Unit Map

How is it possible for a train to float?

Students are challenged to figure out how a floating train works in order to explain it to the citizens of Faraday. People in Faraday are excited to hear that a new train service will be built for their city, but concerned when they hear that it will be a floating train. Students develop models of how the train rises, floats, and then falls back to the track, and then write an explanation of how the train works.

Chapter 1: Why does the train rise?

Students figure out: A train is a big object. Objects can start moving when they are pushed or pulled on by a second object. There must be some force acting between the train and another object to make the train rise.

How they figure it out: Students plan and carry out hands-on investigations and explore text as they seek explanations for why the train rises. They discover patterns in what can make an object change motion by starting to move or stopping. They write their first scientific explanation.

Chapter 2: Why does the train rise without anything touching it?

Students figure out: When the train starts moving as it rises off the track, it does so because of a non-touching force: magnetic force. The train rises because a repelling force acts between magnets on the tracks and magnets on the train.

How they figure it out: Students gather evidence to explain how the train could rise without anything touching it. They plan and conduct investigations that help them discover that magnets can exert forces at a distance. To find out how magnetic force can make objects move, they conduct more investigations, analyze data to find patterns, and gather evidence by reading. As they figure out what they think causes the train to rise, students write new explanations and create both physical models and diagram models that represent the magnetic forces at work.

Chapter 3: Why does the train fall?

Students figure out: When the train falls, it does so because a force is acting on it. Since a second object is not pushing or pulling the train, there must be a non-touching force at work. The train falls because of the force of gravity. We know that forces always act between two objects. The force of gravity is acting between the train and Earth. Earth attracts the train, and the train moves toward it.

How they figure it out: Students figure out what they think causes the train to fall. They make observations and pose questions about gravity and gather evidence from a reference book. They design chain reactions involving touching forces and non-touching forces: magnetic force and gravity. They analyze patterns in data from the chain reaction and make diagrams modeling the forces involved. Students apply what they learned about gravity to write scientific explanations for why the train falls.

Chapter 4: Why does the train float?

Students figure out: More than one force can be exerted on the train at a time. The force of gravity is pulling the train toward Earth, and magnetic force is pushing the train up away from the tracks. Those forces work in opposite directions so when the forces are balanced, the train floats and stays in the air.

How they figure it out: Students investigate why an object might not move even when a force is acting on it. Students gather evidence to support the claim that two forces can act on an object at once. They learn about balanced forces by planning and conducting investigations with a floating paper clip and by reading about an engineer who uses balanced forces to design stable bridges. They go on to create physical models and diagrams, then write scientific explanations to describe why the train floats.

Chapter 5: Why does the train change from floating to falling?

Students figure out: When the track's electromagnet is turned off, magnetic force is no longer exerted and the forces are no longer balanced. When gravity is the only acting force, the forces on the train become unbalanced, and the train falls.

How they figure it out: Students figure out why the train changes from floating to falling. Using the floating paper clip again, they plan and conduct investigations and use mathematical thinking to discover what can make forces not balanced anymore. They apply their developing understanding of balanced and unbalanced forces, and stability and change, to read about and engage in argumentation about a new invention: a hoverboard. They also gather evidence about electromagnets from a demonstration and a reference book. Students synthesize all they have learned to explain the forces that move the train to the citizens of Faraday. They create physical models as evidence of how the train could work and then create diagram models to show the role that forces play. Finally, they write scientific explanations to answer the question *Why does the train change from floating to falling?*

Unit Map

What is the origin of the traits of Wolf 44—a wolf that appears to be different from the rest of its pack?

Students play the role of wildlife biologists working in Graystone National Park. They study two wolf packs and are challenged to figure out why Wolf 44, an adopted wolf, has certain traits. Students observe variation between and within different species, investigate inherited traits and those that result from the environment, and explain how Wolf 44 acquired certain traits.

Chapter 1: Why are wolves different from each other even though they are all the same species?

Students figure out: Even though all wolves are the same species, some wolves are different from others due to variation of traits within a species. This means that even though wolves can have similarities in their traits, there can also be variations in each trait. For example, wolves have different colors of fur: some wolves have a trait for gray fur, others have a trait for black fur.

How they figure it out: Students investigate similarities and differences between a broad array of organisms, including plants and animals. They focus on exploring patterns of similarities and differences of traits between animals, and finally narrow in on similarities and differences in organisms of the same species. By chapter's end, the class constructs an explanation about why wolves are different even though they are all the same species.

Chapter 2: Why is Wolf 44's color similar to one pack but different from the other?

Students figure out: Wolf 44's color is similar to the wolves in the Bison Valley Pack because its parents are in the Bison Valley Pack. Offspring inherit instructions for each trait from both parents. This means that the trait of fur color comes from Wolf 44's parents. This is why Wolf 44 has light-colored fur, similar to its parents.

How they figure it out: Students search for patterns in traits of parents and their offspring in wolf packs and fruit flies. They use a digital modeling tool to make sense of these relationships. They explore why offspring have similar traits to their parents, but not always to their siblings, as they read *The Code*. A lively classroom activity helps students apply the idea that parents pass instructions for traits. Students receive more information about the two wolf packs and then write a scientific explanation about Wolf 44's fur color.

Chapter 3: Why isn't Wolf 44 like the Bison Valley Pack in hunting style and size?

Students figure out: Wolf 44 doesn't hunt like the Bison Valley Pack because it learned to hunt from the wolves in the Elk Mountain Pack. Learning to hunt is a trait that is determined by a wolf's environment. Wolf 44 is medium sized because of inherited instructions and the environment it lives in. Its parents passed on instructions for being smaller in size, but Wolf 44 lives with the Elk Mountain Pack, which has access to a rich diet. This means that Wolf 44 can grow bigger than its parents, but it can't grow as big as the wolves in the Elk Mountain Pack.

How they figure it out: Students get new evidence, ask questions, and investigate with a digital app to figure out that some traits result from interaction with the environment, including learning and diet. Students write an explanation of Wolf 44's traits and whether they were inherited from its parents or acquired from the environment.

Chapter 4: How can scientists investigate questions about traits?

Students figure out: Scientists can investigate questions by looking for patterns in data. For example, data about sparrows shows that two parent sparrows have black stripes, so the offspring will probably have black stripes. The environment also affects which traits the offspring will have. The sparrow's song will be the same as other birds around it because song is a learned trait. The sparrow offspring may also be bigger than its parents because the environment has more food.

How they figure it out: Students are presented with a prediction about the possible offspring of a family of white-crowned sparrows, another organism common in Graystone National Park. Students ask their own questions and review evidence about environmental conditions, the traits of sparrow parents, and patterns and variations in a population. They analyze data from the sparrow families and discuss what they predict the offspring will look like, making claims that are supported with evidence.

Unit Map

How can learning about how grove snails survive help engineers design effective solutions to problems?

In their role as biomimicry engineers, students figure out how the traits of grove snails affect their survival in different environments. They apply that understanding as they explore other organisms, their traits, and the likelihood of survival in different environments. Students then design effective solutions to the problem of invasive plant removal using the structural traits of giraffes as inspiration.

Chapter 1: Why are the snails with yellow shells not surviving well?

Students figure out: In a specific snail population, the snails with yellow shells are less likely to survive because it is harder for them to avoid song thrush birds in their environment. Organisms are more likely to survive if they can meet their needs in their environment, and avoiding predators is one of those needs. The snails with yellow shells are less able to avoid being eaten by the birds, so they are less likely to survive.

How they figure it out: Students imagine that they are different organisms and consider whether they will be able to survive in different environments. They read a book about how earthworms meet their needs for survival and collect data in a board game to understand why organisms are more likely or less likely to survive in different environments. After analyzing data about the snails' environment, they write their first scientific explanation.

Chapter 2: Why are the snails with banded shells more likely to survive than the snails with yellow shells?

Students figure out: Snails with banded shells are more likely to survive because their shells blend in with the environment. The snails live in an environment with brown grass, so it's harder for birds to see snails with banded shells. Another reason snails with banded shells are more likely to survive is that banded shells are stronger than yellow shells. Since birds need to crack the shell in order to eat the snail, snails with the stronger banded shells are more likely to survive.

How they figure it out: Students explore variation in traits within a species and use a physical model to collect data about how different traits affect whether organisms can meet their needs for survival in their environment. They read a book about animal mouth structures and investigate fossil structures so they can make inferences about the function of these structures. Students analyze new data from the snails' environment and write an explanation about why banded-shell snails are more likely to survive. They conclude the chapter by planning a design inspired by their knowledge of grove snails' adaptive traits.

Chapter 3: Why were snails with yellow shells more likely to survive in their environment 10 years ago?

Students figure out: Snails with yellow shells were more likely to survive in the past because their yellow color was an adaptive trait in their former environment. That area used to be sandy, so the snails with yellow shells blended in against the yellow sand. When the environment changed from sandy to brown grass, the yellow color became a non-adaptive trait; it is easier for birds to see the yellow snails against the brown grass.

How they figure it out: Students receive new data about changes in the snails' environment. They engage in a classroom model to explore how the survival of organisms with different traits is affected by changes in the organisms' environment. They read about examples of environmental changes and how each change determined which organisms were likely to survive. Students create models and address the misconception that organisms can decide to change their traits. They write explanations about why snails with yellow shells were more likely to survive.

Chapter 4: How can engineers use what they learn from organisms' traits to design solutions?

Students figure out: Through the practice of biomimicry, engineers observe different organisms to understand the functions of their traits and get ideas that can help them design solutions to problems. They make a design, test it to see how well it meets the design criteria, and revise the design to make it better.

How they figure it out: Students respond to a design challenge where they apply their understanding of how structures allow organisms to carry out different functions. They read about engineers who use biomimicry to design a robot that is inspired by cockroach traits. Students then design a robot for removing invasive plants that is inspired by giraffe traits. Students plan and build design prototypes, test them with a physical model and a digital app, and revise their designs. Students present an evidence-based argument about how well their designs meet the criteria.

Unit Map

Which island would be the best location for an orangutan reserve? How can you protect buildings from damage by weather-related natural hazards?

In their role as meteorologists, students gather evidence and analyze weather patterns so they can advise the Wildlife Protection Organization on selecting one of three islands for an orangutan reserve, the one with hot and rainy weather that is most like the orangutans' natural habitat on Borneo and Sumatra. They then look for location-based patterns in weather as they figure out if it's possible to predict and/or design solutions that can prevent damage from hurricanes and other natural hazards.

Chapter 1: Which island's weather would be best for orangutans?

Students figure out: The reserve should be built on Blue Island because it had the hottest temperature and the most rain on the day that data was measured.

How they figure it out: Through reading and hands-on investigations, students figure out that weather measurements require consistent tools and measurement units so data can be compared. They engage in oral and written argumentation about weather data from Arc, Blue, and Creek Islands—the fictional islands proposed for the orangutan reserve.

Chapter 2: Which island's weather will continue to be best for orangutans?

Students figure out: The reserve should be built on Creek Island because it had the highest temperature range and highest amount of total rainfall over the month of available data.

How they figure it out: Students determine that they need a method for analyzing sets of data. As they interpret data about orangutans and read about numbers, students learn how to create and interpret line plots to find the temperature range for given locations. A digital modeling tool helps students recognize that this range represents a pattern from which they can make predictions. They analyze data to claim which island will continue to have the best weather for the orangutan reserve.

Chapter 3: Over many years, which island's weather will be best for orangutans?

Students figure out: The reserve should be built on Arc Island because one year of data reveals that Arc Island has a consistent seasonal pattern: it is warm and rainy throughout the year, while Blue Island has a dry season and Creek Island has a cold season.

How they figure it out: Students track data related to durian fruit and discover that bar graphs allow them to analyze data over time. They analyze bar graphs of temperature and precipitation for multiple years and read about the weather in two different locations to discover that places have distinct seasonal patterns and climates. A digital modeling tool activity reinforces the idea that one year of data can reveal a seasonal pattern from which long-term predictions can be made. Students apply their understanding of seasonal patterns to argue which island will have the best weather for orangutans over the long term.

Chapter 4: How can the WPO prepare for natural hazards that might damage their offices?

Students figure out: Weather-related natural hazards include blizzards, hurricanes, and lightning strikes. It's possible to implement a variety of protective measures for buildings that can minimize damage from these severe weather events. The Wildlife Protection Organization's office building in Florida has already been damaged by a hurricane. Since this area also has a history of lightning strikes, students recommend solutions that could prevent future damage.

How they figure it out: By inquiring with digital tools, maps and resources in books, students discover that there are patterns in where particular weather-related natural hazards occur. They read about solutions to prevent damage from natural hazards (backup generators, sturdy roofs, storm shutters, stilts, etc.), build and test solutions that can minimize wind and water damage from hurricanes, and recommend preparatory actions that the Wildlife Protection Organization should take when they rebuild.