Alignment to Next Generation Science Standards*

- MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meeting the criteria for success.
- MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Lesson 3 is designed to support students in meeting NGSS performance expectation MS-PS3-3. In Getting Started, students read about the differences between thermal energy, temperature, and heat. In Investigation 3.1, students observe how devices in circuits transfer thermal energy. Then in Investigation 3.2, students apply what they have learned to design and build a device that either maximizes or minimizes the transfer of thermal energy to the surroundings.

During Investigation 3.2, students begin to build a foundation for meeting NGSS performance expectations MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4, and they will continue to develop the engineering practices throughout the unit. In this lesson, they work with their groups to define the design criteria for their systems, build their systems, collect and analyze data to determine how well their designs met their goals, and make changes or refinements to their designs based on their findings.

This lesson incorporates several science and engineering practices. During Getting Started, students construct explanations of how a resistor functions in a circuit. By building a device that maximizes or minimizes thermal energy transfer in Investigation 3.2, students define a design problem, design a solution to that problem, develop a model of their system for testing, and analyze data from testing to determine necessary modifications. During Investigation 3.1, students plan and carry out an investigation to determine the amount of thermal energy transferred by different types of lightbulbs. In addition, students engage in argument from evidence regarding transformations of energy and the law of conservation of energy. Finally, students obtain, evaluate, and communicate information about the potential uses of different types of lightbulbs.

The content of the lesson helps students deepen their understanding of multiple crosscutting concepts, with an emphasis on energy and matter. Students learn the definition of thermal energy and distinguish thermal energy and heat from temperature. Students gain experience with these concepts as they design tests to investigate thermal energy transformations and transfers in Investigations 3.1 and 3.2. Students also relate the function of resistors to the thermal energy transferred by the resistor to its surrounding environment in Getting Started. In addition, students read about the law of conservation of energy and cite evidence from their investigations that supports this law. Students also complete a reading about the Celsius and Fahrenheit temperature scales for Show What You Know (or homework) and assess cause-and-effect relationships throughout the lesson.