Mini-Map for SCI.EE.12.PS.Energy-1

Subject: Science
Physical Science (PS)
Grade band: 9–12

Grade-Level Expectation

DLM Essential Element	DLM Disciplinary Core Idea Family[1]	Framework Disciplinary Core Ideas
SCI.EE.12.PS.Energy-1 Gather data to describe the thermal energy transfer between two objects or substances in contact with each other.	Physical Science – Energy	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS4.A: Wave Properties

[1] DLM Science Essential Elements organize Disciplinary Core Ideas (defined in the *Framework for K-12 Science Education*) into DCI families. By combining similar concepts within a domain, science content from the general education standards is reduced in depth, breadth, and complexity to provide access for students that qualify for the DLM alternate assessment.

Linkage Level Descriptions

Initial Precursor	Distal Precursor	Proximal Precursor	Target[2]
Recognize that the presence or features of objects can change.	Identify the relationship between energy and the sensing of heat (i.e., energy is needed to heat things up and the greater the heat sensed within the things, the greater the energy within those things).	Based on temperature data, describe the relative amounts of thermal energy (i.e., heat) within objects, changes in thermal energy within objects, and the transfer of thermal energy between objects.	Use initial and final temperature measurements from tests to describe the thermal energy transfer that occurs between objects and/or substances in contact with each other.

[2] The target linkage level description is a measurement target that describes the expectations (content and performance) of the Essential Element for assessment purposes.

Essential Element Three Dimensions

Each Essential Element is defined in the three dimensions described in the *Framework for K-12 Science Education*: disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). The table below lists the details of each dimension from the individual DLM Essential Element descriptions, with color-coding of dimensions corresponding to the Next Generation Science Standards (NGSS). The first row (in blue) lists the SEP(s) used to construct the Essential Element and describes ways each SEP could be incorporated. The second row (in orange) describes the science concepts within the DCI family related to this Essential Element. The third row (in green) lists the CCC(s) associated with the Essential Element and explains how each might be incorporated in the grade band (quoted from NSTA, 2013, matrix of CCCs). Note that the SEP is presented first here (rather than second, as it is in the full list of Essential Elements) to reflect the emphasis on practices in instruction and across the linkage levels. The final row (in white) includes examples of how the three dimensions could work together to support instruction for the Essential Element. These examples provide ideas for integrating the dimensions and are not exhaustive, nor are they intended to limit instruction.

Science and Engineering Practices	**Planning and Carrying Out Investigations:** Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions. • Manipulate variables and collect data to serve as evidence for claims about the natural world. • Gather and use data to inform the improvement of a design solution. **Analyzing and Interpreting Data:** Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world. • Represent and analyze data to determine and describe relationships between variables. • Use data to construct and evaluate arguments. • Analyze data to design and evaluate solutions to problems. **Constructing Explanations and Designing Solutions:** Constructing explanations and designing solutions in grades 9–12 builds on K–8 experiences and progresses to constructing and evaluating explanations about processes or relationships in the natural or designed world. • Gather and use information to construct descriptions and explanations of processes and relationships in the natural world. • Use data and models to evaluate and improve design solutions.

Disciplinary Core Ideas	**Energy** • Energy can neither be created nor destroyed (see SCI.EE.8.PS.Energy-2). • The term heat refers to the motion of particles of matter (i.e., the thermal energy of matter). The particles of hot substances move more or faster relative to particles of cold substances (see SCI.EE.8.PS.Energy-1). o The higher the total kinetic energy of particles of objects, the higher the temperature (i.e., thermal energy of matter). • Heat, or thermal energy, can be transferred from one object or substance to another when those objects or substances are in contact and are at different temperatures. o When two objects or particles are in contact, each one exerts a force on the other that can cause kinetic energy to be transferred from one of the objects or particles to the other (see SCI.EE.8.Energy-2 and SCI.EE.8.PS.Forces-2). o Heat energy continuously flows from hotter objects (i.e., objects comprised of particles moving more or faster) to cooler objects (i.e., objects comprised of particles moving less or slower) until those objects are at equal temperatures (i.e., their comprising particles have equal, average kinetic energy). • The type of matter (i.e., particles) comprising an object or substance, the size or amount of the object or substance, and the temperature of the environment in which the object or substance is found affect the amount of heat (i.e., thermal energy transfer) needed to change the object's or substance's temperatures. o A substance may absorb heat without a change in temperature by changing its state of matter (i.e., melting, boiling, and condensing) (see SCI.EE.8.PS.Matter-1).
Crosscutting Concepts	**Cause and Effect: Mechanism and Explanation**: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects.

	Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change. • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. • Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. • Patterns observable at one scale may not be observable or exist at other scales. • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). **Systems and System Models**: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. • Systems can be designed to do specific tasks. • When investigating 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. • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. • 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. **Energy and Matter: Flows, Cycles, and Conservation**: Tracking energy and matter flows into, out of, and within systems helps one understand their system's behavior. • The total amount of energy and matter in closed systems is conserved. • 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. • Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. • Energy drives the cycling of matter within and between systems.

