able to refine and analyze a scientific question for an experiment using Kirchhoff's Loop rule for circuits that includes determination of internal resistance of the battery and analysis of a non-ohmic resistor. [**SP 4.1**, **4.2**, **5.1**, **5.3**]

5.B.9.8: The student is able to translate between graphical and symbolic representations of experimental data describing relationships among power, current, and potential difference across a resistor. [**SP 1.5**]

5.C.3.4: The student is able to predict or explain current values in series and parallel arrangements of resistors and other branching circuits using Kirchhoff's junction rule and relate the rule to the law of charge conservation. [**SP 6.4**, **7.2**]

5.C.3.5: The student is able to determine missing values and direction of electric current in branches of a circuit with resistors and ***no*** capacitors from values and directions of current in other branches of the circuit through appropriate selection of nodes and application of the junction rule. [**SP 1.4**, **2.2**]

5.C.3.6: The student is able to determine missing values and direction of electric current in branches of a circuit with ***both*** resistors ***and*** capacitors from values and directions of current in other branches of the circuit through appropriate selection of nodes and application of the junction rule. [**SP 1.4**, **2.2**]

5.C.3.7: The student is able to determine missing values, direction of electric current, charge of capacitors at steady state, and potential differences within a circuit with resistors and capacitors from values and directions of current in other branches of the circuit. [**SP 1.4**, **2.2**]

Topics from this chapter assessed on the SAT Physics Subject Test:

- **Circuit Elements and DC Circuits**, such as resistors, light bulbs, series and parallel networks, Ohm's law, and Joule's law.
- **Capacitance**, such as parallel-plate capacitors and time-varying behavior in charging/ discharging.

1. Voltage
2. Current
3. Resistance
4. Energy & Power
5. Circuits
6. Capacitors

Skills learned & applied in this chapter:

- Working with material-specific constants from a table.
- Identifying electric circuit components.
- Simplifying circuit diagrams.

Use this space for summary and/or additional notes: