Unit Map

Why does Ergstown keep having blackouts?

Students take on the role of systems engineers for Ergstown, a fictional town that experiences frequent blackouts, and explore the reasons why an electrical system can fail. Students apply what they learn to choosing new energy sources and energy converters for the town, and then they prepare arguments for why their design choices will make the town's electrical system more reliable.

Chapter 1: What happened to the electrical system the night of the Ergstown blackout?

Students figure out: The devices stopped working in Ergstown because they weren't able to get electrical energy from the electrical system. To convert energy to light, heat, motion, or sound, devices need to be plugged into the wall and receive electrical energy. During the blackout, the devices weren't getting this electrical energy.

How they figure it out: Students investigate several different systems, including a simple circuit powered by a solar cell. They review evidence from the blackout and make an argument about what they think caused the blackout.

Chapter 2: What makes the devices in Ergstown output energy or fail to output energy?

Students figure out: Energy isn't created or destroyed. Devices can convert electrical energy to light, heat, motion, or sound when they get electrical energy because these are all forms of energy. When all the devices were running, they caused a blackout. The devices needed more energy from the electrical system than was available. Either the town was using too many devices, or the devices were not energy efficient. If more energy is needed from the electrical system than is available, a blackout can occur.

How they figure it out: Using the *Energy Conversions* Simulation, students explore different ways to convert energy from one form to another. They consider the relationship between the amount of energy used and the amount of energy in the electrical system. Finally, students write their first argument for how to solve the problem of blackouts in Ergstown.

Chapter 3: Where does the electrical energy for the devices in Ergstown come from?

Students figure out: Electrical energy that comes through the electrical grid must have a source and a source converter. There are many possible sources, such as fossil fuels, wind, water, and sunlight. Each source has a converter that changes the energy form of the source to electrical energy. Energy use in Ergstown could have caused a blackout if there wasn't enough energy coming from the source, there weren't enough source converters to convert energy from the source, or the source converters were broken.

How they figure it out: By investigating why the hospital did not lose power, students discover a variety of energy sources that provide power to Ergstown. They read about solar devices and design and build a wind converter that can power an electrical device. They weigh the strengths and weaknesses of two possible solutions to the problem.

Chapter 4: How does energy get to the devices all over Ergstown?

Students figure out: The energy that comes from the source is transferred through the electrical grid. The devices won't function if the wires that connect the source converter and the devices are broken. This can happen if the connections between the grid and the converters aren't strong enough, if the wires aren't in a secure location, or if there aren't enough backup wires.

How they figure it out: Students review evidence from Ergstown and analyze the efficiency of various converters. They assess different improvements to the electrical system and design and present two possible "best" solutions.

Unit Map

Why is an increase in light affecting the health of Tokay geckos in a Philippine rain forest?

Working as conservation biologists, students figure out why a population of Tokay geckos has decreased since the installation of new highway lights in the rain forest. Students use their understanding of vision, light, and information processing to figure out why an increase in light in the geckos' habitat is affecting the population. Then students turn their attention to humans by designing their own investigations in order to learn more about how our senses help us survive.

Chapter 1: How does a Tokay gecko get information about its environment?

Students figure out: In order to survive, a gecko must avoid predators and find prey. To do this, geckos use structures to get information from their environment. For instance, a gecko uses its ears to hear if there is a predator nearby and its vision to watch for predators.

How they figure it out: Students do hands-on investigations with their own senses to learn that information travels to them from their environment. They read about what senses different animals use to find their food. Through a Mystery Box activity, students learn that we need light to see.

Chapter 2: How does light allow a Tokay gecko to see its prey?

Students figure out: First, light travels from a source to the gecko's prey. Then, it reflects off the prey and travels to the gecko's eyes. As it travels from the prey to the gecko's eyes, it carries information about the prey.

How they figure it out: Students use the *Vision and Light* Simulation to explore the path of light from a source to an object and to an animal's eye, a process that is necessary for the animal to see. Students confront several common misconceptions about the role of light in vision by improving inaccurate models of how light reaches the eye.

Chapter 3: How does a Tokay gecko know that it is looking at its prey?

Students figure out: Light from a source reflects off the prey and travels to the Tokay gecko's eyes. The light enters the eye through the pupil and then reaches light receptors. The light receptors respond to the light and send information from the light to the brain. The brain processes this information and forms an image. By comparing the image to memories, the gecko can recognize what it is looking at and make a decision that might help it survive.

How they figure it out: Through research in the Simulation and *Handbook of Animal Eyes*, students learn that light enters the eye through the pupil and then reaches light receptors. These light receptors respond and send information to the brain. Students return to the Simulation to investigate how a predator knows if it's looking at prey or at an animal that would be toxic to eat.

Chapter 4: How could more light at night make it hard for a Tokay gecko to see its prey?

Students figure out: When light gets to a Tokay gecko's eyes, the gecko's light receptors respond and send information to the brain. The brain processes this information to form an image. Since the highway lights were installed, there is much more light at night. Tokay geckos have light receptors that form clear images in very low-light conditions, so the extra light at night makes it difficult for them to form clear images of their prey.

How they figure it out: Students use an informational text to learn that different animals sense information in different ways due to having specialized receptors with varying sensitivities. Students use the Simulation along with a digital model to compare the vision of nocturnal and diurnal animals in differing amounts of light. They build physical models of nocturnal and diurnal eyes and use them to explain the role of light in vision and survival.

Chapter 5: How do our senses help us understand our environment?

Students figure out: By designing an investigation that only changes one variable at a time, it's possible to understand how human structures and receptors inform our senses and help us survive.

How they figure it out: Using a jigsaw approach, groups of students design, conduct, and share the results of hands-on investigations into one of three human senses: hearing, smell, or touch. The shared results of multiple investigations allow students to learn about other senses and to compare the results of multiple investigations.

Unit Map

What was the environment of this place like in the past?

Playing the role of geologists, students help the director of Desert Rocks National Park explain how and when a particular fossil formed and how it came to be in its current location. Students figure out what the environment of the park was like in the past and why it has so many visible rock layers.

Chapter 1: How did the fossil get inside the rocky outcrop?

Students figure out: A fossil is the preserved remains of an organism that lived a long time ago. Fossils begin to form when the organism dies, and sediments sink through the water to completely cover its body. More and more sediment continues to build up over the body, compacting the sediment that was already there. That sediment cements and becomes rock. This process gradually makes a thicker and thicker rock layer. Parts of the organism are preserved in this rock layer.

How they figure it out: Students gather evidence from fossils and rocks, read *Clues from the Past*, and use the *Earth's Features* Simulation to explain how fossils and rock form. They apply what they learned to create a model of the process of sedimentary rock formation. Finally, they construct an argument about what Desert Rocks National Park was like in the past.

Chapter 2: What was the environment of Desert Rocks National Park like in the past?

Students figure out: The environment was a floodplain when the lower rock layer formed and a deep ocean when the upper rock layer formed. The lower layer is made of siltstone and contains a *Lepidodendron* fossil. This is evidence that the environment was a floodplain because siltstone can form in floodplains and *Lepidodendron* lived in watery areas with a lot of plants. The upper layer is made of mudstone, and a *Mosasaurus* fossil was found in this rock layer. This is evidence that it was a deep ocean because mudstone can form in a deep ocean and a *Mosasaurus* was a large animal that swam in deep water.

How they figure it out: Students use digital and physical models to investigate how fossils and rock can be used to make inferences about past environments. They gather and analyze data from informational texts and observations as well as diagrams of an area to engage in arguments about what the area was like in the past.

Chapter 3: What is the order of the past environments of Desert Rocks National Park?

Students figure out: The siltstone layer is below the mudstone layer, which is below the shale layer. Lower rock layers form first, and new rock layers form on top of them, so lower rock layers are older than the layers above them. This means that the siltstone layer formed first, then the mudstone layer, and then the shale layer. Therefore, the environment was a floodplain first, then a deep ocean, and then a shallow ocean.