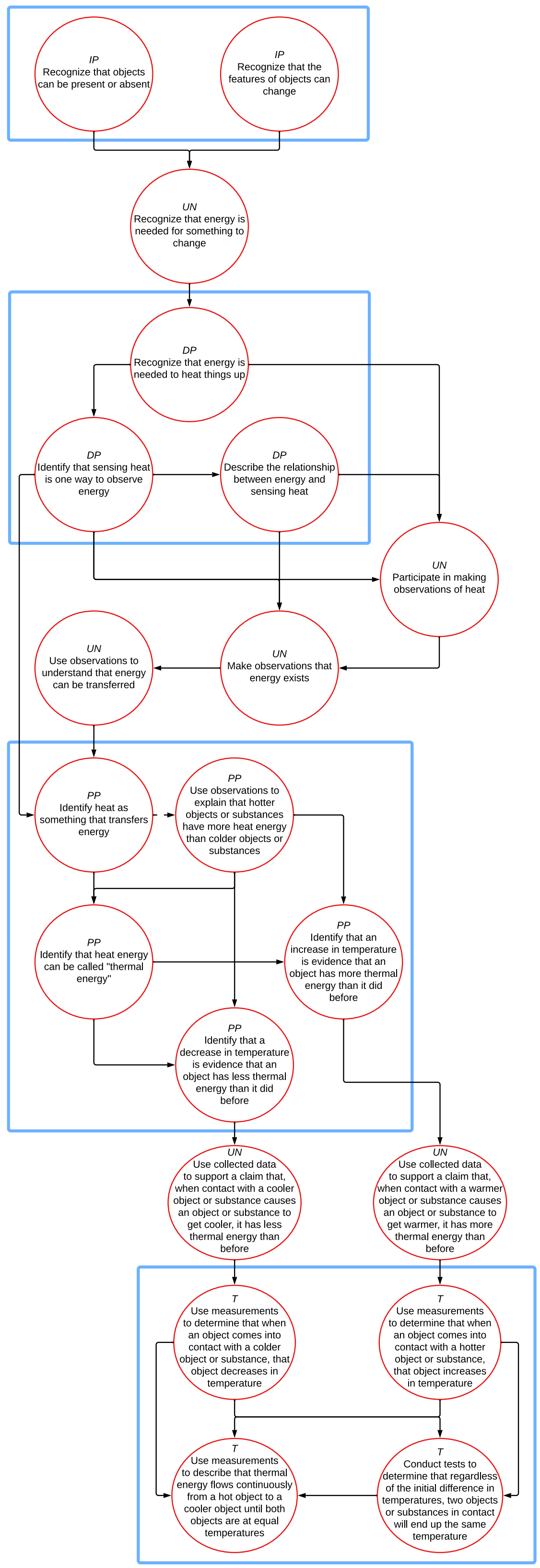
	• In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
How three dimensions support instruction for this Essential Element	Students can learn about cause-and-effect relationships through investigations of thermal energy in substances or objects in contact with one another. They can come to understand that thermal energy flows from hotter things to cooler ones and that the more thermal energy an object or substance has, the warmer it will be. Data can be used to describe that a substance may absorb heat without a change in temperature when a change of state occurs. Students come to understand that faster-moving particles in a substance result in higher temperatures and that a change of thermal energy may result in matter undergoing a change of state. The concepts of systems and system models can support student understanding that thermal energy transfers from one object or substance to another when they are in contact and at different temperatures. This flow of energy within the system can be observed through analysis and interpretation of collected data. By analyzing data, students can observe that a closed system does not gain (create) or lose (destroy) energy, but that energy is transferred within the system. Concepts related to scale, proportion, and quantity are connected to students learning that when a greater quantity of particles of matter move, the greater the change in temperature (i.e., temperature is directly related to the average kinetic energy of particles, meaning more particles moving results in a larger overall change in temperature). Students can use measurements of changes in thermal energy when objects are in contact as data to support a claim that different objects or substances may require different amounts of heat for a change in temperature.

Instructional Resources

Resources
Learning modules and additional science instructional resources can be found at https://www.dlmpd.com/science/
A glossary defining key science terms found in the Essential Elements can be found at DLM Glossary for Science Learning Maps.

[Link to Text-Only Map]

SCI.EE.12.PS.Energy-1 Gather data to describe the thermal energy transfer between two objects or substances in contact with each other.



Map Key	
IP	Initial Precursor
DP	Distal Precursor
PP	Proximal Precursor
T	Target
UN	Untested
→	Direct Connection
- - →	Indirect Connection that omits intervening node(s)

Boxes show nodes in each linkage level