<table>
<tr><td>Strand 8.1: Matter and energy interact in the physical world</td><td colspan="2">The physical world is made of atoms and molecules. Even large objects can be viewed as a combination of small particles. Energy causes particles to move and interact physically or chemically. Those interactions create a variety of substances. As molecules undergo a chemical or physical change, the number of atoms in that system remains constant. Humans use energy to refine natural resources into synthetic materials.</td></tr>
<tr><td>Standard: 8.1.5

(MS-PS1-4.)</td><td colspan="2">Develop a model that uses computational thinking to illustrate <u>cause and effect</u> relationships in particle motion, temperature, density, and state of a pure substance when heat energy is added or removed. Emphasize molecular-level models of solids, liquids, and gases to show how adding or removing heat energy can result in phase changes and focus on calculating density of a substance’s state.</td></tr>
<tr><td></td><td>Developing and using models/Using mathematics and computational thinking
Develop a model using mathematical representations to illustrate relationships between energy and matter.</td><td><u>Cause and effect: mechanism and explanation</u>
Cause and effect relationships may be used to predict phenomena in natural or designed systems.</td></tr>
<tr><td>DCI</td><td colspan="2">PS1.A: Structure and Properties of Matter
Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.</td></tr>
<tr><td>Student Friendly Objectives</td><td colspan="2">I can create a model of what the molecules are doing while adding or removing heat energy.

I can make graphs that illustrate the cause and effect relationships of particle motion, temperature, density, and state of a pure substance when you add or remove heat.</td></tr>
<tr><td>Anchor Phenomena</td><td colspan="2">Heat energy changes the state of a substance.
Why does ice feel cold and steam feel hot?</td></tr>
<tr><td rowspan="2">Vertical Learning Progression</td><td>Previous Science Content (Discussed in K-7 Standards)</td><td>Future Science Content (Discussed in 9-12 Standards)</td></tr>
<tr><td>Effect of heat energy on the state of matter. (6th grade)
Effects of heat energy on state of matter and density. (6th grade)
Determine the relationship between temperature, the amount of heat transferred, and the change of average particle motion. (6th grade)</td><td>Plasma
Sublimation or deposition</td></tr>
</table>

What students will be doing this year:	Components of the model a. To make sense of a given phenomenon, students develop a model in which they identify the relevant components, including: i. A substance in one of the states of matter (e.g., solid, liquid, gas at the macro scale) ii. Particles, including their motion. iii. Thermal energy of the system. iv. Temperature of the system. Relationships a. In the model, students describe relationships between components, including: i. The relationships between: 1. The state of the substance and the temperature of the system. 2. The motion of particles (freely moving and not in contact with other particles, freely moving and in loose contact with other particles, vibrating in fixed positions relative to other particles). in a system and the temperature of the system. 3. The density of the substance and the temperature of the system. Connections a. Students use their model to provide a causal account of the relationship between the addition or removal of thermal energy from a substance and the change in the particle motion of the substance. b. Students use their model to provide a causal account of the relationship between the addition or removal of thermal energy from a substance and the change in state from a solid to a liquid or from a liquid to a gas. c. Students use their model to provide a causal account of the relationship between the addition or removal of thermal energy from a substance and the density of a substance.