Eighth Grade Science
Unit 2: Thermal Energy
Number of Days: 35

Unit Focus	Essential Questions	Next Generation Standards	Disciplinary Core Ideas(DCI)
In this final unit of study, students *ask questions, plan and carry out investigations, engage in argument from evidence, analyze and interpret data, construct explanations, define problems and design solutions* as they make sense of the difference between energy and temperature. They use the practices to make sense of how the total change of energy in any system is always equal to the total energy transferred into or out of the system.	• **How is temperature related to kinetic energy?** • **How can a standard thermometer be used to tell you how particles are behaving?** **Links to Unit 2** **https://njctl.org/courses/science/8th-grade-science/thermal-energy/attachments/thermal-energy-unit-plan/** *All teachers must register at https://njctl.org	**MS-PS3-3** **MS-PS3-4** **MS-ETS1-1** **MS-ETS1-2** **MS-ETS1-3** **MS-ETS1-4**	• **PS3.A: Definitions of Energy** • **PS3.B: Conservation of Energy and Energy Transfer** • **PS3.C: Relationship Between Energy and Forces** • **ETS1.A: Defining and Delimiting Engineering Problems** • **ETS1.B: Developing Possible Solutions** • **ETS1.C: Optimizing the Design Solution**

NGSS Framework		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4) **Constructing Explanations and Designing Solutions** • Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3) **Asking Questions and Defining Problems** • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Developing and Using Models** • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) **Engaging in Argument from Evidence**	**PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)	**Scale, Proportion, and Quantity** • Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-4) **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3) **Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) • The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

• Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	• There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) • Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

Unit 2a: Conservation of Energy

Standard(s):

- **MS-PS3-3-ENERGY**-*Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*
- **MS-ETS1-1-ENGINEERING DESIGN -** *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-ETS1-4-ENGINEERING DESIGN-***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.*
- **MS-ETS1-2- ENGINEERING DESIGN** *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.*

Student Outcomes	Inquiry Based Learning Activities	Materials/Resources
Students will know that: • The Law of Conservation of Energy states that energy can be transferred from one type to another. The difference between renewable and non-renewable energy sources. • How different types of energy resources convert mechanical energy into electrical energy. **Students will be able to:** • ***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.	***STEM EDA-Explore Alternative Energy-Temperature & Solar Cooker*** **http://nicerc.org/product/6th-grade-explore-alternative-energy/** • ***Temperature and KE Lab****-Lab questions/**write up** **https://njctl.org/courses/science/8th-grade-science/thermal-energy/attachments/temperature-and-ke-lab/** • ***Thermal Energy Transfer Lab**** **https://njctl.org/courses/science/8th-grade-science/thermal-**	**Explore Alternative Energy-Solar Cooker-nicerc.org** • stop watch • thermometer • aluminum foil • chocolate bar • poster board • cotton balls • bubble wrap • cling wrap • plastic bags • glass jars

• ***apply*** scientific principles to design, construct, and test a device (e.g. solar cooker/insulated box), that either minimizes or maximizes thermal energy transfer. • ***Construct,*** use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.	**energy/attachments/thermodynamics-lab-teacher-file/** • ***Conductors and Insulators Lab****-Lab questions/ **write up** **https://njctl.org/courses/science/8th-grade-science/thermal-energy/attachments/conductors-insulators-lab/**	• plastic cups • paper plates • foam board • black paint • cardboard boxes **Temperature and KE Lab** • hot water in a clear cup* • cold water in a clear cup* • food coloring **Thermal Energy Transfer Lab** • lab sheet • 2 paper cups • dry sand • Thermometers • masking tape • scissors **Conductors and Insulators Lab** • lab sheet • spoons of varying materials (wood, stainless steel, aluminum, plastic, china) • large bowl full of ice ***Resources:*** • **www.NJCTL.org** • **www.nicerc.org**

		• **http://www.ck12.org/** **Additional Technology Resources:** • ***Explore Learning*** • ***Nearpod.com*** • ***Edpuzzle.com*** • ***Brainrush.com*** • ***YouTube*** • ***Phet*** • ***Teacher Tube***

Differentiated Instruction: • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Provide ELL students with multiple literacy strategies.	**ELL Modifications:**

• Structure the learning around explaining or solving a social or community-based issue. • Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)	

Assessments:

- **DOQ-Edconnect**

Unit 2b: Relationship between Energy and Forces

Standard(s):

- **MS-PS3-3-ENERGY**-*Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*
- **MS-ETS1-1-ENGINEERING DESIGN -** *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-ETS1-4-ENGINEERING DESIGN-***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.*
- **MS-ETS1-2- ENGINEERING DESIGN** *Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.*

Student Outcomes	Inquiry Based Learning Activities	Materials/Resources
Students will know that: • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the	• ***Thermal Energy transfer Lab 2 **** **https://njctl.org/courses/science/8th-grade-science/thermal-energy/attachments/thermodynamics-lab-teacher-file/** • ***Thermodynamics*** **https://njctl.org/courses/science/8th-grade-science/thermal-energy/attachments/conductors-insulators-lab/**	**Materials Needed:** **Thermal Energy Transfer Lab 2*** • lab sheet • 2 paper cups • dry sand • Thermometers • masking tape • scissors **Thermodynamics Lab** • 2 paper cups • dry sand • thermometers • masking tape scissors

environment. (MS-PS3-4)

- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

Students will be able to:

- ***apply*** scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- ***plan*** an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
- ***construct,*** use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Resources:

- **www.NJCTL.org**
- **www.nicerc.org**
- **www.PSI-Algebra Based Physics: Kinematics YouTube**
- **http://www.ck12.org/**
- **http://bpsscience.weebly.com/science-and-literacy-close-reading-cwa--more.html**

Additional Technology Resources:

- ***Explore Learning***
- ***Nearpod.com***
- ***Edpuzzle.com***
- ***Brainrush.com***
- ***YouTube***
- ***Phet***
- ***Teacher Tube***

Differentiated Instruction:

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids;

ELL Modifications:

pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Provide ELL students with multiple literacy strategies. • Structure the learning around explaining or solving a social or community-based issue. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)	

Assessments:

- **DOQ-Edconnect**