Unit3: How can we get energy to flow from one place to another?

Content Area:	**Science**
Course(s):	
Time Period:	**MP3**
Length:	**45 days**
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NJSLS - Science

9-12.HS-PS2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
9-12.HS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
9-12.HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
9-12.HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

Science and Engineering Practices

Planning and Carrying Out Investigations

Plan and conduct an invasion individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, me), and refine the design accordingly. (HS-PS2-5), (HS-PS3-4)

Using Mathematics and Computational Thinking

Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)

Constructing Explanations and Designing Solutions

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3)

Disciplinary Core Ideas

PS2.B: Types of Interactions

Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-5)

PS3.A: Definitions of Energy

Energy is a quantile property of a system that depends on the moon and interactions of matter and radiation within that system. That there is a single quantity called energy is because a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1)

At the macroscopic scale, energy manifests itself in multiple ways, such as in the moon, sound, light, and thermal energy. (HS-PS3-3)

PS3.B: Conversion of Energy and Energy Transfer

Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)

Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4)

Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged parcels, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)

The availability of energy limits what can occur in any system. (HS-PS3-1)

Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, and objects higher than their surrounding environment cool down). (HS-PS3-4)

PS3.D: Energy in Chemical Processes and Everyday Life

Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3), (HS-PS3-4)

Crosscutting Concepts

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5)

Systems and System Models

When investing or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4)

Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)

Energy and Matter

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3)

Influences of Science, Engineering, and Technology on Society and the Natural World

Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)

Rationale and Transfer Goals

This unit focuses on developing student understanding of how energy flows. Energy is quantile and depends on the moon and interactions of matter and radiation within the system. Students will develop an understanding of thermodynamics, focusing on the first two laws, and examining all types of energy, especially the relationship between heat and chemical energy in a region. Students will be able to use mathematical representations to describe energy changes both conceptually and quantitively. This unit will also explore how an electric current can produce a magnetic field and how energy flows in and out of a system including devices like solar cells, solar ovens, and generators.

Enduring Understandings

- The first law of thermodynamics: heat is a form of energy, and in thermodynamic processes, energy is conserved.

- Entropy is a thermodynamic property related to how the energy of a system is distributed among the available energy levels.
- The second law of thermodynamics: the total entropy of an isolated system can never decrease over me, and is constant if all processes are reversible.
- A system is the part of the universe chosen for study. There are open systems, closed systems, and isolated systems.
- The surroundings are the part of the universe outside of the system with which the system interacts.
- Energy is the ability to do work. Kinetic energy is a moving object and thermal energy is the kinetic energy associated with a random molecular moon.
- Potential energy is the energy associated with forces of aracon or repulsion between objects.
- Chemical energy is associated with chemical bonds and intermolecular aracons.
- The relationship between electric currents and magnetic fields.
- Thermochemical measurements and calculations are used to assess materials as energy sources.

Essential Questions

- How can we get energy to flow from one place to another?
- Why is energy conserved in a reaction?
- How can entropy be quantified?
- What determines a system or surroundings?
- What types of energy are involved in chemical reactions?
- What is the relationship between electric currents and magnetic fields?

Content - What will students know?

- The difference between a system and the surroundings and that the total energy is conserved in an isolated system. (Law of Conservation of Energy)
- How energy is converted from one form to another (ex: potential to kinetic, kinetic to chemical)
- Create a computational model and apply it to the change in energy of a component of a system when other energies and energy flows are known.
- The second law of thermodynamics: When two components of different temperatures are combined within a closed system results in a uniform energy distribution throughout the components in the system.

Skills - What will students be able to do?

- Define and give examples of systems and surroundings as well as explain the law of conservation of energy and calculate the change in thermal energy of a system.
- Design and build a device that converts energy from one form to another - identifying forms of energy being converted in the system and losses of energy by the design system to the surroundings.
- Use a computational model to calculate the changes in the energy of a component of a system and

predict the maximum possible change in energy of one component when other energies and energy flows are known.
- If a hot object comes in contact with a cold object, the thermal energy lost by the hot object will equal the amount gained by the cold.

Activities - How will we teach the content and skills?

- Students will complete a similar acvity titled “Energy Changes in Chemical Reactions.” [Link] This acvity shows how energy transforms but is conserved.
- Students will use the materials provided to build a device that will convert energy from one form to another. Students will first research and define multiple types of energy and then apply the research to their devices.
- Students will create a model using a computer program (ex: Excel) based on the principle of the conservation of energy. Students will be able to manipulate the model to determine a component of the system’s energy (with other energies known.)
- Students will perform a laboratory acvity to understand the transfer of thermal energy collecting data including the masses of the components and the initial and final temperatures. Students will evaluate their invasion including the accuracy and precision of the data. [Link]

Evidence/Assessments - How will we know what students have learned?

- Students will complete a laboratory acvity to collect and record data that will be used to calculate a change in thermal energy. Students will evaluate their invasion including the accuracy and precision of the data and discuss the limitaons of the experiment as well as sources of error.
- Students will give a short presentation of the designed device.
- Students will take an assessment calculating a change in energy of a component (when other energies are known) as well as on entropy and the second law of thermodynamics.
- Chemistry Unit 3 Benchmark

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Energy is a quantile property of a system that depends on the moon and interactions of matter and radiation within that system. • In an endothermic reaction thermal energy flows out to	• Energy has multiple forms including moon, sound, light, and thermal energy. In an isolated system, energy is conserved. • In a chemical reaction, energy can flow into the system or out to the	• Students will complete a self-guided POGIL acvity on the types of energy and identifying systems and surroundings. • Students will reexamine energy level diagrams of reasons and explain the

the surroundings. In an exothermic reaction thermal energy flows into the system. • Electric current produces a magnetic field and energy transfer can occur through fields.	surroundings. • Electric current is the rate of flow of electric charge.	flow of energy for a particular chemical reaction. • Students will complete a laboratory acvity titled “Energy Transfer Invesgaon.” [Link] Students will be able to determine the flow of energy transfer as well as the conversion from kinetic to thermal energy

Key Resources

Dynamic Periodic Table [Link]

POGIL: Process-Oriented Guided Inquiry Learning [Link]

PhET Simulations [Link]

American Association of Chemistry Teachers [Link]

Career Readiness, Life Literacies, & Key Skills

TECH.9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a,

	7.1.AL.PRSNT.2).
TECH.9.4.12.IML.6	Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5).

Interdisciplinary Connections/Companion Standards