How they figure it out: Students use physical and digital models as well as analogies to discover that the lowest rock layers formed first. They obtain information from text and a digital model about which types of rock tend to form in particular environments, and they use this information to make an evidence-based argument about the order of past environments in Desert Rocks Canyon.

Chapter 4: Why did more rock layers get exposed in Desert Rocks Canyon than in Keller's Canyon?

Students figure out: More rock layers got exposed in Desert Rocks Canyon because its river is faster and has been there longer than the river in Keller's Canyon. Water can erode rock. The longer the time period that a river flows, the more the rock will erode, and a faster river can erode more rock than a river that flows slowly. Based on evidence about the speed and age of the river in Desert Rocks Canyon, this river eroded more rock because it has been flowing over the rock for a longer time and at a faster speed.

How they figure it out: Students plan and carry out investigations of the effects of water eroding rock using a model of a river as well as the Simulation. They observe that both the speed of the water and the flow of water over time affect how a rock formation can look. Students analyze evidence from models, maps, diagrams, and text to construct an argument that explains the factors that can cause more erosion in a canyon.

Unit Map

How can a mother dolphin and her calf communicate underwater when they cannot see each other? How can humans use patterns to communicate?

Working in their role as marine scientists, students figure out how mother dolphins communicate with their calves. They write a series of scientific explanations with diagrams to demonstrate their growing understanding of how sound waves travel. Then they apply what they've learned about waves, energy, and patterns in communication to figure out how to create patterns that can communicate information over distances, transferring data from one place to another.

Chapter 1: How does a mother dolphin communicate with her calf across a distance?

Students figure out: Dolphins communicate through sound. When a mother dolphin makes a sound, that sound travels away from her in a pattern of motion called a wave. The sound energy moves through the water all the way to her calf even though the water itself only moves a little.

How they figure it out: Students use models to investigate waves, read about tsunamis, and explore different sounds with a digital simulation. They create sound diagrams and, using these diagrams as a resource, create a scientific explanation of the phenomenon.

Chapter 2: How does sound energy travel through water from a mother dolphin to her calf?

Students figure out: Sound energy travels by way of water particles. The water that the sound energy travels through is made of tiny particles that are too small to be seen individually but can move a little. When the mother dolphin makes a sound, the vibration from the sound hits the water particles near her and transfers energy, which makes those particles move. Those particles collide with particles next to them and transfer their energy, which makes the next particles move, and so on. This results in a wave—a pattern of motion that occurs when particles collide (compress) and then spread back apart. When the sound wave reaches the calf, the calf hears the sound.

How they figure it out: Students investigate how sound travels through different materials using hands-on activities, physical models, and digital models, as well as information they gather from books. They create models showing how energy travels through materials. Students revise their sound diagrams and write a revised scientific explanation.

Chapter 3: How does a dolphin calf know which call is his mother's call?

Students figure out: The sound waves that the mother dolphin makes have a certain amplitude and wavelength. When the amplitude of a sound is different, dolphins hear sound at a different volume. Sound with a larger amplitude is louder. This means that if the amplitude of the sound that the mother dolphin makes is large enough, the calf will be able to hear it. Dolphins make their own signature whistles. Each signature whistle has a certain pattern of wavelengths. When the wavelength of a sound is different, dolphins hear the sound at a different pitch. This means that dolphins hear certain patterns of pitches when they hear a signature whistle. The calf recognizes his mother's signature whistle and knows to respond.

How they figure it out: Students use a digital model to manipulate waveforms and hear the resulting sound waves, enabling them to intuit the concepts of amplitude and wavelength. They read about dolphins' use of unique patterns in sound and apply their understanding as they create and recognize sounds from waveforms, and vice versa. Students revise their sound diagrams and explanations one last time so they represent their deeper understanding of how a mother dolphin and her calf communicate.

Chapter 4: How can humans use patterns to communicate?

Students figure out: There are multiple ways to transmit information across a distance, all of which involve using patterns as well as coding and decoding information.

How they figure it out: Students read about various methods of distance communication through history. They are then challenged to use a digital device to efficiently and accurately transmit a message across a distance using binary code.