Light and Matter

Unit Overview

How does a one-way mirror work? Though most everyone knows that one-way mirrors exist, having students model how they work turns out to be a very effective way to develop their thinking about how visible light travels and how we see images. Initial student models in this light and matter science unit reveal a wide variety of ideas and explanations that motivate the unit investigations that help students figure out what is going on and lead them to a deeper understanding of the world around them.
A video of an experience with a one-way mirror, gets students to organize and write down their initial ideas and then they dig in to test those ideas and figure out what is really happening. Students build a scaled box model of what they saw in the video to test out their ideas. Using two boxes combined together with a one-way mirror in between the two, students vary the presence of light in the two boxes to figure out how a one-way mirror works and improve their initial models so they accurately explain how light is reflected and transmitted through materials and the basics of how these behaviors of light result in the images we see.

Performance Expectations

- MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

- MS-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Thermal Energy

Unit Overview

What keeps different cups or containers from warming up or cooling down? Students begin this science unit by experimenting whether a new plastic cup sold by a store keeps a drink colder for longer than the regular plastic cup that comes free with the drink. Students find that the drink in the regular cup warms up more than the drink in the special cup. This prompts students to identify features of the cups that are different, such as the lid, walls, and hole for the straw, that might explain why one drink warms up more than the other.

In this science unit, students investigate the different cup features they conjecture to explain the phenomenon, starting with the lid. They model how matter can enter or exit the cup via evaporation. However, they find that in a completely closed system, the liquid inside the cup still changes temperature. This motivates the need to trace the transfer of energy into the drink as it warms up. Through a series of lab investigations and simulations, students find two ways to transfer energy into the drink: (1) the absorption of light and (2) thermal energy from the warmer air around the drink. They are then challenged to design their own drink container that can perform as well as the store-bought container, following a set of design criteria and constraints.

Performance Expectations

- MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

- MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer

- MS-PS3-4 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

- MS-PS3-5 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.
- MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

- MS-ETS1-4 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.

Weather and Climate: Decline in the Lobster Population

Unit Overview

The overarching concept of this unit is to describe why the lobster population is migrating north when, in past years, they have been stable in New England. From there, the students study the water cycle and the reasons for each step. Then, the students learn about how different salinities and different temperatures have different densities which lead to the formation of ocean currents and wind currents. Moving forward, the students learn weather and climate are affected by different factors: sun, human activities, atmosphere, living things, and landforms. Next, water holds on to heat longer than land, creating changes in weather patterns locally and globally. Global water ocean currents allow heat to be transferred to different parts of the globe. Following that, human activities can increase the levels of greenhouse gasses in the atmosphere and therefore increase climate globally. Finally, in the last sequence, you are looking at environmental factors that influence climate. Students make sense of how Earth's geosystems operate by modeling the flow of energy and the cycling of matter with and among different systems. A systems approach is important here, examining the feedback between systems as energy from the sun is transferred between systems and circulates through the ocean and atmosphere.

Performance Expectations

- MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

- MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

- MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

- MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Disaster Movies Trailer

Unit Overview

Hollywood movies have triggered imaginations sparked by spectacular images for decades. The question is - could those images be real? In this unit students explore the line between reality and entertainment as they learn about destructive natural events that occur on Earth. Does Hollywood have it right?

Students watch disaster movie trailers making observations and creating arguments as to whether they could or could not happen. Students explore the structure of Earth looking for patterns as they analyze data, researching theories such as Wegener and Fixists. Students investigate what drives Earth's surface movement, and they make a connection between land and sea breezes and tectonic plates. Students examine the processes that change the Earth's surface both rapidly and gradually over time including tsunamis, earthquakes, and glaciers. Students read how some natural disasters can be predicted and damage mitigated. Students explore the rock cycle including weathering, erosion, and deposition. They create a design used to limit beach erosion from wave action and test its effectiveness. Then they research the uneven distribution of renewable and nonrenewable resources on Earth. Students revise their original thoughts on disaster movie trailers, explore the 1906 San Francisco earthquake, and create their own realistic disaster movie trailer.

Performance Expectations

- MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

- MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

- MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

- MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

- MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

- MS-ETS1-4 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.

Natural Hazards

Overview

This unit begins with students experiencing, through text and video, a devastating natural event that caused major flooding in coastal towns of Japan. This event was the 2011 Great Sendai or Tōhoku earthquake and subsequent tsunami that caused major loss of life and property in Japan. Through this anchoring phenomenon, students think about ways to detect tsunamis, warn people, and reduce damage from the wave. As students design solutions to solve this problem, they begin to wonder about the natural hazard itself: what causes it, where it happens, and how it causes damage.

The first part of the unit focuses on identifying where tsunamis occur, how they form, how they move across the ocean, and what happens as they approach shore. The second part of the unit transitions students to consider combinations of engineering design solutions and technologies to mitigate the effects of tsunamis. Finally, students apply their understanding to consider how to communicate about another natural hazard to stakeholders in a community.

Performance Expectations

- MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- MS-PS4-3**:** Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.
- MS-ETS1-1: 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-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.