Important Concepts Energy 9-12 Level	Alaska Science Content Standard **B2** Students develop an understanding that energy appears in different forms, can be transformed from one form to another, can be transferred or moved from one place or system to another, may be unavailable for use, and is ultimately conserved. Alaska Science Content Standard **B3** Students develop an understanding of the interactions between matter and energy, including physical, chemical, and nuclear changes, and the effects of these interactions on physical systems. (partially addressed)

Grade Level Expectations:

The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by:
[9] SB2.1 applying the concepts of heat transfer (i.e., conduction, convection, radiation) to Alaskan dwellings
[9] SB2.2 recognizing simple electrical circuits
[10] SB2.1 examining energy (i.e., nuclear, electromagnetic, chemical, mechanical, thermal) transfers, transformations, and efficiencies by comparing useful energy to total energy
[11] SB2.1 demonstrating energy (e.g., nuclear, electromagnetic, chemical, mechanical, thermal) transfers and transformations by comparing useful energy to total energy (entropy) (**L**)

The student demonstrates an understanding of the interactions between matter and energy and the effects of these interactions on systems by:
9] SB3.2 explaining that in chemical and nuclear reactions, energy (e.g., heat, light, mechanical, and electrical) is transferred into and out of a system
[11] SB3.2 researching applications of nuclear reactions in which a small amount of matter is converted directly into a huge amount of energy (i.e., E=MC2) (**L**)

According to AAAS's Benchmarks for Science Literacy*, some of the things that students should know and understand by the end of the twelfth grade are:

- Although the various forms of energy appear very different, each can be measured in a way that makes it possible to keep track of how much of one form is converted into another. Whenever the amount of energy in one place diminishes, the amount in other places or forms increases by the same amount.
- In any system of atoms or molecules, the statistical odds are that the atoms or molecules will end up with less order than they originally had and that the thermal energy will be spread out more evenly. The amount of order in a system may stay the same or increase, but only if the surrounding environment becomes even less ordered.
- The total amount of order in the universe always tends to decrease.

*Project 2061, American Association for the Advancement of Science, Benchmarks for Science Literacy. New York: Oxford University Press, 1993.

- As energy spreads out, whether by conduction, convection, or radiation, the total amount of energy stays the same. However, since it is spread out, less can be done with it.
- Chemical energy is associated with the configuration of atoms in molecules that make up a substance. Some changes of configuration require a net input of energy whereas others cause a net release.
- When energy of an isolated atom or molecule changes, it does so in a definite jump from one value to another, with no possible values in between. The change in energy occurs when light is absorbed or emitted, so the light also has distinct energy values.
- Energy is released whenever the nuclei of very heavy atoms, such as uranium or plutonium, split into middleweight ones, or when very light nuclei, such as those of hydrogen and helium, combine into heavier ones. For a given quantity of a substance, the energy released in a nuclear reaction is very much greater than the energy given off in a chemical reaction.
- Thermal energy in a system is associated with the disordered motions of its atoms or molecules. Gravitational energy is associated with the separation of mutually attracting masses. Electrical potential energy is associated with the separation of mutually attracting or repelling charges.
- In a fluid, regions that have different temperatures have different densities. The action of a gravitational force on regions of different densities causes them to rise or fall, creating currents that contribute to the transfer of energy.
- Many forms of energy can be considered to be either kinetic energy, which is the energy of motion, or potential energy, which depends on the separation between mutually attracting or repelling objects.
- If no energy is transferred into or out of a system, the total energy of all the different forms in the system will not change, no matter what gradual or violent changes actually occur within the system.

*Project 2061, American Association for the Advancement of Science, Benchmarks for Science Literacy. New York: Oxford University Press, 1993.